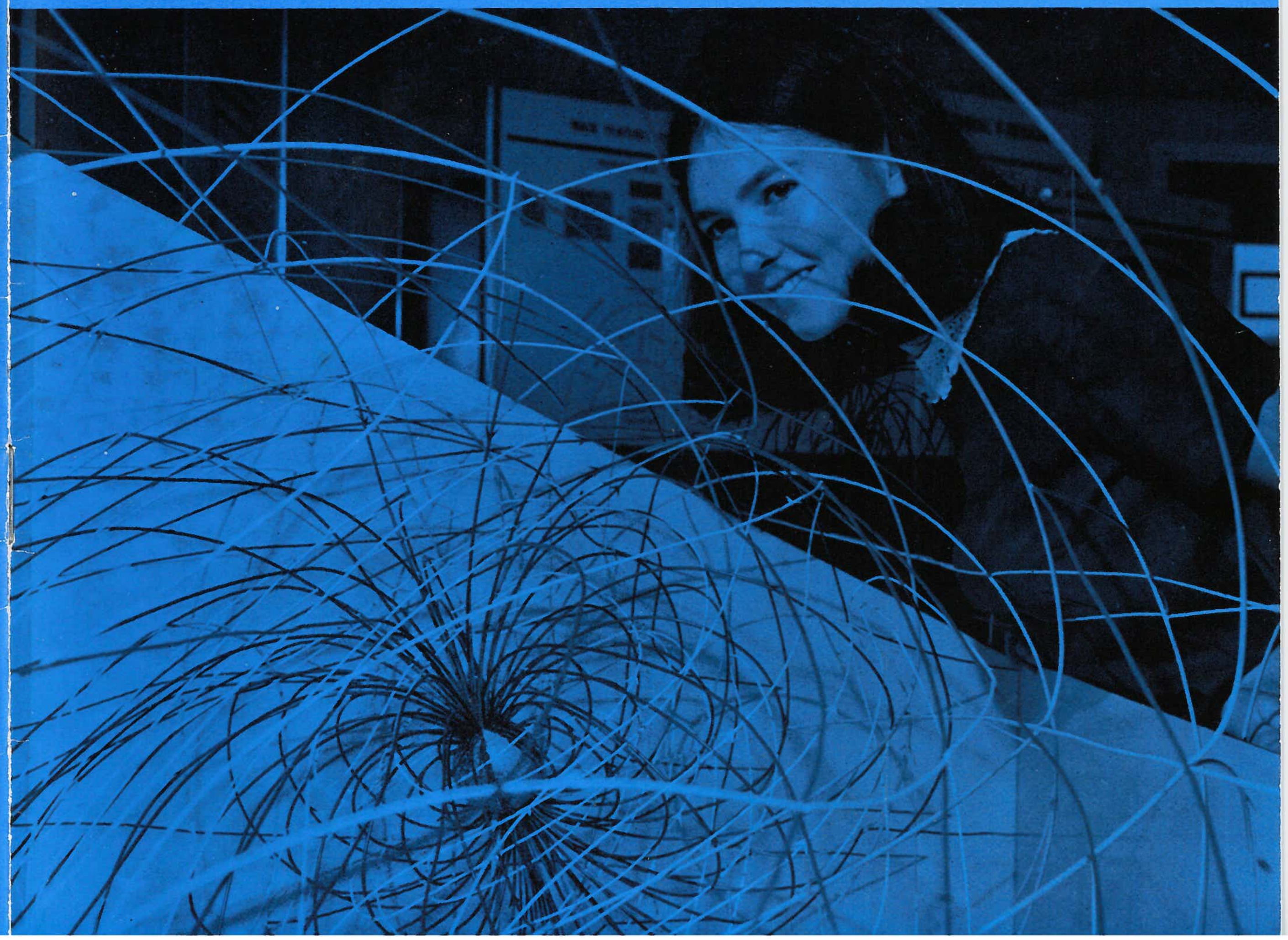
QUEST



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contents

Cover picture: Jean White magnetised by a wire sculpture which is in fact a model of the field pattern evolved in course of studying the earth's magnetic environment. It was constructed by Dr. Buckley for RSRS Open Days and is now on display in the entrance hall.

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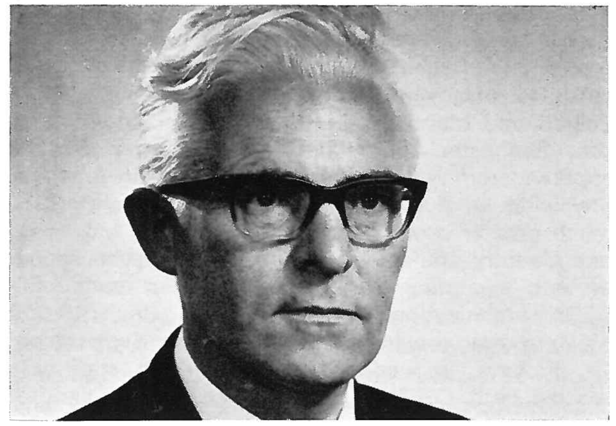
profile

Dr. Thomas Gerald Pickavance CBE



Dr. Pickavance who has the spending of £20 million a year to supervise as Director for Nuclear Physics was appointed to this new post in September 1969. Elected a Fellow of St Cross College, Oxford in 1967, a member of the Court of the University of Surrey in 1968 and of the Council of the University of Reading in 1969 and awarded a Doctor of Science Degree *honoris causa* on December 1 from the City University, London, for contributions to high energy physics at a national and international level, he first graduated at about the same time as 'nuclear' science.

In 1937 nuclear fission had not yet been discovered when he gained an Honours Degree in physics at Liverpool University and joined the team of research students under Professor (later Sir) James Chadwick to develop and construct one of the first two cyclotrons in Britain; the other being built at the Cambridge Cavendish Laboratory. The students were needed for technical rather than theoretical assistance but being practical he was happy to tackle the mechanical problems of circuit wiring and metal work. Dr. Pickavance (he gained his PhD in 1940) was also engaged on the development and use of a high pressure cloud chamber, the predecessor of today's bubble chamber, for research into cosmic rays. Work was concentrated on particles that reached down to sea level and could be examined in the University building: this being cheaper than taking equipment to a mountain top.

war service

Soon after the discovery of nuclear fission, in Germany in 1939, Government interest turned to nuclear physics because of the war and a need to look into ideas that might be exploited by the enemy. Investigations into Nuclear and other relevant properties of materials carried out at the Universities of Birmingham, Cambridge, Liverpool and Oxford were Government sponsored from 1940. At first on a small scale, support of the project, code named 'Directorate of Tube Alloys', increased as war efforts extended. In the UK research was concentrated on certain aspects as a complement to the larger USA programme which developed from 1942 onwards. Under the contract Dr. Pickavance investigated nuclear properties of very heavy elements, the separation of isotopes in uranium, and developed mass spectrometers to determine uranium's isotope enrichment.

After the war when the Atomic Energy Research Establishment at Harwell was set up to carry out research for the atomic energy programme and associated pure research, Dr. Pickavance was invited to lead a group to construct a synchro-cyclotron accelerator. Three years later a 110 inch accelerator was working at 175 Mev and, refurbished, it is still running to this day. His principal colleague was John Adams later Director General of CERN and now Director of the CERN 300 GeV Project.

'hard and competitive'

Five or six universities had facilities for nuclear or 'high energy' physics but the latest accelerators were too large and expensive to build at each one. Since research was (and is) an essential function of a university, the then Director of Harwell – Sir John Cockcroft – wanted to provide facilities on a new large national machine for university research which would remain within the tradition of the campus. This had its difficulties, later expressed by Dr. Pickavance, a strong supporter of the policy, when stating a case for particle physics on the international scale:

> *'Life around a big accelerator is very hard and very competitive . . . but life is especially hard for the visiting university scientists [who] have to spend long periods at the machine away from home and from their university . . . The more of the preparatory and analytical work that can be done away from the international centre, the more closely can the universities be involved in the work'.**

In the accelerator field the emphasis lay on collaboration; the laboratory staff gaining as much from the ideas of the campus as the visitors did from the machine and its creators.

Dr. Pickavance led the development team at AERE on the first project embodying these ideas – an accelerator of linear design intended to reach 600 MeV. An advantage of the design was that it could

* *Paper: 'Remarks on some Technical and Organisational problems of Elementary-Particle Physics'.*

be developed in stages and the energy increased with each addition. The 50 MeV first stage was under construction when the importance of the 'strange particles' discovered in the work of Professor C. F. Powell and his collaborators at Bristol and Professors Rochester and Butler at Manchester became apparent from work on large accelerators in America. Physicists in Europe had asked for accelerators of much greater power to continue research and as no one Country could afford a machine of such scope, several, including Britain, collaborated under the CERN organisation to build the 25 Gev (25,000 MeV) proton synchrotron at Meyrin in Switzerland. Dr. Pickavance was one of the British staff who worked with CERN in its formative stages, and for a time was Deputy Director of the synchrotron group on a part-time basis.

British physicists decided that they must have a machine of several Gev to provide a source of these important new particles and to form the centre of a national laboratory, complementary to CERN. A proton synchrotron of 7 Gev was recommended and the linear accelerator (PLA) was left at 50 Mev. Meanwhile University collaboration had been taken a step further. A self governing body, to be financed by the United Kingdom Atomic Energy Authority, had been established by Royal Charter. The members of the Board came chiefly from the university world and were responsible for the administration and production of large scale research facilities provided by the UKAEA for use by universities and other bodies, under the collective title the National Institute for Research in Nuclear Science – NIRNS.

advantage of a takeover

The synchrotron project was undertaken by the new Board which set up an independent foundation in 1957 – the Rutherford High Energy Laboratory – next door to Harwell with Dr. Pickavance as Director. The linear accelerator, transferred to the new Laboratory by UKAEA, provided a facility for four years before the 7 Gev Proton Synchrotron – Nimrod – was ready. Also in from the beginning were Dr. Stafford (now Director of RL) who took charge of the PLA and Dr. Willis (now in the Council Secretariat at LO) who became Secretary of NIRNS and of the Rutherford Laboratory.

The Laboratory was in full operation when it came under the Science Research Council in 1965. For nuclear physics, which had been divided for its support between NIRNS and DSIR, the reorganisation was a step in its history. In relating the subject with other sciences under a national research programme, it also gave the opportunity to extend its experience and facilities in a wider field.

Research in nuclear structure physics, into the properties of groups of particles in atomic nuclei, can be carried out at relatively low energy and this also forms part of the national programme supervised by the Nuclear Physics Board and administered under Dr. Pickavance's direction. The Board allocates the means, one-third of its present annual budget of £20 million being the British contribution to the CERN laboratory and grants support work on university accelerators and 'film analysis units' evaluating high energy physics data from bubble chambers operated at CERN and at Nimrod.

his own contribution

During the thirty years of his professional career Dr. Pickavance, like many scientists of his generation, has moved steadily (he says 'drifted') from personal participation in research to its management and administration. His fifty and more personal contributions to scientific literature with colleagues at Liverpool, Harwell and Chilton have been on radioactivity and nuclear structure, high energy physics during its earlier stages as a subject in its own right, particle accelerators and, more recently, articles and chapters in books on the organisation of research.

A daughter and a son through university, (at Birmingham) and another son just started (at York) gave Dr. Pickavance another look at the system from a student's point of view although not one of his children is a physicist. His daughter is a biochemist engaged in cancer research and intends finally to become a schoolteacher, having taught in Malawi for eighteen months under the VSO scheme. His wife teaches mathematics – they met as undergraduates at Liverpool – and sings in a music society choir in Abingdon where they lived for ten years, and where many of their friends are, before moving to Oxford ten years ago.

Their musical interests are shared by their elder son who plays the trumpet and the younger who prefers the piano and french horn; now reading history he also revived another interest of his father's in taking up photography and film processing. The elder having inherited practical abilities is a civil engineer working on the M1–M6 motorway link which is relevant to one of his father's main interests and relaxations – driving fast cars. Dr. Pickavance likes to drive anywhere and everywhere, whether on family holidays in Europe or to northern universities.

Until recently he went in for speed with a succession of second-hand Jaguar cars but the seventy mile limit, he says, put a check on his performance and he now drives less exciting machines. Nevertheless one imagines he must go well on a motorway, after all who would know better the principles of acceleration.

guest column

A contribution from Robert C. Cowen, Natural Science Editor of the Christian Science Monitor.

rich pool of talent

To an American science writer the mission of the Science Research Council seems a paradox. Here is that bugaboo of American scientists, a single source of support for most of basic science. Were such an agency to arise in America, where diversity of funding helps guarantee research freedom, we'd be forever suspicious of favoritism and political discrimination. Yet in Britain it works.

Indeed, it is a bulwark against those very evils an American might expect it to engender. I don't mean to imply there's no fault in the system. Watchdogs like *Nature* Editor John Maddox find plenty to criticize. But corruptive misuse of power is no part of it.

Maybe that's one of the reasons writers like me find it so refreshing to poke about in SRC labs and the labs of grantees. I began doing it in 1952 in the grand old days of DSIR. A tour of the establishment then took you from the cosmic perspective of radio astronomy to the practical focus of industrial research associations, whose directors often bootlegged basic research on the side. ('It's really the most interesting thing to do.')

In those days, two disadvantages stood out – a general paucity of equipment and the stranglehold on opportunity maintained by the 'old boy' system. In single-chair university departments and highly structured laboratories, young scientists worked for a pittance. Often they looked forward to many dreary years before emerging into responsible positions. Who could blame them for going down the brain drain?

It's been gratifying to watch these disadvantages dissolve. In spite of its economic problems, Britain has done very well by science. With the budget cutback in the US, there are a lot of young American scientists who would like to brain drain to Britain.

a potent system

So why, as I go around SRC establishments, do I still hear the old refrain of 'how much more we could do if we had money like you have in the States'. I know self-deprecation is a national habit. And of course the absolute level of funding is important to a nation's scientific strength. But I think the Anglo-American money gap is irrelevant. Britain has built a potent basic research system. And it has built into it an integrity American scientists envy.

There's the moral integrity of a system that would abhor black lists of politically annoying scientists such as the US Department of Health, Education, and Welfare has kept. There's the integrity of purpose of a system of civilian funding that integrates science into the national budget on a rational basis.

American science funding is an uncoordinated mix of civil and military money that leaves responsibility for a healthy overall science program undefined. As funds are cut across the board, no one sees to it that a well balanced research spectrum is maintained. What's worse, mission orientated projects, especially secret military work, have distorted the pattern of academic research. Many American universities now suffer corporate agonies as they try to rationalize this pattern under heavy student pressure. As Sir Brian Flowers put it in a recent interview with The Christian Science Monitor, secret military research on campus can be 'unhealthy for the universities and for the public.' American scientists are learning this the hard way.

free discussion

This basic integrity of their science-support system is one of the most valuable assets British scientists have. SRC exemplifies this quality which colors what I see in visiting its projects.

In touring the labs for nearly two decades, I've always been received with courtesy. But often also there's been that curious diffidence British scientists feel towards the press – 'Will he get it right? Will he jazz it up and make me look foolish?' In the States, we've broken down such diffidence to a large extent partly through continued, organized contact between scientists and writers.

Each year, for example, we hold a number of seminars at which scientists brief the writers on specific fields. These usually take a day for formal presentation and free discussion. Usually they're sponsored by science writers and by a professional society such as the American Institute of Physics. They's paid for by private sources or by the Federal Government through the National Science Foundation as part of a commitment to promote public understanding of science. Over the past decade, this kind of seminar has done much to raise the standard

guest column continued

of science presentation in print and over television. It has fostered mutual understanding between writers and scientists.

Might not SRC benefit from sponsoring similar seminars? A day, or even an afternoon, in which, radio astronomers say, briefed the press on their field could pay off in more accurate presentation and better public appreciation of science.

Certainly, SRC has a rich pool of talent among its staff and grantees from which to draw. It's been a privilege and pleasure to meet some of them over the years. I want to thank them all for hospitality to a science writer who often intruded at busy times and I'm especially grateful to the press officers who make my visits to Britain seem a little like coming home.

£1M A YEAR FOR ATOMS MOLECULES AND PLASMAS ++ BEST DATA YET FROM SKYLARK SPACE PROBE IN SOLAR ULTRA-VIOLET SPECTRUM ++ SYMPOSIUM ON ELECTRON AND PHOTO INTERACTIONS ++ £59,000 HARDWARE FOR MULTI ACCESS COMPUTER SYSTEM ++ BRITISH EXPERIMENT IN ORBITING SOLAR OBSERVATORY O[illegible]-G ++ FIRST LUNAR SAMPLES FOR BRITAIN ARRIVE AT SRC ++ [illegible] SRC GRANT FOR CONTROL ENGINEERING RESEARCH ++ ANGLO-AUSTRALIAN TELESCOPE CONSIDERABLE CONTRIBUTION TOWARDS SCIENTIFIC DISCOVERY ++ RSRS PARTICIPATES IN UK4 SATELLITE TO MEASURE INTENSITIES OF ELECTROMAGNETIC RADIATION ++ DEVELOPMENT IN ANALYSIS OF BUBBLE CHAMBER PHOTOGRAPHS BY SWEEPNIK AIDED BY SRC GRANT OF £40,473 ++ SUCCESSFUL LAUNCH OF

council commentary

There is not usually a Council meeting in September, but this year a week-end conference was arranged at the AEA conference centre, Durley Hall, Bournemouth on September 26th–28th. Fourteen Council members and assessors, eleven other representatives of the Boards, and sixteen of the staff took part. On the Saturday the support of research and postgraduate training awards was discussed in two very full sessions during which many ideas were put forward and debated. Four stalwart recorders, a glamorous but strictly part-time hired typist and a highly temperamental duplicating machine helped in getting out notes on these sessions which the conference revised and approved on the Sunday morning. This record contains much material to be worked up with further study into specific proposals to be put to the Council and Boards later. Also on the Sunday morning domestic matters were discussed, and in particular the details of the reorganisation of the Boards and the London Office, which was to take effect two days later.

The October meeting opened with a welcome to a new member, Dr. D. S. Davies, General Manager R & D of ICI Ltd, and new assessors: Mr. N. Coles for the Ministry of Defence and Mr. R. L. Lickley for the Council of Engineering Institutions. The Chairman and Professor Wilkinson then gave a moving appreciation of the late Professor Cecil Powell.

The Council cleared up several items of business from the vacation, noting what the Chairman had needed to do under his emergency powers, and approving some further details of the new Board structure, which had come into effect on 1st October. The outline draft Estimate for 1970/71 was then considered and approved, the Chairman being invited to prepare the final submission on the lines proposed. The Staff Side's memorandum on the 300 GeV project was considered again, together with observations submitted by the Nuclear Physics Board; a reply was subsequently sent to the Staff Side on the Council's behalf.

The Council received status reports on the high-flux beam reactor proposal and on the UK/USA collaborative satellite programme, and approved a number of capital items: a 'Galaxy' plate measuring machine for the RGO, as developed for the ROE, an expansion of the Daresbury central computer, a heavy laboratory at Daresbury and a small hostel also at Daresbury. Finally, the panels of the NP Board, which will in future be re-named Committees, were granted delegated authority to approve grants up to £20,000.

At the November meeting the major item was a first discussion of the preparation of the financial forward look for 1971–76, and in particular the guidance to be given to the Boards for the preparation of their proposals for this period. One aspect of the forward look that was particularly discussed was scientific manpower policy, and the need to find out more about the numbers that the universities and industry were likely to need, and about the scope in industry for scientists and engineers with various different forms of postgraduate education.

Another topic in November was the improvement of school science education. While this is mainly outside the Council's responsibility, members are anxious to help wherever possible, and some suggestions were made.

A new PDP-10 computer was authorised for nuclear physics work at the Kelvin Laboratory, University of Glasgow. The Council received a report on difficulties in the development of the S/68 experiment for ESRO satellite TD1, in which the universities of Edinburgh and Liege are collaborating, and endorsed the emergency action which the Chairman had taken to reduce the resulting delays. Among formal items in November, the accounts for 1968/69 were presented for information.

After the meeting, the Council saw 'Insight', a new educational film on the SRC which had just been completed, and several members commented favourably on it.

Rutherford Laboratory seen from the North-West, Nimrod lies below the grass covered mound at bottom centre; the large building on the right is the new Experimental Hall 3.

research at Rutherford

part 2

'nimrod the mighty hunter'
(Genesis X, 9)

In Part 1 of this article (in Quest, July 1969) we saw how and why the Rutherford High Energy Laboratory was formed. The design, construction and commissioning of Nimrod was described and the story taken up to 1964. This second and final part reviews the progress during the past five years.

In 1964 the Trend Committee's Report on the organisation of civil science recommended the extension of the Research Council (or Haldane) principle, whereby pure research is carried out by Government funded but otherwise autonomous bodies, free from short term parliamentary and departmental control. Most of the Trend Committee's proposals were given effect by the Science and Technology Act 1965. This made provision for the setting-up of the Science Research Council with responsibility for a number of research activities and establishments some of which had belonged to Civil Service Departments, and some to the National Institute for Research in Nuclear Science (NIRNS) to which Rutherford Laboratory belonged. NIRNS was dissolved, though several members of its Governing Body now sit on the Council or on its Boards and Committees. The SRC also become responsible for the UK contribution to CERN, resulting in better co-ordination of this country's support of nuclear physics research.

plans for research

Meanwhile, back at the Laboratory the first elementary particle physics experiments were getting under way on the recently inaugurated Nimrod. As at other laboratories, the experiments which are allocated machine time form a carefully planned research programme. It is usual for a proposed experiment to be scrutinised in detail before being accepted to ensure that it makes good scientific sense in the existing state of the subject. Theoreticians in the elementary particle field continually try to correlate existing experimental results by devising models, which ideally should be simple and based on as few assumptions as possible. In practice, due to the complication of the phenomena in this field, theories are far from simple. To be of use, a theory must not only correlate existing knowledge it must make predictions which can be experimentally tested so as to decide between two or more alternative models. In real life the situation is seldom so clear cut. Very few experiments are definitive, giving an unequivocal yes/no answer, and in the short term high energy physics sometimes seems to expose more problems than it solves. But when examined over a period of years there is definite progress to which the RHEL has made significant contributions.

High energy physics was defined in Part 1 as being the study of the properties and interactions of the elementary or fundamental particles. To be more specific, the phenomena investigated include the details of the strong interaction which binds together the nucleus in the nuclens and of the weak interaction which governs the decay of unstable particles. In the latter case, much interest has been shown over the past ten years in invariance or symmetry principles, that is to say whether a physical process looks the same if seen in a mirror, or if all the particles taking part are replaced by anti-particles, or if the direction of time were to be reversed. Several such experiments have been carried out on Nimrod in the past few years, since the results could have far-reaching consequences affecting our basic ideas on space and time. There is also considerable interest in precise measurements of the mass and other properties of particles and resonances (the distinction is becoming more and more nebulous). This basic data is needed to test various suggested classifications or groupings (e.g. the octets and decuplets of the highly successful SU (3) theory).

Before describing a few experiments let us outline some experimental techniques. These are usually divided into visual or electronic methods, depending on whether the data emerges as pictures or electrical signals. Recently the distinction has become less clear-cut but operational and data processing considerations are still different in the two cases.

particle pictures

The longest established visual method still in common use is the bubble chamber, in which the paths taken by charged particles are made visible as strings of tiny bubbles. By careful control of the temperature and pressure of the liquid with which the chamber is filled, boiling can be caused to take place preferentially along these paths; the tracks are quickly photographed by stereoscopic cameras, yielding pictures from which any interesting collision can be reconstructed in three dimensions. As an aid to particle identification a magnetic field is applied to the chamber to bend the particles by an amount dependent upon their momentum. The chamber filling can be one of a number of liquids. Liquid hydrogen (bringing with it problems of cryogenics and safety) is the most popular since the struck particle in a collision is bound to be a proton. However the lightness of liquid hydrogen makes it inefficient as a detector of gamma-rays which frequently arise, directly or indirectly from the interactions being studied. A denser liquid can be used to overcome this difficulty but then the identity of the target particles are subject to doubt. An ingenious compromise, recently demonstrated at the Rutherford Laboratory, is to have two chambers, one inside the other. The central region contains pure hydrogen and is separated from the outer region, which contains a much denser hydrogen/neon mixture, by a thin perspex wall. Tracks can be obtained in both liquids simultaneously.

Bubble chambers are very useful for the broad survey type of experiment, in which one must be prepared for, and instrumentally unbiassed against, the unexpected. The major disadvantage, which can be partly overcome by using counters to control picture-taking, is that only quite low incident beam intensities can be used. This limits the data acquisition rate. Another complication is the necessity to process and examine many miles of film although the examination and measurement phase has been extensively automated by using complex track-recognition devices on-line to the Laboratory's IBM 360/75 main computer.

spark chambers and counters

Electronic detection methods embrace all those devices called counters which give an electrical signal when a particle passes through, the signal strength often being related to the particle's energy or velocity. The most common is the scintillation counter, where the passage of the particle through a special substance gives a flash of light which is converted into an electric pulse by means of a photomultiplier tube. These tubes are also used in Cerenkov counters which operate on a different principle and which can be arranged so that a pulse is emitted only if the particle velocity exceeds a certain threshold value.

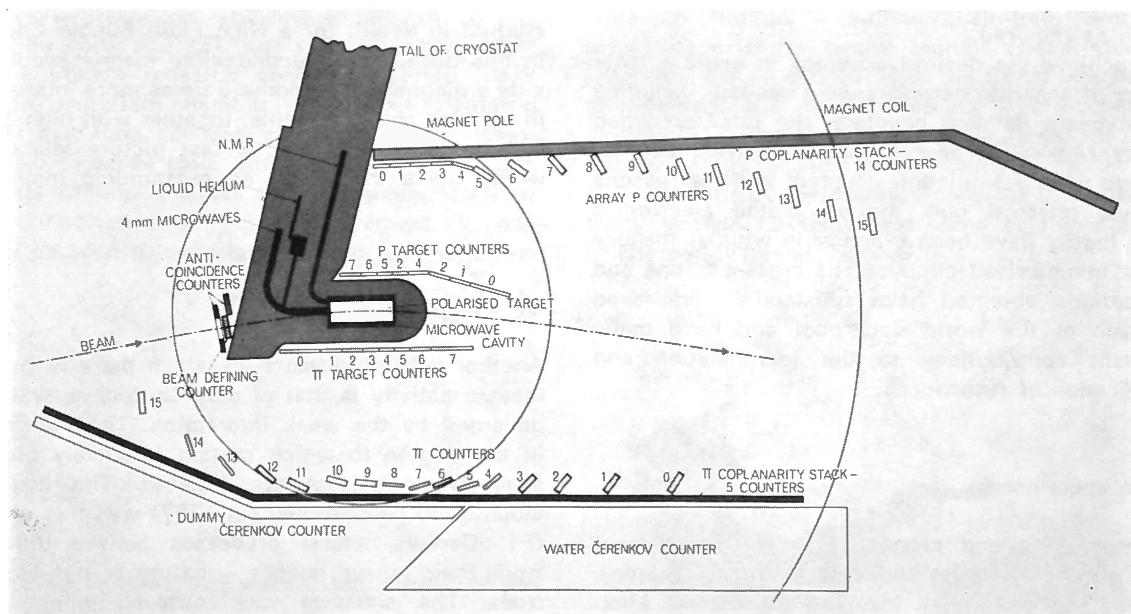
Spark chambers fall into an intermediate category; they can be regarded as visual or as electronic depending upon how the information they provide is extracted. In all types, a spark occurs between suitable electrodes when a particle passes through. It is possible to determine the position of the spark (and hence, for instance, deduce an angle or a distance) with considerable precision. This may be done purely electronically (by magnetostrictive or acoustic methods), purely visually (by stereoscopic photography, followed by film measurement by methods broadly similar to those used for bubble chamber pictures) or by a hybrid method in which the sparks are viewed by Vidicon TV cameras which provide

electrical signals related to the position of the spark.

Counters and spark chambers are used in experiments in which particular reactions or decays are to be studied. It is possible to define a particular type of event by specifying that one group of counters must 'fire' while another group do not; this is done by means of fast electronic logic circuits. Data acquisition is much more rapid than with bubble chambers. More accurate data can be obtained especially in the case of rare events for which bubble chambers cannot be made anywhere near as selective.

A typical experiment would take two to three years from formulation of the proposal to publication of the final results. During this period up to a dozen people would spend most of their time on this one investigation. In many cases the team would be a collaboration between one or more universities and resident Rutherford Laboratory physicists, the participants sharing in the various phases of the work, namely design, construction and assembly of equipment, setting up and data collecting on Nimrod, and data analysis. The data collection phase involves manning the apparatus round the clock since the demand for beam time is such that Nimrod runs twenty-four hours a day as well as providing beam for several experiments simultaneously. A large fraction of the experiments that have been carried out on Nimrod involve the measurement of cross-sections (i.e. the probability of occurrence) for a variety of interactions. Counter techniques have been used to study the elastic scattering of positive and negative pions and kaons from protons, and also the polarization (dependence on spin direction). The quantities measured depend on the energy of the incoming particle and also on the angles at which the resultant particles are detected. It is therefore necessary to make measurements at closely spaced intervals of both angle and energy in order to detect any fine structure that may be present. The distribution in angle can be analysed in terms of partial waves (broadly similar to the breakdown of a waveform into fundamental plus harmonics), and the occurrence of peaks in the resulting curves indicates the presence of resonances (short-lived compound states of the particles involved). The mass, spin and other properties of the resonances can be deducted and compared with theoretical predictions.

Figure 1 Plan view of counters mounted round the polarised target (see text below)



polarization

A number of recent experiments of this type have been carried out using a polarized target. When protons are the struck particles, the usual target chosen is liquid hydrogen because it contains no other particles, the effects of which would have to be measured separately (or estimated) and subtracted out. However the spin directions of the protons in liquid hydrogen occur at random, and if the spin directions of the incoming particles are also at random any spin dependent effects will be averaged out and will be unobservable. It is sometimes possible (as on the PLA) to polarize the beam. This is not practicable on Nimrod and the target

research at Rutherford continued

protons must be polarized instead. The protons are contained in the water of crystallisation of lanthanum magnesium nitrate single crystals, and the polarization is achieved by utilising the 'solid effect' to preferentially populate one spin state. This involves the use of very low temperatures (in the 1°K region), microwave power at 70 GHZ (4mm wavelength) and highly homogeneous strong magnetic fields. The majority of the target particles are not free protons and thus give rise to background events. These can be eliminated by noting that in an elastic collision the energy and angle of the scattered and recoil particles are inter-related on account of energy and momentum conservation. In addition the incident particle and the two outgoing particles are co-planar. If the energy and angle of both outgoing particles is measured, an electronic logic circuit or a computer program can be used to decide whether the target particle for each individual scattering was a free proton, as required.

To achieve the desired accuracy in angle a large number of separate detectors were needed; including special beam defining counters, the total exceeded seventy. *(A plan is shown at figure 1)* The vast majority of these were scintillation counters and for reasons of sheer physical bulk the associated electronics would hardly have been practicable without the use of fast miniaturised circuits. The cross-sections and polarizations obtained have substantially improved the state of the world data pool and have made important contributions to the identification and classification of resonances.

hadron spectroscopy

The production and properties (other than decay) of the class of particles known as hadrons (nucleons, mesons and hyperons) involves the strong interaction. The study of the energy levels of this system of particles is known as hadron spectroscopy by analogy with spectral studies in and around the visible region which led, some fifty years ago, to the Bohr model of atomic structure. Unitary symmetry schemes, such as SU(3), have achieved considerable success in inter-relating the properties of the many particles and resonances and there are signs that the elementary particle analogue of the Bohr model may soon be formulated. Hadron spectroscopy is a fruitful field of research for bubble chambers, which in some respects are better suited to interactions in which the final particles differ from the initial ones, than are electronic techniques. Reactions that have been studied include those in which cascade, sigma and Lambda hyperons are produced. Recent work has shown the need for an order of magnitude increase in the precision of measurement in order to resolve closely spaced levels. This is one of the major reasons for the proposal, currently being studied in detail, for a High Field Bubble Chamber. In this device a superconducting magnet would provide a magnetic field some 6 times more intense than in existing chambers; this, together with high quality stereoscopic optics and a fast picture taking rate, would make the HFBC an outstanding instrument.

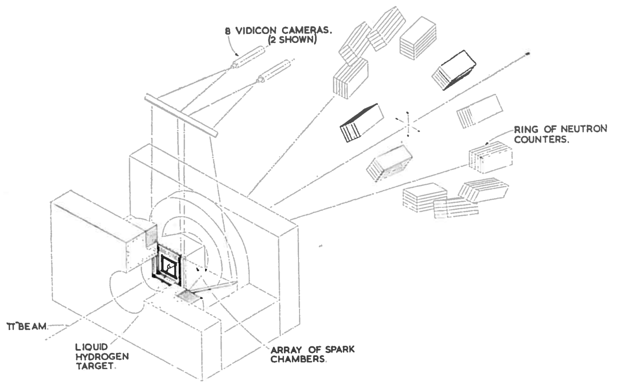


Figure 2 Apparatus used in the search for c. violation in eta meson decay.

CP violation

Another field of research in which there is currently intense activity is that of particle decays, which are governed by the weak interaction. The interest lies in the degree to which certain intuitively plausible symmetry principles are violated. The first such violation to be observed (in 1957) was that of parity (P). Certain natural processes behave differently from their mirror images – nature is not ambidextrous. The situation was retrieved when it was realised that one ought to expect reversability only if, in addition to reflecting processes in a mirror (changing the sign of spatial co-ordinates), one also changed all the particles involved into their antiparticles. This is CP symmetry which survived until 1964, when it was overthrown by some measurements in the USA on the decay of the long-lived neutral kaon (K^0_2). If CP symmetry is strictly obeyed in this process, decays resulting in two pions should not be observed. In fact, about 1 decay in 500 was seen to result in a $\pi^+ \pi^-$ pair. This important result was soon confirmed by independent experiments, one of them at RHEL. Here the momentum and angle of the decay products were measured by means of a magnet and spark chamber system. A number of theoretical explanations of this CP violation had been advanced, the RHEL work eliminated a few of these,

but additional evidence was needed. It was decided to study the closely associated decay of the K^0_2 into two neutral pions. This is a technically much more difficult experiment; the neutral pions can be detected only when each one decays into a pair of gamma rays and the measurements have to be made against a background resulting from the 100 times more frequent decay into $3\pi^0$ (giving six gamma-rays). CP violation was again observed, but the underlying reason still remains unknown.

research in decay

One possibility is that C violation might be occurring and a convenient test of this hypothesis is to study the decays of eta mesons. One of the decay modes of this particle results in three pions – one positive, one negative, one neutral. If C violation occurs it will show up as a difference in the energy spectra of the two charged pions. The first experiment of this type to be done at RHEL was a collaborative effort with the French research centre at Saclay. Their hydrogen/deuterium chamber was brought to Nimrod since at that time our own similar chamber was at CERN. No evidence for C violation was found within the limits of experimental error. However, in view of the importance of this measurement, it was recently decided to undertake another experiment on the 3 pion decay of the eta, this time using electronic techniques. The eta mesons are produced by allowing negative pions to strike a liquid hydrogen target; neutrons are produced in this reaction and are detected by means of suitable counters so as to prevent the recording of particles from other pion-proton reactions. The eta meson decay pions are detected by means of a spark chamber array suitably disposed in the 1 metre gap of a large, specially designed electromagnet *(as shown in figure 2)*. The positive and negative pions are bent opposite ways, and the radii of curvature enable the energies to be deduced.

This experiment is one of the first two to be mounted in the new Hall 3. The acquisition of the hall has doubled the floor space available for experiments and beam line equipment. New facilities such as this, and the continual evolution of better detection and data handling techniques, inject new life into accelerators. There seems little likelihood of running out of worthwhile experiments that can be done on Nimrod – outline beam-time allocation schedules exist for twelve months ahead. Nor will Nimrod suffer an eclipse when the CERN intersecting storage rings and the proposed 300 GeV machine are operational – there are many experiments for which a lower energy machine is better suited.

In the forest of elementary particles there are still many strange beasts within range of the slingshot of our mighty hunter, Nimrod.

rare books

Here are some titles that do not yet appear on the Library shelves:

A Million Gone—*Ida Grant*
Just a Quark—*Vera Littel*
Diamonds on the Moon—*R. U. Shaw*
Green Cheese—*Ann Akronism*
Quasars There Be—*I. Erdham*

Of special local interest are:

Bouncing on the Ceiling *by Ray Dios*
Most Celestial Tla'ksin—*Sin Ka Por*
Judgement for Solomon—*O. Port-Stanley*
On a Braw Bricht Moonlicht Nicht—*R. O. Esau*
Stars in Reflection—*Ivor Mote*
Hope to Heaven—*I. C. Staars*
The Sky Beneath—*A. A. Tee*
Ever Straight and Narrow—*P. L. A. Stoppt*
Fastest for Least—*Axel Erater*
Nina and Frederik's Folk Songs for Lost Electrons

Your Money for my Science *by N. E. Chairman*

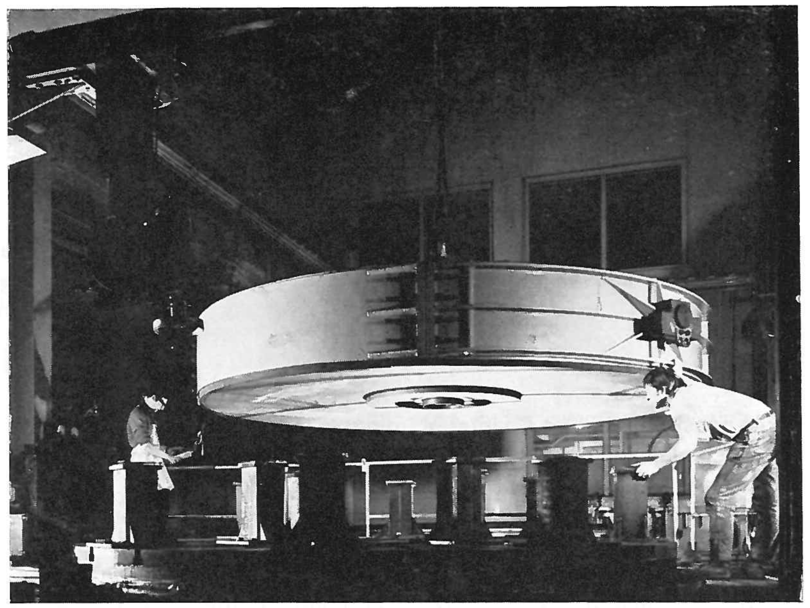
Also recommended

Circulation Restricted *by A. Garter*
Heads Together—*G. P. See*
Do Thou Likewise—*C. C. E. Emms*
500 Today—*B. A. Dear*
At Length Approved—*Sean Lamb*

Acknowledgements are due to the scribes of the SRC conditions of employment who helped to compile this unique list.

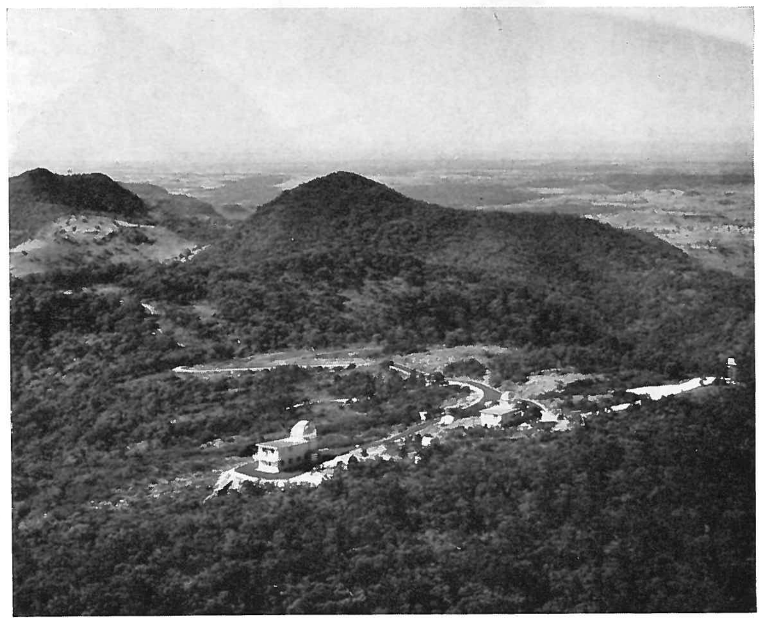
quest photo feature

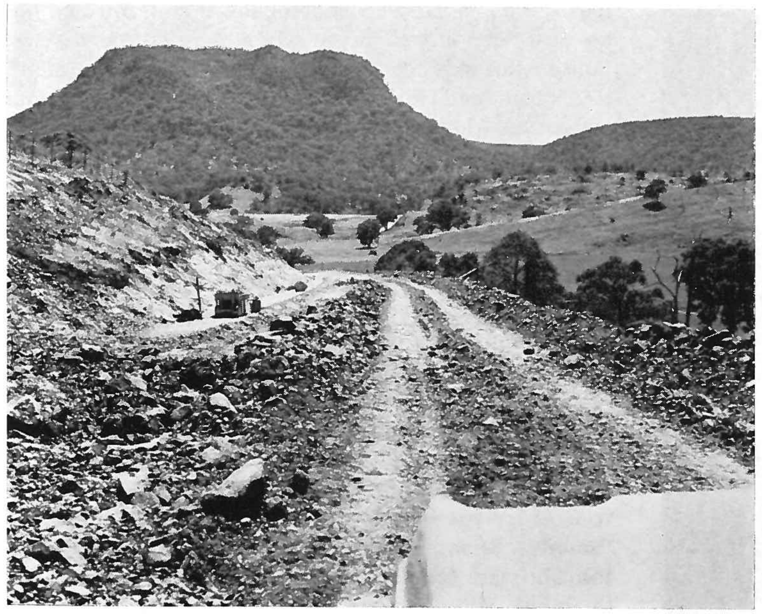
Anglo-Australian 150 inch telescope



Shown above is the 155 inch mirror blank for the Anglo-Australian telescope. It is the first telescope mirror of anywhere near this size to be made in the new low-expansion glass ceramic cer-vit material. Cast in America by Owen-Illinois of Toledo, Ohio, it is now with a British firm Sir Howard Grubb Parsons of Newcastle upon Tyne, who gained the contract for grinding the mirrors against international competition.

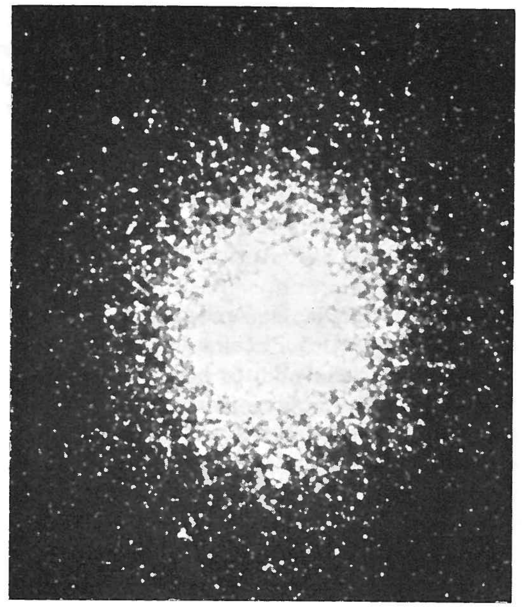
Since the disc was first cast, several tons of material have been removed to produce the shaped mirror blank. When it leaves Grubb Parsons in two years' time the dimensions and weight will have changed very little but the accuracy of the surface will be ten thousand times better. Work will be done on the same machine which was used to grind and polish the 98 inch mirror of RGO's Isaac Newton telescope.

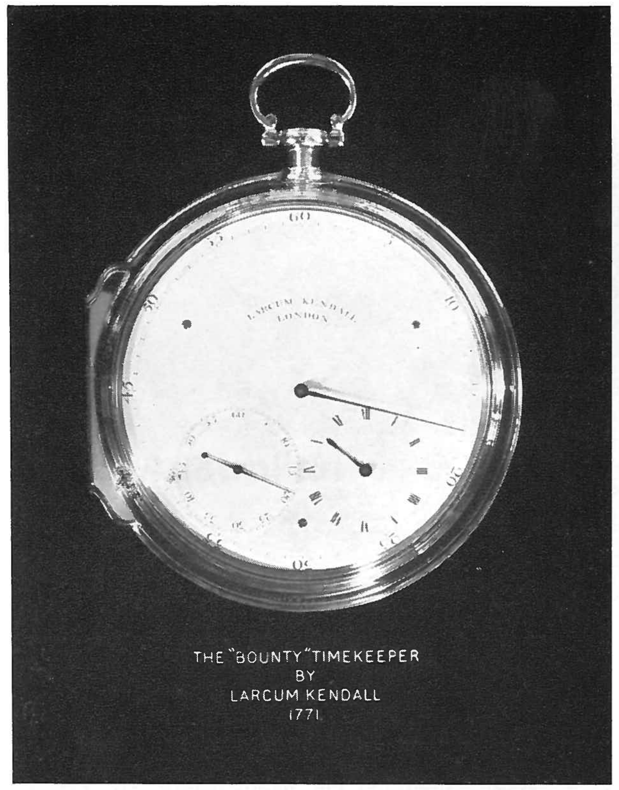




The site of the telescope is close to the Observatory of the Australian National University *shown on opposite page.* The place is Siding Spring near Coonabarabran in New South Wales, on the edge of the Warrumbungle National Park.

The Science Research Council is responsible for the British share of this £4.4 million project, financed jointly by the United Kingdom and the Australian Governments. Early stages of the construction of the approach road to the site are *shown in the picture above.* A travelling exhibition of photographs and plans of the telescope project is to be shown at each SRC establishment. *In the picture below left* Mrs. H. Lennon and Mr. N. Bence of RSRS look at a model of the telescope which was made (in his spare time) by Richard Harris of ASR Division. Behind them are pictures of star clusters and plans of the project. *Below right* is an enlarged view of the globular cluster M.13.





THE 'BOUNTY' TIMEKEEPER
BY
LARCUM KENDALL
1771

watch for mutiny

Alex Morrison

'Don't let him have it!' The shout came from the group of men crowded at the stern of the squat little wooden ship. 'Don't give it him. He'll have us all hung!' The shout was repeated and curses were directed at the small, heavily laden boat as it swung astern the ship.

The men in the boat appeared to have dressed hurriedly, and an air of apprehension hung over them. A sturdy, slightly portly figure stood in the sternsheets, and it was at him that most of the abuse was flung.

Captain William Bligh of His Majesty's Armed Transport 'Bounty', was begging for his chronometer before being cast adrift by the mutineers.

The date was 28th April, 1789.

*

In February, 1808, an American whaler 'Topaz' put in to the island of Pitcairn in search of seals. The island was believed to be uninhabited and the master, Mayhew Folger, was surprised to see a small boat putting out, manned by a couple of dark-skinned youths. They clambered nimbly aboard and the amazed Folger had no difficulty in understanding their speech which he thought to be a strange sort of English. They explained that their father was ashore and had a story to tell which would interest him. Folger agreed to accompany them. On landing, he was conducted to a white-bearded patriarchal figure who embraced him warmly with great emotion. He introduced himself as John Adams, one time known as Alexander Smith, and the sole survivor of the 'Bounty' mutineers.

Folger heard for the first time the story of the 'Bounty' wanderings after the mutiny. He heard of the drunken orgies, murder and violence which finally culminated in the massacre of the white men – Adams, though badly wounded, being the sole survivor; then how the native women had risen and killed the Tahitian men and had nursed him back to health. He was now the sole male adult on the island.

Adam's story came quietly and easily. He was obviously relieved to unburden himself after those eventful twenty years. He told how, in thanksgiving to God for sparing his life he had, with the aid of the 'Bounty' Bible, converted the heathen islanders to the Christian faith. Folger looked around at the faces of those who had gathered during the harrowing recital and could sense the great affection in which Adams was held in this little community.

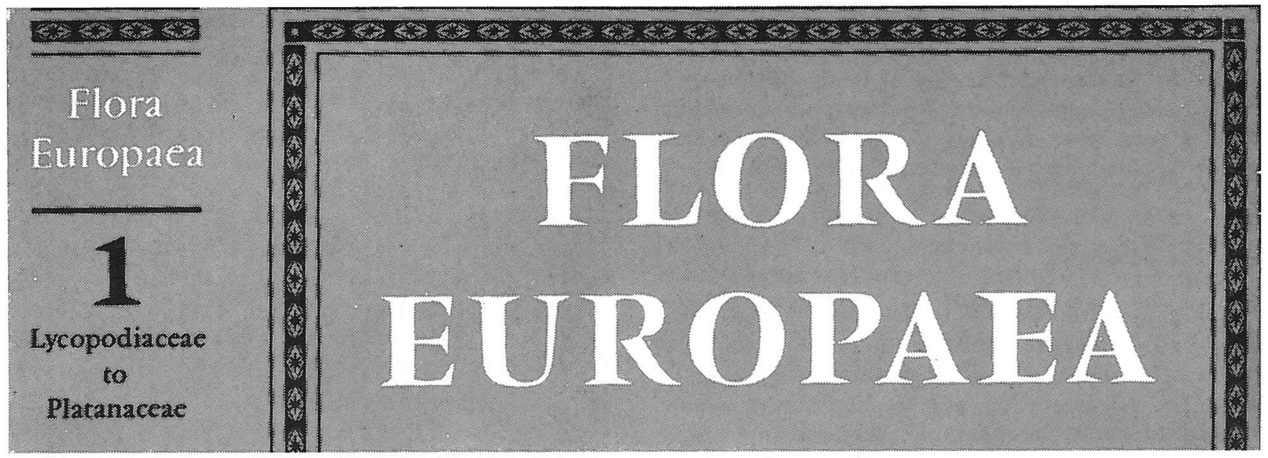
Finally, to confirm his amazing story, Adams handed Folger the 'Bounty' chronometer. This timekeeper had been salvaged from the boat with other valuables before she was burnt at the cliff edge to prevent detection by searching British warships.

The travels of the chronometer were not yet finished. Later on, Folger claimed, it was taken from him in Chile and after passing through various other hands it apparently appeared in a ship chandler's store in Valparaiso. There it was bought by Alexander Colclough who sold it to Captain Thomas Herbert for the sum of fifty guineas. His descendants later presented it to the Royal United Services Institution and when this was closed the chronometer was given to the National Martitime Museum.

Before this last and – we hope – final move it was sent to the Chronometer Department of the Royal Greenwich Observatory to be fitted with a stand for public viewing.

I had long been interested in 'Bountiana'. I had seen the original receipt for the chronometer signed by William Bligh in the Archives of the Observatory and then, in January 1964, I had the great privilege of holding this timepiece in my hands for a few moments – needless to say under the watchful eyes of the Chronometer Department. I truly felt that I had been carried back through the years.

K2, as the timekeeper is known, was the second copy of Harrison's famous watch. It was commissioned by the Board of Longitude; Larcom Kendal being paid £200 for his work. Although not as valuable as the priceless Harrison timepiece, it may well have had the most adventurous history of any watch in the world.



the project

Professor V. H. Heywood of the University of Reading, Department of Botany, and Secretary of the Flora Europaea project has contributed this 'Grant' article.

The preliminary work on Flora Europaea began in 1956 with grants from the Royal Society and other bodies until DSIR (and later SRC) agreed to give support over twelve years up to 1968. A four year extension is being covered by an SRC grant of £36,560.

The scene Vienna, location the Naturhistorisches Museum, the year 1959. Seated in the gilt and red plush velvet chairs round the conference table were botanists from about twenty European countries. Microphones, tape-recorders and translators were at the ready. The first full meeting of the Flora Europea Organization, whose aim is to write a complete Flora of Europe, was about to begin. After the usual preliminary exchanges of courtesies, the Chairman of the Editorial Committee, Professor T. G. Tutin of Leicester, rose to address the assembly. 'Fools rush in where angels fear to tread', he began, and was met by blank incomprehension and then the meeting erupted into chaos for the next fifteen minutes while attempts were made to translate Pope's quotation into German, French, Italian or indeed any European language. Even Latin was tried. Eventually order was resumed and the meeting got under way.

This anecdote illustrates so well the kinds of problem, expected or unexpected, that beset a major venture of international co-operation. Not that there were no scientific difficulties to be overcome, as I shall mention later.

beginning

Flora Europaea consists essentially of a systematic account, with descriptions and dichotomous keys (for identification), of all the flowering plants and ferns that grow wild or are extensively naturalised in the European continent. There have been attempts in the past to do this but the only one to be completed was a multi-volumed folio manuscript, Gandoger's Flora Europaea, of such bizarre content that it is fortunate that it has been 'outlawed' by botanists on technical grounds. The present project arose largely out of a general agreement on the one hand at the Paris International Botanical Congress in 1954 that a European Flora was an urgent scientific need but failure on the other to take positive action. A gathering of botanists, mainly British, met in the last days of the Congress to discuss the position and towards the end of 1955 an informal committee was set up in Britain. It held its first meeting in January 1956 and, receiving an encouraging response from colleagues elsewhere in Europe, it decided to go ahead and map out general lines of policy.

One of the first problems to be decided was how to delimit Europe for the purposes of the Flora. Initially it was agreed to exclude those parts of Russia-in-Europe already covered by the monumental thirty-volumed *Flora URSS* which was nearing completion, but so many people regretted this decision that we decided to include European Russia, because it would otherwise be so difficult to make any reasonable political or plant geographical eastern limits to Europe. Where Europe ends in the USSR is not however of particular interest to the Russians so we had to draw our own boundaries along the Urals, and included the Crimea in the South but not the Caucasus. There were similar problems in the Mediterranean especially in the Eastern Aegean where we decided to exclude Cyprus and some other islands. The Azores were at first excluded and then included; the Canary Islands and Madeira were out.

Flora Europaea continued

For practical reasons the Channel Islands are included in France and Gibraltar in Spain; Germany is treated as a single country. Another problem in this context was how to spell place-names. This was solved by adopting the usage of The Times Atlas.

language problems

A big question was in what language the Flora should be written. We felt that the possibilities were english, the most widely understood language, or latin. The advantage of latin is that it was widely used in the earlier literature of taxonomic botany and even today it must be employed when describing new species or other groups so that all practising taxonomists have to have a working knowledge of the language. Other advantages are the absence of nationalistic implications or overtones, and it has a readymade technical vocabulary (although not one that would recommend itself to classicists). We prepared sample pages in both languages and circulated them for comment to botanists throughout Europe who were evenly balanced in their preferences so, despite any nationalistic implications, we decided on English. After all, the Committee editing the Flora was english-speaking and while it would have been possible to cope with latin descriptions, the writing of detailed comments on the variation and distribution of the species would have somewhat taxed our scholastic abilities. In any case many of the users of the Flora would not be taxonomists or even botanists and could not be expected to read a dead language fluently. Indeed, if the truth were known, only a few taxonomists have real competence in Latin.

The general organisation of the Flora consists of a British Editorial and Organizing Committee, a panel of Advisory Editors from various European countries who advise on general matters of policy, and, probably our major innovation in scientific collaboration, a team of Regional Advisors covering each country or state of Europe. Some of the larger countries have two or more regional advisers. These Advisers are primarily responsible for checking the information circulated in the draft accounts for their own country, although they are free to comment on any aspects. Thus the organization is fully international with a British core.

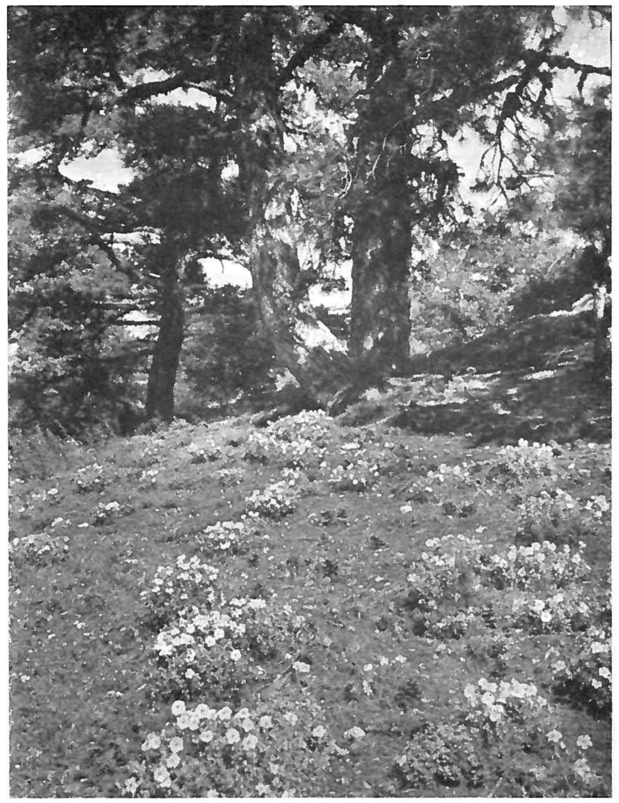
Financing an operation of this kind is difficult and we worked on a hand-to-mouth basis for a number of years with *ad hoc* grants from public bodies and private individuals until we were able to show that the project was viable and obtained an initial three-year subvention from the then DSIR to cover the employment of two research assistants and secretarial assistance plus running costs. The grant was an unusual departure for the DSIR in many ways, not least in the fact that the major items of expenditure were on stationery and secretarial costs. Paper and postage were major items; so were the expenses of holding regular meetings of the Editorial Committee. Circulating copies of edited manuscripts to the panels of Regional Advisers and Advisory Editors and preliminary and revised versions to the Committee, made a total of over 200,000 stencilled sheets distributed during the preparation of volume I alone. At peak periods when preparing the final manuscripts for the press up to six typists have been employed full time. Ten typewriters have been consumed to date!

The project was clearly going to be a long-term one and this was accepted by DSIR which undertook to continue to support it throughout the twelve years estimated to be necessary for completion. It was the first long-term grant to be awarded and, to date, it is the largest amount ever awarded in biology.

material for research

The problems of editing were even worse than we had expected. Over the years we have had to consider practically every aspect of descriptive plant taxonomy from basic concepts of species and genera to sequence of families and terminology of leaf shape, hairs, fruits, etc, etc. We produced a small printed summary of our decisions: 'Guide to Contribution'. This became known as the Green Book and was widely used even outside the organisation.

Terminology posed some difficult problems for we had to avoid using too many technical terms and yet not produce too stilted a style. There were two main difficulties here: first we had to write the Flora which required us to read the information available in the national Floras and other literature written in Polish, Czechoslovakian, Russian, Romanian, Latvian, and so on, as well as more familiar languages; second, we had to provide a glossary of those English terms which were ambiguous due to their diverse interpretations. At the same time it was necessary to produce an Anglo-Latin vocabulary of the most frequently used words which readers not too familiar with English might find useful in reading our Flora. Professor Webb was responsible for the preparation of these glossaries which circulated in draft form to the Regional Advisers and provided a fascinating theme for discussion at our Geneva Symposium in 1963. For instance we found that there was no equivalent to *pinna* in some languages; in another *acuminate* and *mucronate* were not distinguished; in others ostensibly the same term as in English meant the exact opposite; and we had to



explain to readers why we needed to distinguish between 'beneath' and 'below'.

Discussions had to be steered away from detailed considerations of comparative linguistics. One of the advisers commented that he would like British botanists to alter a good many of their terms before English was adopted as the basic language! Professor Webb's reply is worth quoting: 'That illustrates neatly a point I wish to make (I can say this as an Irishman although an English-speaking one.) The editorial committee are prepared to receive advice and criticism from people from any country as to the correct use of words in their language or in Latin, but we are not prepared to accept advice as to their correct use in English . . .'

The raw materials available to write *Flora Europaea* are extremely varied. No other continent or part of the world with a comparable number of species has been subjected to such a detailed study as has Europe. Most European countries already possess a recent handbook of their Flora although there are notable exceptions, especially in the Mediterranean: the only complete Flora of Spain, for example, was written between 1862 and 1893 and is now badly out of date. Since the Spanish flora is very rich in overall numbers and in endemic species this leads

picture on left: black pine (pinus migra subsp. Salzmannii (Dunal) Franco) growing in the Sierra de Cazorla, SE Spain, at 1500m. with Helianthemum croceum (Desf.) Pers. in flower in the foreground.

to an inbalance of knowledge. There are hundreds of national, local or regional Floras which vary enormously in their degrees of completeness, precision, accuracy, clarity, intelligibility and correctness of nomenclature. There are also many thousands of papers on European plants scattered in hundreds of journals.

assessment of specimens

Flora Europaea is by no means just a simple compilation based on the information given in these books and papers. During the preparation of the first volumes, scores of thousands of specimens have been examined in herbaria and museums all over Europe and we were fortunate in receiving the cooperation of the major herbaria in Britain such as Kew, the British Museum (Natural History) and Edinburgh, and of those on the continent of Europe, notably Vienna, Leningrad, Florence and Munich, as well as scores of smaller collections.

Because the naming of plants is determined by the original material (types) described by an author, we have had to scour Europe for type specimens, often with little success. In many cases it has been difficult to localize any material at all of local endemic species described during the last fifty years and it is almost impossible to assess them from descriptions alone. This problem arises especially with Russian species, despite the assistance of colleagues in the USSR in obtaining material. Furthermore, the Floras of many countries have been written by foreign botanists whose materials are not available in the National Herbaria of the countries concerned. Thus for the flora of Spain we have to seek authentic material and types in many places including Lisbon, Copenhagen, Geneva, London and other places, as well as in Madrid, Barcelona and elsewhere in Spain. Often, too, species are badly under-collected and poorly represented in herbaria, so that it is difficult to work out distributions without combing the literature for records whose accuracy one has no means of checking. We have in fact produced a series of source lists for the floras in these areas.

many meetings

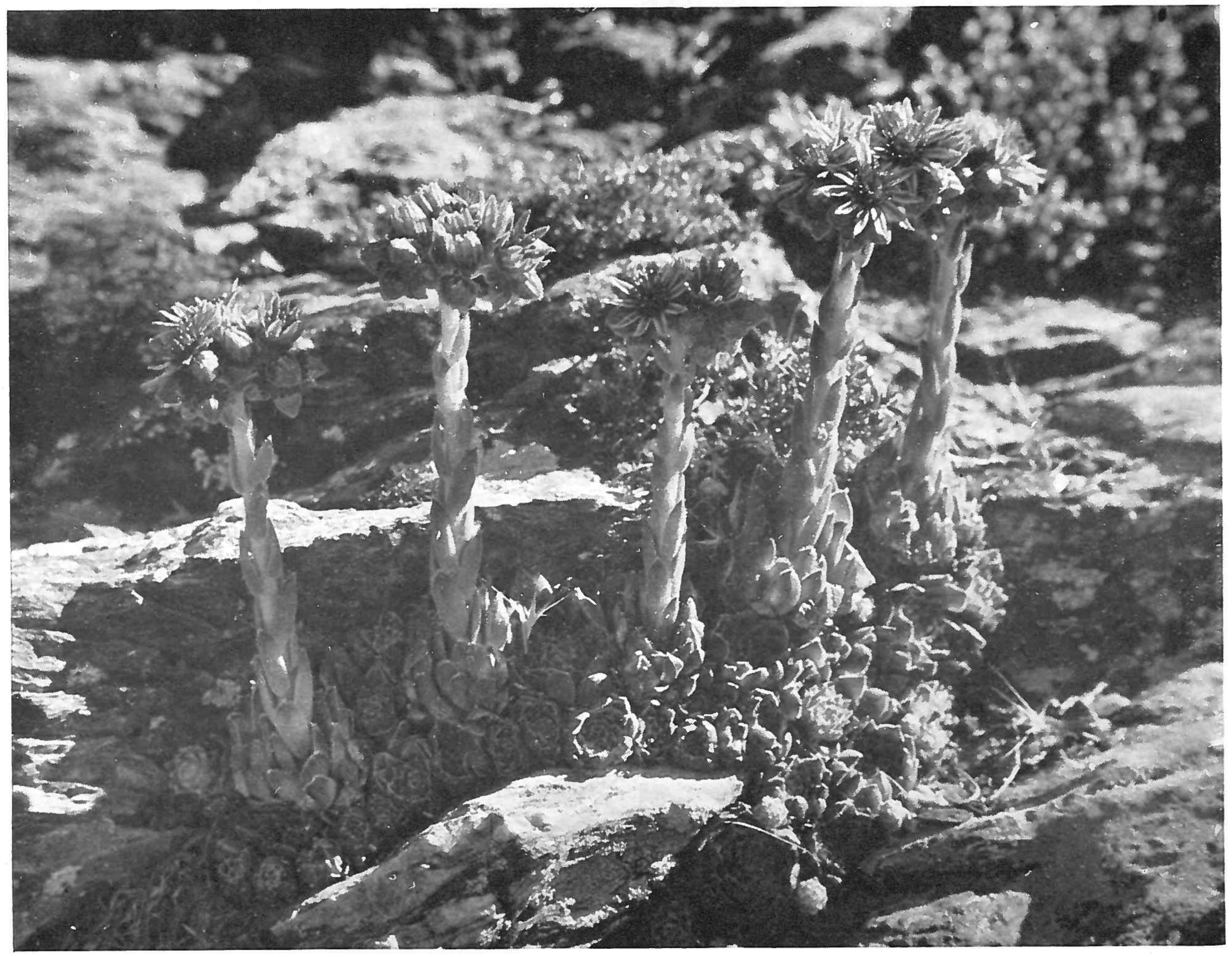
Successful completion of Flora Europaea depends upon goodwill and cooperation. It is therefore

Flora Europaea continued

important for the committee and its panels of advisers to meet at regular intervals. A series of biennial symposia were initiated at Vienna in 1959, followed by Genoa and Florence (1961), Romania (1963), Copenhagen and Arhus (1965), and Sevilla and Madrid (1967). All the meetings have been very successful and have served incidentally as a stimulus to taxonomic studies in the countries where they are held. Attendance is strictly limited to members of the Flora Europaea organization and botanists of the host country. Apart from valuable scientific sessions at which problems of taxonomy are discussed, a feature of the meetings has been the associated field excursions. These are most instructive for not only are different opinions on the identity of plants and their affinities put to the test – often leading to violent disagreements between distinguished specialists – but they give an unrivalled opportunity to make comparative studies of the floras of different regions. In every excursion new records have been found for several plants and revised interpretations made of species of the native flora. Conversations on such excursions are multilingual and on one occasion I was impressed to see a Spanish and a Hungarian colleague, who as far as I knew had no language in common, conversing with obvious fluency. On overhearing them I found the solution – they were discoursing in Latin! Nor is entertainment forgotten.

Highlights included dinner in the reed marshes of the Neusiederlsee at Rust; a cornucopian reception in the Academy of Sciences in Bucharest. In Jutland, to quote the official account of the meeting, 'the work of the day ended with large size flounders in Logstor' and 'all available beds were called for to secure the night stop in the village Rye'. Being botanists many opportunities were taken to study the applied side of the subject such as a winetasting at Murfatlar in Romania and visiting bodegas in Jerez de la Frontera: The organization excelled itself by lunching in the bodegas of the wine cooperative in Valdepeñas surrounded by 1,000,000 gallons of wine.

picture below: sedum nevadense Wale growing on schistose screes at 2000m. in Sierra Nevada, Spain.



publication

It is planned to complete Flora Europaea in five volumes. The first appeared in 1964, the second in 1968 and volumes 3 and 4 are far advanced. The Flora is published as a normal commercial venture by Cambridge University Press. Subsidiary publications include several symposia volumes and a series of papers under the title Notulae Criticae and Florum Europaeam Pertinentes. An associated project is the index to European Taxonomic Literature prepared with the assistance of colleagues at Kew Herbarium and published annually by the International Association for Plant Taxonomy in their series *Regnum Vegetabile*.

The Flora itself is not illustrated but a series of plates figuring each of the species covered is being prepared in Czechoslovakia under the title of *Icones Florae Europaeae*. Another separate venture is the preparation of a series of distribution maps which is organized by the Committee for Mapping the Flora of Europe which is based in Helsinki. The Flora Europaea Organization maintains a close liaison with both these projects.

The influence of the Flora Europaea project has already spread far beyond Europe. American botanists have publicly acknowledged that they were inspired to launch the *Flora North America* project by the example and success of Flora Europaea, and a number of other recent Floras, notably a Flora of European Russia, are being closely modelled on Flora Europaea.

SRC projected

The producer of the first film made for the Science Research Council is Peter Hadingham and we asked if he would write for Quest about his impressions of the various establishments during shooting. He protested that this was the most difficult part of his assignment but nevertheless came up with the entertaining article printed here.

Peter Hadingham has been connected with 16mm films since he was seventeen. This included some time in the Army Kinema Service as part of his six years in the army during the war, where he attained the rank of Major. For a number of years he was assistant to the General Manager of the 16mm company of the Rank Organisation until he left in 1952 to found his own unit, Swift Film Productions.

He is somewhat unusual in working single handed, directing and carrying out all production stages personally; also scripting and, if required, as in the Science Research Council film, speaking the commentary. Eight of his sponsored films have been selected for preservation in the National Film Archive.

fifteen floors up!

No wonder my head was swimming – but it was not the fine view of London from the top of State House that was the cause. I had just been handed literature on ESRO, CERN, on nuclear reactors, computers and astronomical observatories. There were existing films on these subjects. Could I make a composite film from them, taking a few extra scenes as necessary? Well, my knowledge of science was not exactly overwhelming – the last films I had made were on lawn tennis and rose cultivation – but I would be able to come to the new subject as a layman and, as this was the level of the intended audience, I might be a good judge of what would prove interesting. Few clients have been so trustingly helpful, allowing one to get on with the job; but although left in peace to produce the film, I did receive valuable guidance. This was essential, since most of the existing films proved to be unavailable or unsuitable for editing into a composite film and I ended up by shooting almost the entire subject.

SRC project continued

My first impressions were associated with State House. I was most courteously guided to parking space for my car in the basement, but would then find myself entering the building above through all sorts of entrances, and managed, with unerring regularity, to take a lift that stopped at the 13th floor, leaving me to walk the last two floors. I would then try to orientate myself by remembering the view from the window of the PRO's office, only to find that in heading for the corner I wanted I would get into a corridor with a dead end. Perhaps if I had observed the outside of the building more closely and remembered its shape it would have been easier. Later I had the opportunity to do this when I made a shot of State House from the top of the GPO Tower. All that was required was a 15-second slow zoom away from the building; but after I had waited nearly four hours for the sun I had become familiair not only with State House but with almost every other major building in London! Such is film-making – but not always.

shooting in Scotland

One of the most pleasant locations I have ever been to was the first establishment I visited, the Royal Observatory, Edinburgh. The setting of the Observatory can only be described as magnificent – rolling hills on one side and a view right over the ancient city on the other. So fine was the view of Edinburgh from the roof of the Observatory that it might be of equal interest to visitors as the fine telescopes and the domes. It was not so ideal for filming, though I did manage to get the view I wanted by clinging to some rocks. It is very easy to lose one's balance while looking through a viewfinder, yet had I absentmindly stepped back I would have disappeared into a chasm!

Later, I wanted to mount the camera and tripod on the counterweight of the twin 16 inch telescope so that when the instrument was moved the operator at a control desk would slowly come into view. I got the camera roughly into position when a tea-break was announced. Receiving assurances that it was not necessary to lock the dome as no one would come near it, you can imagine my horror to return and find a visitor being shown round the telescope by someone who was looking for the button to move it. He had not seen the camera and had he caused any movement at all it would have crashed to the floor – with dire consequences. On another occasion I was setting up lights for a short shot in one of the lecture rooms when a lecturer told me somewhat firmly that there would shortly be a class and that I must not be long. Now, film producers are not unknown to throw their weight around but, fortunately, my only reaction was to get through the sequence as quickly as possible, as I learnt afterwards that the lecturer was Mrs. Brück, the wife of the Astronomer Royal for Scotland.

There was a splendid atmosphere there, perhaps typified by the bearded Scots maintenance man who offloaded and transported my heavy equipment without a murmur and flatly refused to accept the normal token of appreciation of his help. Surely one of Scotland's ambassadors!

seen in laboratories

Another establishment was housed in a modern building in spacious surroundings. This was the Atlas Computer Laboratory. Once again people who had no direct concern with the film were always ready to help. Could I put my lights near the computer cabinets without the heat affecting operations? Could I rearrange the girls in the preparation room so that the blonde who would later appear in close-up and the girl in the bright dress and the 3-D figure would be in the front row? All such questions were met with cheerful co-operation. Would it help if the cover of the teleprinter was removed? Yes, it would, so it was done and a nut inadvertently dropped into the works caused an hour's fruitless search. Particularly helpful was the offer to produce a film sequence on a high-speed microfilm computer recorder. However, I don't think that the exciting development of computers being able to reproduce animated drawings and diagrams will cause me to switch from direction to programming yet awhile.

The spacious surroundings at Atlas made a pleasant walk to the large staff canteen. Here one rubbed shoulders with the staff from the Rutherford Laboratory, and as I wanted some exterior shots of this I arranged to be shown round. As we walked up a hill around the wired perimeter of the nuclear accelerator I noticed a small aluminium capsule lying on the ground. 'Isn't that one of the containers used for radioactive materials?' I asked – yes, it was! Hoping that my genes were not about to be mutated or my film stock fogged, I moved to the top of the hill to find staff sunning themselves during the lunch hour and I was able to select some suitable foreground interest.

invisible waves

The Radio and Space Research Station at Slough – a curious mixture of appropriately modern buildings and rough wooden huts – produced many filming problems. After all, you can't actually see radio

wave propagation and radio aerials are not terribly impressive especially when they are slightly bent and twisted. However, a run down to Chilbolton to the large steerable dish aerial gave me all the movement I wanted, and at the satellite tracking station at Winkfield continuous spasms of feverish activity were extremely impressive to the layman. The overall impression I gained at RSRS was of great enthusism for the job and here again a great willingness to 'cook up' experiments for the film.

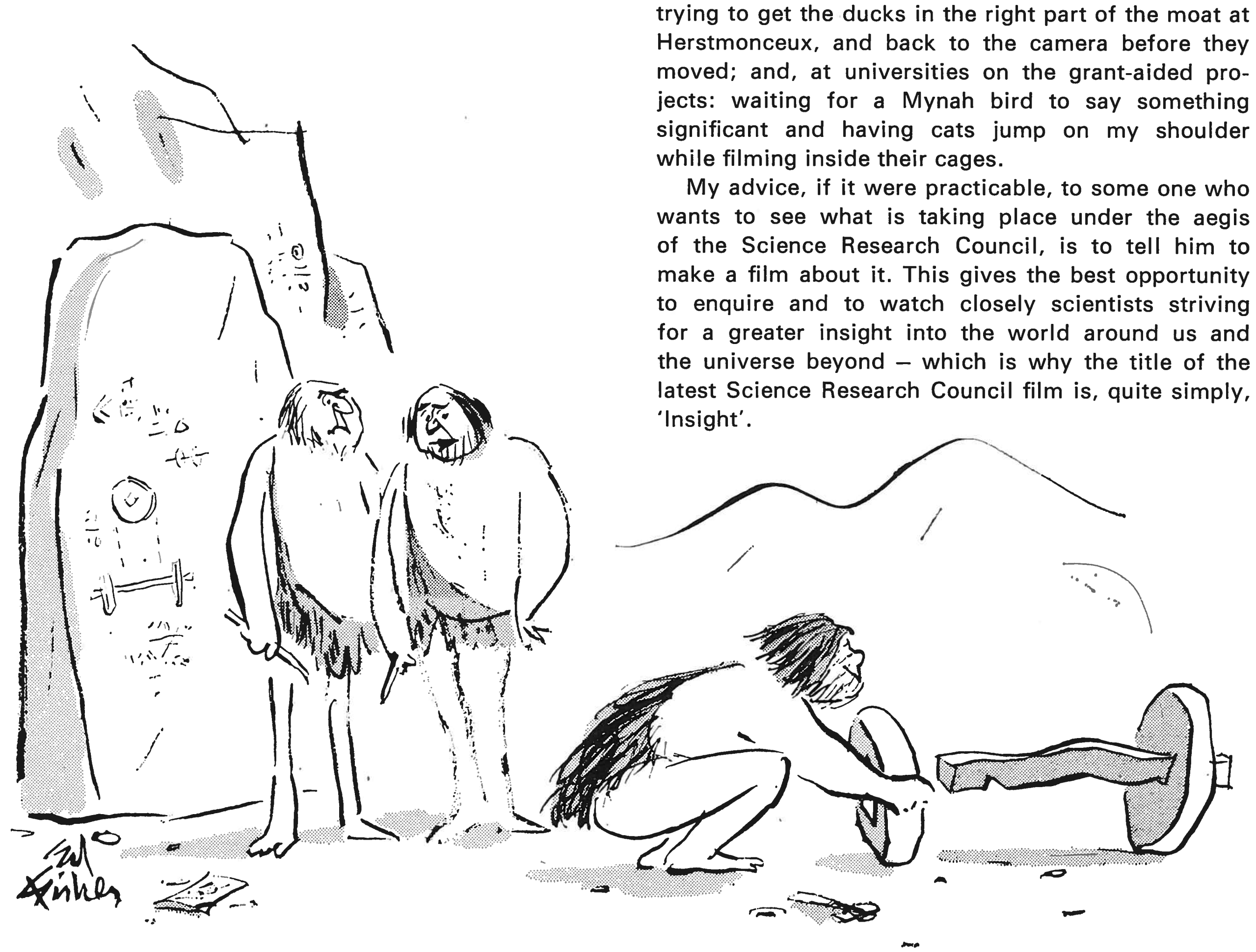
On one visit to RSRS my own activities were reduced to a standstill. I had been warned about the cows in the field where one of the huts stood, but was unprepared for the mud, so the car of the so-called film 'unit' had to be ignominiously towed out by a Landrover.

Perhaps my favourite location was the Royal Greenwich Observatory at Herstmonceux. While climbing in and out of the Isaac Newton Telescope and trying to light it for colour filming has its problems, the setting of the castle and the grounds, and the welcome from everyone I met made a very happy atmosphere. I thought this might be generated in part by an unconscious humility resulting from the study of a subject that tends to reduce us to such insignificance, but there was nothing insignificant about the Astronomer Royal. I approached him as though he was sitting on a charger defending the castle against marauding film producers – after all Sir Richard Woolley *is* a knight! – to ask if I could film him at leisure, playing Bach on the piano. He reluctantly agreed to perform and an afternoon's filming under the lights demonstrated the great patience which must be part of every astronomer's character.

developments

There were amusing incidents during the making of the film – the entire Atlas computer 'going on the blink' when I took out my tiny portable tape recorder in front of the row of massive tape machines there; trying to get the ducks in the right part of the moat at Herstmonceux, and back to the camera before they moved; and, at universities on the grant-aided projects: waiting for a Mynah bird to say something significant and having cats jump on my shoulder while filming inside their cages.

My advice, if it were practicable, to some one who wants to see what is taking place under the aegis of the Science Research Council, is to tell him to make a film about it. This gives the best opportunity to enquire and to watch closely scientists striving for a greater insight into the world around us and the universe beyond – which is why the title of the latest Science Research Council film is, quite simply, 'Insight'.



*"Some people just can't understand the disinterested pleasure of pure research. Give them a theory and they've got to **apply** it!"*

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people and their pastimes

Dave Boffin

Dave Boffin played an active part in setting up the independent administration office for the Astrophysics Research Unit at Culham Laboratory when it became part of SRC. He has now returned to the UKAEA part of the Laboratory.

Dave Boffin is a radio amateur (he doesn't like the term 'ham), but he's a 'ham extraordinary'; he's been one since his twelfth birthday, some thirty-eight summers ago, he's a member of an elite corps of 'First Class Operators'; and he is able to send and receive morse signals at a speed of thirty words a minute.

His call sign, G3 HS, vintage 1938, is known in practically every country of the world and he has a large collection of QSL cards to prove it. These cards, a sample of which is reproduced, provide proof of the operator's contact, the strength of the signal, the time, and details of the equipment . . . all in Q code, the international language of the air.

For instance, the Falklands Island contact John Cheek, call sign VP 8CW, who is probably quite well known to many at RSRS Ditton Park, was made at almost twenty minutes to ten on the third of March 1966 on the 14 Megacycles waveband.

news scoop

Dave was introduced to radio when his father gave him a secondhand crystal set which he had bought from a local house-sale. The thing didn't work and nothing the young 'boffin' could do would get a squeak out of it. Finally, he flung it away in disgust and made one for himself. This one worked very well and his first constructional success inspired him to read all he could on the subject and to scrounge as many components as he could get hold of. These were made up into first of all a one-valve set, then a two valve set, until he had accumulated sufficient 'bits' to make into a more complicated type of receiver which would cover the short-wave bands.

Using his bed spring as an aerial, the young Dave used to lie awake far into the night tuning in to crackling, spluttering conversations all around the world. Every movement of his body had the effect of changing the capacitance of the mattress aerial, so there were times when he had to suffer the agonies of cramp in order to hold on to particularly interesting signals.

He recalls the most exciting of these instances, when he overheard the announcement of the loss of the US airship Akron which foundered off the coast of New Jersey in 1933 with the loss of seventy-three lives, including the Head of the US Bureau of Aeronautics. He awoke his parents to tell them the news, but they thought he must be dreaming and urged him to go back to sleep. However, the morning papers provided the proof of the story.

licensed operator

Although often exciting, this was nothing more than a spectator sport for Dave, because he had no licence to operate for himself and he missed a great deal of the action through being unable to read Morse or the Q code. In 1936 he decided to get down to some serious swotting and in the following year, he obtained a Post Office licence for 'an artificial aerial'. This enabled transmitters to be constructed and tested, but did not permit any signal to be radiated. In 1938, after passing the Morse Code Test, he got

the full licence to transmit. In those days, all new licence holders had to serve a period of twelve months 'probation', during which time communications with other stations could only be through morse code.

Transmitting power was limited to 25 watts, so that a great deal of skill and ingenuity was demanded of the early 'hams'. Today, the power has been raised to 150 watts, but these skills are still required because British operators often have to compete with 1 kilowatt of power used by foreign amateurs. One of the results of this restriction has been the incredible sophistication of the equipment, especially the aerial systems, which have been developed to beam the weak signals all around the world with the minimum of power loss.

With the outbreak of World War 2, all licences were rescinded and equipment impounded; so denied the use of his own gear, Dave joined the Signals branch of the RAF and spent the duration furthering his skill and knowledge at the Government's expense. He went to France shortly after D-Day and was involved in an American campaign all the way from Omaha beach in Normandy to Berlin. After demob. he joined the Communications Branch of the Foreign Office and in the succeeding eight years, spent much of his time in the most unattractive of the foreign postings. Perhaps the fact that he was unmarried had something to do with it.

He served a term in Pakistan, where he was invited to draw up regulations for the issue of radio amateur operators' licences . . . and of course, he obtained the first one . . . AP 5B. This made him a natural target for 'hams' all over the world and especially in America where they used to try for hours to get into contact with him, for the privilege of adding his unique call sign to their collection of QSL cards.

comfortable shack

Marriage, a home, and children restricted Dave's air time for a while and he changed his gear for neat, miniaturised equipment which he built up from kit form. This is now installed in what all hams persist in calling their 'shack' in the loft of his new bungalow near the White Horse Hill in Berkshire.

By the time this story is published, he will have erected a sixty-foot lattice tower, on top of which will be fixed a rotary beam antenna which he will be able to control through 360° azimuth from his operating desk. His equipment is portable, so that he is able to take it up to the nearby Ridgeway (see 'The Old Way' in Quest July 1969) to take part in transmission competitions organised by the Radio Society of Great Britain, or he can instal it in his car and talk to friends during his drive to the laboratory, or on his holidays.

The 'shack' houses a Heathkit Transceiver Type SB 101, plus a linear amplifier Type SB 200. A triple conversion superhet receiver Type Eddystone EA12 is used as a stand-by receiver. Aerial tuning units and field strength meters, plus the main control unit complete the installation.

There's no need to twiddle knobs or fiddle with a screwdriver; there's not even a warm-up stage; simply switch on, select the wavelength and call. The equipment is voice-actuated and as it does not generate a carrier and the voice is on either the upper or lower sideband, depending upon the frequency in use, the conversation, whether it be from Ohio or High Wycombe, is as clear as a local telephone call.

To do justice to this story would require at least twice the available space. No mention has been made of the three week holiday in America and Canada with old radio friends he had never even seen; his appearance on American television; his Australian transmitting licence written on the back of a beer mat; his many awards, the innumerable associations; or how the amateurs have contributed to the scientific advancement of radio communication since its beginnings with the old railway telegraph system to the present-day stage where we are able to speak to the man on the moon.

column by 'observer'

cinematic

'Insight', the SRC's first film is now going its domestic rounds at our laboratories and London office, before being distributed through official libraries to a wider public. It is a 16mm colour film with sound commentary and runs for nearly forty minutes. Peter Hadingham of Swift Films who had the difficult – in some ways almost impossible – task of making a corporate acount of SRC in cinematic and entertaining fashion gives his own background description to its production on pages 17 to 19. We think it makes interesting reading but in a way it is only the beginning of the story. Because now, while brickbats and bouquets are in the air, we want to make sure that it is shown as widely as possible. A film of this sort has a comparatively short life, probably no more than three to four years, before it is overtaken by events. Ideally it might be shown with either the Daresbury or Rutherford laboratory films in order to give depth as well as balance. In which case the discerning will note that sequences from both these films have been edited very skilfully into 'Insight'.

how's your seat?

If too big for your chair or too small for your desk, you may be suffering from a lack of ergonomics or, in other words, a study of the working environment in relation to the man. Acute discomfort might even lead to 'ergophobia' ('a morbid dislike of work' according to one dictionary). Lack of sympathy from the powers that furnish may be a cause. This subject has its own researchers and we find from a book in the library that the usual chair for desk work, eighteen inches high, may leave the legs of a small woman swinging while a tall man may be almost in a reclining (or roman orgy?) position. From our own research we deduce that visitors will stay longer in a low deep armchair, while still wondering how to manage a graceful and timely exit. This is useful to keep an audience captive but they may just fall asleep. To the less welcome, offer a hard shiny seat, fairly high and with a slight forward tilt (as ergonomically frowned upon) and they will soon be up – and off – again.

● *Remember our first column and the 'Q' meeting query? At last the issue is resolved. In fact it was announced by the Chairman at the post-annual-report staff meeting at the London office. 'Q' stands for 'quiddity' and to save you reaching for your Oxford English Dictionaries (or perhaps we should asume that is unnecessary?) let us explain that 'quiddity' is described as a 'quibble', a 'captious subtlety', 'the essence of a thing that make it what it is'. We can rest happily therefore in the knowledge that Monday mornings may be devoted, at least in essence, to making us what we are – or even more so.*

on the air

Open Days that were to be have come and gone (sounds like the opening of a hymn?). Despite a heartfelt Amen from all at RSRS as the last visitor departed in peace, it's probably true to say that a pretty good time was had by everybody – including the press who, each in his own way, featured the Station's work. Headings varied from the sober and factual to such flights of fancy as 'MINI-WAVES BEAT SOUND BARRIER'. Make what you will of that.

Now boards are stowed, silken dalliance – or at any rate sober suiting – in the wardrobe lies, and all our sketches, pictures, arguments are shrunk to the little measure of five brown paper parcels and a cryptic note, suggestive of dark deeds at the MCC, which tells us 'Three short legs missing'.

● *What do you think of this? – 'Working in SRC is rather like elephants making love. Everything takes place at a very high level; all those beneath are trampled underfoot and it takes years to see any results'. This was, we hope,* misapplied *to SRC by one who until recently was the training officer at LO. You may recognise the quotation – it has been used against other eminent bodies. We are sorry to hear that things look like this but we hope they will appear brighter from his new position in SUGA.*

Quest Quarterly Quote

'Fair is a four letter word'

Sir Brian Flowers speaking on research grants.

Apollo observed

Because of bad weather very few people saw the bright cloud in the sky caused by the dumping of liquid oxygen from the S IV B rocket of Apollo 12 on the evening of November 14. However, the following evening was clear and Apollo itself was detected visually by Mr. G. E. Taylor at the satellite tracking station at Cowbeech in Sussex, using a 50cm reflector. It was a very faint object, magnitude about +12, and only moving at the rate of about seven seconds of arc in a minute. Using the position obtained at Cowbeech, the 65cm refractor at RGO, some 5km away, was used by Dr. D. V. Thomas to obtain a photograph when Apollo 12 was 210,000km distant, just over half way to the moon. We are sorry the picture was just too faint for us to reproduce – Apollo really was a very long way away.

Mr. Taylor works in the Nautical Almanac Office and is President of the British Astronomical Association. He operates the Cowbeech satellite tracking station, which is sponsored by SRC through the Royal Society, in his spare time.

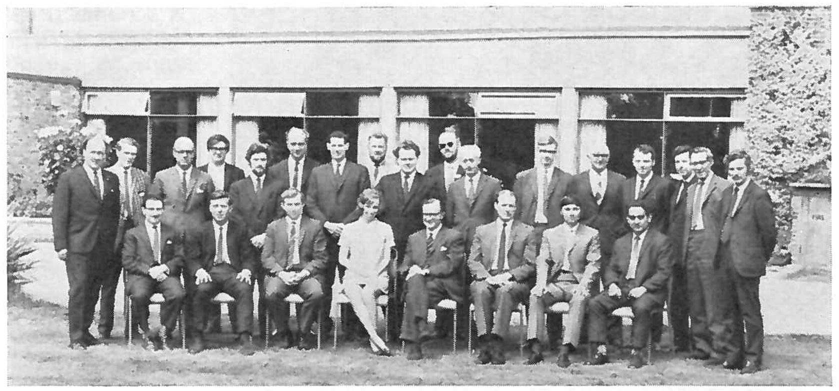
no cheap . . .

Many things are said about careful Scotsmen; not all printable and some perhaps incredible. However we remembered that saying about a grain of truth when some visitors to State House from ROE said they would use the lunch hour 'to go down to the Universal Stores to look at the telescopes'. We hope they found a bargain!

were you here?

Every seat of learning has its group photographs and the SRC central training section is no exception. Here are pictures from Induction courses held at RSRS and ACL.

At RSRS
back row (l. to r.)
Dr. T. G. Walker RL, P. R. Cook RS, F. N. Goodall RS, D. A. Cooper ROE, G. Raymond-Barker RGO, J. A. Hirst RL, A. M. Cooper DL, G. L. Cooper LO, A. A. Handley RS, J. R. Lyall DL, G. R. Berry DL, G. L. Addison RS, D. H. Brooks LO, R. H. Weaver LO.
front row (l. to r.)
P. Muzlish RS, J. S. Moore RS, R. Bell RL, R. W. Parker ROE, Mrs. C. Shepperson LO, G. W. Gardiner RS, D. N. Wellings RL, N. Chadderton RL, S. J. Bridgett RL, R. Jenkinson DL.

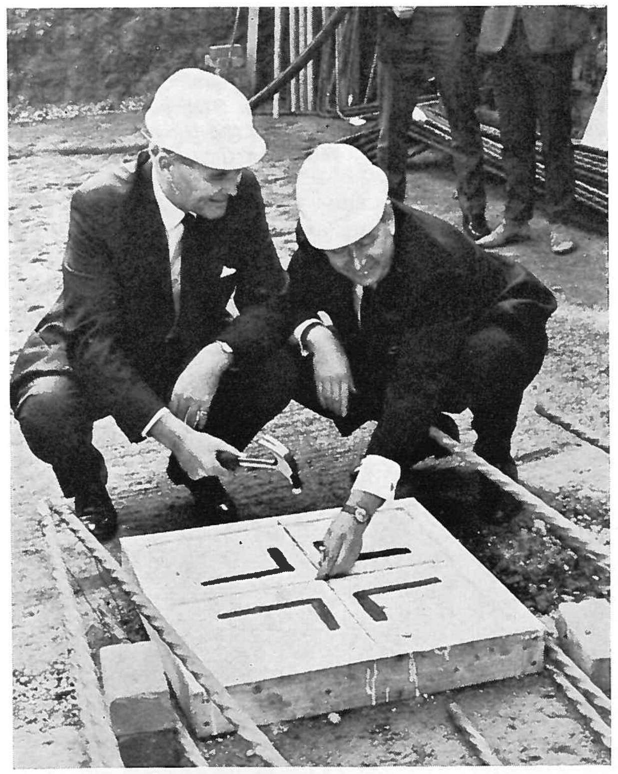


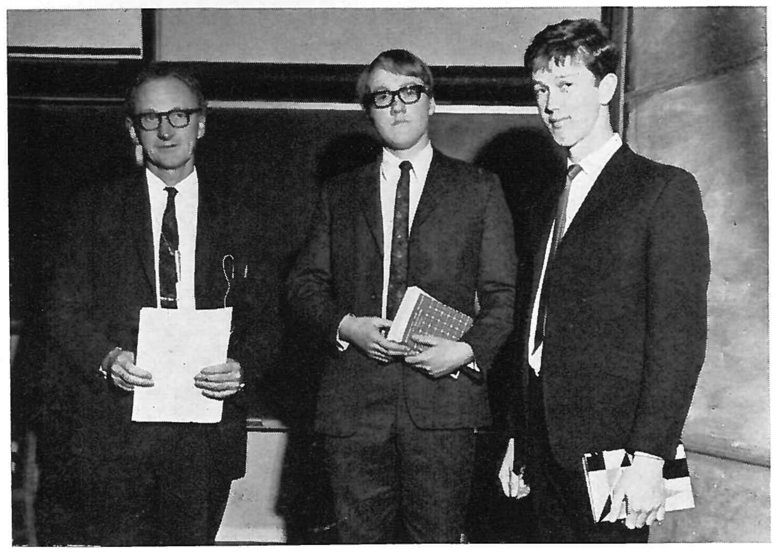
At ACL
back row (l. to r.)
J. M. Howson DL, J. A. Irvine ROE, G. I. Janes ARU, S. H. Michael ACL, J. R. Brook DL, Dr. J. Barlow RL, P. Casey LO, Dr. J. H. Price LO.
middle row (l. to r.)
Dr. C. J. S. Dammerell RL, L. R. V. Mitchell RS, D. P. Wormald RS, D. R. J. Chapman RGO, D. Lehrle DL, T. Yarwood DL, C. J. R. Stevens RS, H. Sangster RL, A. Jefferies ACL, R. T. Count LO.
front row (l. to r.)
C. L. Roberts ACL, Miss I. R. Radford LO, Miss A. R. Thomas LO, D. H. Brooks LO, Dr. J. Howlett ACL, Miss K. Hall LO, Miss D. Ackland LO, Miss G. Keats ACL.

newsfront

centre of a centre

below *Dr. R. B. Hunter and Dr. J. E. Pope Vice-Chancellors of the Universities of Birmingham and Aston mark the centre point for the new 3 Mev Dynamitron accelerator of the Birmingham Radiation Centre to be built on the Edgbaston campus.*





october PLA off

At 11.00 a.m. on Friday, 3 October, in the company of many past and present 'old sweats', the Director, assisted by John Dickson (who joined the PLA on the same day), switched off the Proton Linear Accelerator for the last time. Thus ended a period of nine and a half years of medium energy nuclear physics at the RHEL.

Installation of the machine began in 1955, and the first twenty feet (Tank 1) produced a 10 MeV beam for the first time in late 1958. Tank 2 raised the energy to 30 MeV in May 1959 and the final section of the PLA reached its design energy of 50 MeV in July of the same year.

In comparison with modern competitors in the nuclear structure field (i.e. the Tandem Van de Graaff and AVF cyclotrons) the PLA had two main drawbacks. Firstly only protons could be accelerated, and secondly the beam energy could be varied only within narrow bands centred on 50, 30 or 10 MeV. Two years ago it became necessary to face up to the implications of this lack of flexibility, and closure was the result. However, despite the fact that its life as an independent accelerator is finished, there is a scheme (PLANIM) on the stocks to use it as a new injector for Nimrod. With this in mind the PLA will be mothballed.

most promising

At RL the John Wilkins awards are made every year to the most promising young student apprentice or craft apprentice (selected in alternate years) and a scientific assistant. This year the awards went to craft apprentice Kevin Wain, who is in his last year of apprentice training in engineering and is working in the Advanced training workshop in Hangar 9 before returning to RL for a final period of workshop experience; and to scientific assistant Jeffrey Penfold who gained an ONC in science with sufficiently high marks to gain a place on the B Tech sandwich course in Applied Physics at Brunel University. He has returned to RL for industrial training during the summers of 1968 and 1969.

The award scheme perpetuates the memory of John Wilkins who was one of the principle architects of Nimrod and carried responsibility for the magnets, the beam handling programme and research on high magnetic fields.

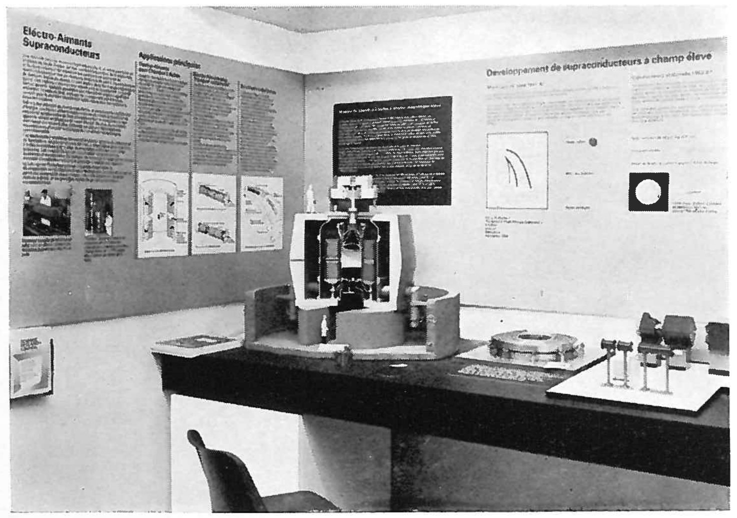
Inthe picture (l to r) are the Director – Dr. G. H. Stafford, J. Penfold and K. J. Wain.

november/big bang

The rural and spacious Ditton Park seems an ideal place for celebrating November 5 which is perhaps one reason for the popularity of this event in the RSRS Calendar. This year was no exception and employees and their families, with guests invited from local children's homes, celebrated the destruction of poor Guy Fawkes with high spirits and a callous delight in his downfall. Two months without rain had ensured an effective funeral pyre and the blaze could surely be seen for miles. Fireworks were exploded at a safe distance from the crowd and one or two comic mishaps to the set pieces seemed to add to the enjoyment. Afterwards everyone gathered in the vehicle store for hot drinks and hot dogs; children were taken home and put to bed; and that was the end of Guy Fawkes – at least for twelve months.

december/super in paris

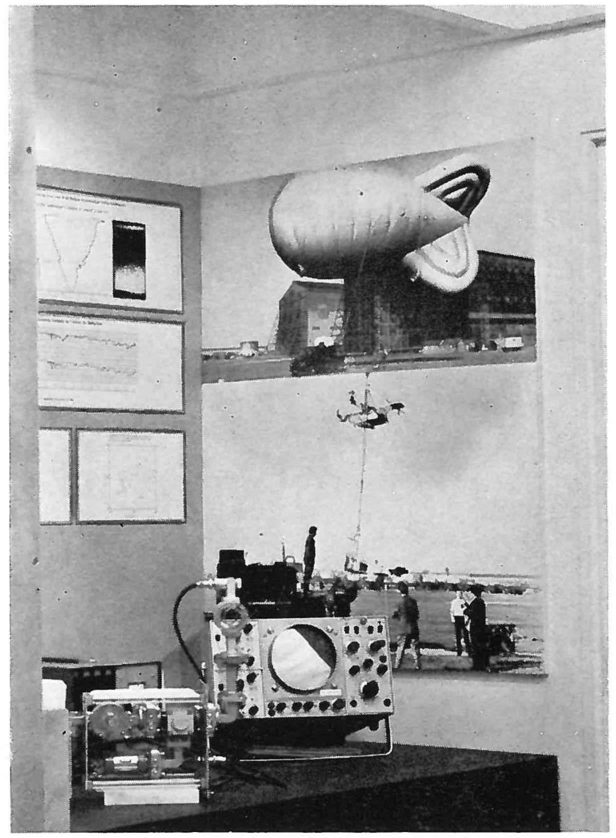
Superconducting Magnet Technology in High Energy Physics was the theme of the RL exhibit at the 1969 French Physics Exhibition held in Paris on 8–13 December. The discovery and development of materials which will remain superconducting in high magnetic fields can be used to construct magnets with field strengths up to 100 kilogauss or more which consume no power except for the relatively small amount required to maintain them at the low temperature. Rutherford Laboratory is playing a leading role in the development of this technology. *(Picture below).* A Microwave Refractometer was exhibited by RSRS. This is used to study the variations of refractive index in the lower atmosphere which are important in the propagation of very high frequency radio waves, as used both in terrestrial and space communications. *(Picture on right)*



new year honours

Quest is pleased to congratulate

Mr. R. St.J. Walker – CBE.
Mr. H. Rothwell – OBE.
Mr. C. E. Franklin – MBE.



stop press

a happy new year to you all