

BOOKS

Accelerators — machines of nuclear physics, by R.R. Wilson and R. Littauer (London, Heinemann Educational Books Ltd., 1962; 6s.) is a volume in the *Science study series* and was first published in the U.S.A. in 1960. This series of books arose from the activities of the Physical Science Study Committee organized at the Massachusetts Institute of Technology in 1956 and is intended to provide surveys of the most stirring and fundamental topics of science within the grasp of the young student or scientifically inclined layman.

The subject of accelerators is introduced by a chapter that enquires more closely than usual into the act of 'seeing', and shows in a convincing way how, in order to 'see' smaller and smaller things, smaller and smaller wavelengths, that is ever greater energy, must be used for the 'illumination'. The conversion of the energy of an accelerated particle into the mass of newly 'created' particles is also explained.

Then the development of particle accelerators is treated in a more or less historical fashion, from the early x-ray tube of 1895 to the prospects of colliding beams as seen in 1959. Successive chapters in between deal with direct accelerators — the Cockcroft-Walton machine and the Van de Graaff generator, linear accelerators, the cyclotron, the betatron, the electron synchrotron, the synchro-cyclotron, the proton synchrotron, the alternating-gradient principle and sector-focused cyclotrons. A concluding chapter deals with ideas on 'cosmic accelerators', the means by which charged particles in interstellar space acquire energies that make man's greatest achievements seem small.

The style of writing is easy, almost colloquial; to an English reader it is obviously American. But it has the immense advantage that the knowledge and enthusiasm of the authors is fully communicated. Diagrams are used to help explain the text and a number of interesting analogies are introduced to make things clearer. Those who are bewildered by terms such as 'phase stability', 'bunching', 'betatron oscillations', and 'acceptance', who wonder why many accelerators work in pulses instead of continuously, who would like to know why a proton synchrotron needs a linac as 'injector', will find everything explained here in terms that are easy to understand. As the story unfolds, each new type of accelerator is seen to grow out of those preceeding it, with now and again a crucial idea that opens up a whole new field. One such idea was that of E. O. Lawrence, to whom, in effect, the book is dedicated. His cyclotron was the forerunner of all the circular accelerators since invented, including our own two at CERN, and the chapters describing Lawrence's work and the development of his Radiation Laboratory at Berkeley are among the best in the book.

In spite of the emphasis on machinery, the purpose of particle accelerators is not lost sight of, and the close relationship between accelerator builders and physicists is underlined. Rapid progress is also mentioned, and this leads to the major criticism of the book. Written at the end of 1959, it is already out of date. At that time CERN's proton synchrotron had just started to work (with a beam of 10^{10} protons/pulse!), Brookhaven's was yet to be finished, and the idea of bigger accelerators was still largely a dream. The prediction is made that beams of high-energy neutrinos might be possible at CERN and Brookhaven, and the table of 'elementary particles' looks rather old-fashioned. It seems a pity that before republishing this text in England (even

Saclay / CERN polarized - proton target (cont.)

temperature; the magnet, which must provide an extremely uniform field; the microwave system, which polarizes the protons; and the high-frequency system, which measures the sign and the amount of the polarization. Except for the magnet, the target was developed by M. Borghini, M. Odehnal, P. Roubeau and C. Ryter at Saclay, in the laboratory of Prof. A. Abragam. The cryostat is of a new type having two major advantages: it is horizontal, allowing the magnet pole faces to be horizontal also and thus permitting the disposition of spark chambers and other equipment horizontally around the target, and it is fed continuously with liquid helium. The helium comes in 50-litre insulated containers (from the liquefier operated by CERN's TC Division), each providing enough for about a day, and it takes only ten minutes or so to change from one to the next. From the container the liquid helium passes first into a 'separator' in the cryostat, where it is filtered through sintered brass. Vapour produced during the transfer is pumped

away through spiral tubes which are used to cool thermal shields to about -240°C . The liquid from the separator goes through a heat exchanger, where it is cooled, and is then expanded through a needle valve into the microwave cavity holding the target crystals, where it vapourizes. With the radio-frequency power on, a temperature of about 1.1°K (-272.3°C) is obtained in the cavity. The vapour is pumped off via the heat exchanger previously mentioned.

The microwave system uses power sources of 10 Watts at frequencies around 70 000 Mc/s; a change of about 160 Mc/s is necessary to reverse the sign of the polarization. The high-frequency system operates around 80 Mc/s and consists of a nuclear-magnetic-resonance detector which can take a reading in 10 milliseconds and display the sign and the percentage of the polarization on a digital voltmeter, for photographing on the same

film as the spark-chamber tracks. Polarizations ranging between 50 and 60% were currently obtained in the 5-cm³, 5-cm-long target during the first runs of the xi-parity experiment.

Two magnets have been made, designed by G. Petrucci, of CERN's NP Division, and manufactured in the MSC workshop. The first, seen in the photograph, was used in the preliminary experiments at the SC and the one now in use is of a somewhat improved design. As can be seen, the windings and pole pieces are strongly tapered, to allow for the positioning of other equipment, and in spite of the large air gap, compared to the size of the pole faces, the field of 18 500 gauss is uniform to 1 part in 5000 over an area 1 cm $\times$ 1 cm $\times$ 5 cm. This was done by carefully measuring the field and 'shimming' the poles correspondingly with small pieces of iron, a process carried out by the MSC section under E. Braunsreuther ●

in 1962) the authors were not induced to bring it up to date. In spite of some inconsistencies which have arisen in trying to adapt the text for English rather than American readers, to those at CERN who can read English and who would like to know more about the PS and the SC (and for anyone else interested in the development of modern high-energy physics) this book can be thoroughly recommended.

Accelerators of charged particles, by B. S. Ratner (Oxford, Pergamon Press Ltd., 1964; 17 s. 6 d.) is in a different category altogether. Translated from the Russian edition of 1960, it claims to describe 'in an easily understandable manner the history and latest developments in accelerator technology' and 'no prior knowledge of nuclear physics or mathematics is needed...'. In fact, we find the first two chapters (a third of the book) devoted to a kind of 'layman's guide to the development of atomic energy', which few layman will understand, with the early accelerators of Cockcroft and Walton and of Van de Graaff mentioned in passing. Successive chapters then deal, in what might be called text-book language, with the main types of accelerators, ending in an imaginary journey to Dubna to examine 'one of the most interesting installations of the present day'. The last chapter mentions the start-up of CERN's proton synchrotron, but nowhere in the book is Brookhaven mentioned — or Berkeley, come to that, except for Lawrence's invention of the cyclotron.

It must be admitted that the story is difficult to follow, padded with unnecessary detail, inconsistent in its references to names of people and places, misleading on a number of facts, and (in spite of the translation editor) shows obvious signs that the translator was not familiar with the subject. The bibliography mentions only Russian publications, including what appear to be Russian translations of standard American texts, and the index is meagre. The book may have been useful in its original form, but there seems to be no good reason for translating it and republishing it now in English without considerable revision.

A.G.H.

The development of weak interaction theory, edited by P.K. Kabir (New York, Gordon and Breach Science Publishers Inc., 1963; \$ 4.95).

This, the fifth volume in the publisher's *International Science Review Series*, provides a very useful review of what may be called 'classical' weak-interaction theory, presented as a collection of the relevant original papers prefaced by a compact survey of the field by the editor. The timing is almost perfect. The Universal Fermi Interaction, which has proved so useful in the understanding of the weak interactions of non-strange particles, appears to have spent its force; the new approaches based on the SU_3 formalism are not yet fully developed.

The general layout of the book is excellent. Before the preface there is a block diagram, illustrating the development of the theory (upon which the selection of papers is based), which impresses upon the reader the extensive feedback between the various sub-sections. Taking the selected papers in order one can clearly see the historical development: the almost uncanny insight of Fermi, the breakthrough of Lee and Yang leading to the rapid refinement of the theory, and finally the difficulties encountered with strange-particle decays and the hypothesis of the intermediate vector boson. The fact that five of the authors whose work is quoted are Nobel laureates shows the rapidity and ingenuity with which this development was carried through.

The preface is adequate for its purpose. One gets the impression that the editor has a typical theoretical physicist's devotion to the intermediate vector boson, but as an experimental physicist one is tempted to ask: if it exists, where is it? One fears that the ghosts of Michelson and Morley are once again walking the cloisters of physics, chanting penitentially the word 'ether'.

As regards the editor's selection, I feel that, although this is a review of the theory, the inclusion of a few experimental papers would have been useful — for example,

The fascinating exploration of Romanesque art in French-speaking Switzerland, made under the guidance of Prof. P. Bouffard, at that time Mayor of Geneva, had a sequel this autumn when a party from CERN was introduced to the charms of the Haute-Savoie, by Prof. P. Guichonnet, of the University of Geneva. Once again this excursion provided an opportunity to strengthen the bonds between CERN, Geneva and the neighbouring regions, and those taking part were thus particularly appreciative of the warm welcome they received from the authorities of the aptly named town of Bonneville. To end the tour, which revealed to everyone a number of previously unsuspected treasures, a visit was paid to the château at Thorens owned by the Sales family.

The CERN Staff Association continues to extend its friendly contacts with the people of Geneva, and early in 1965 an exploration of some of the lesser-known parts of the City will be arranged. Like the other outings, this will be open to everyone at CERN.

The photograph here shows Prof. Guichonnet and the party from CERN outside the Town Hall in Bonneville.



on one of the classic experiments demonstrating parity violation or the decay of a pion into an electron. Again, at a certain point in its progress the theory was considerably embarrassed by conflicting experimental data. On reading through the selected papers one sees the anxiety building up; then, at a certain moment, one must assume everything has been resolved because the discrepancies are never mentioned again. Descriptions, at the appropriate points, of the experiments which clarified the situation would have greatly assisted the continuity of the book. Apart from this criticism, however, the selection of papers is excellent.

One final comment. I stated at the beginning that I felt that the timing of the book was *almost* perfect. The editor concludes his selection with several papers describing the possibilities of high-energy neutrino reactions, but the final choice of papers was apparently made just too soon to include mention of the first astounding result in this field — the non-identity of the electron and muon neutrinos. Maybe this book covers only one chapter of the development of the theory of weak interactions, but the last page of the chapter seems to be missing.

I. M. Blair

Progress in nuclear energy, Series IV : Technology, engineering and safety, volume 5, edited by C.M. Nicholls (Oxford, Pergamon Press Ltd., 1963 ; £ 6 6 s. 0 d.)

Reviews of books dealing with nuclear engineering are appearing rather frequently in *CERN COURIER*. So much so, that the editor even wrote a short editorial (May 1964, p. 62) stressing that CERN, as an organization, is not concerned with activities in the field of the uses of nuclear energy. This editorial also gave the justification for reviewing books on nuclear engineering : firstly the subjects of the books are thought to be sometimes of interest to members of the CERN staff, and secondly it was said that readers of *CERN COURIER* have interests in other than fundamental research.

Are there indeed several subjects in nuclear engineering that are of interest to accelerator engineers ?

Before high-intensity accelerators were considered, accelerator and nuclear engineering had, as a matter of fact, very little in common. Health physics techniques, safety, and reliability of instrumentation were perhaps the main common interests. High-intensity accelerators, however, have confronted the accelerator engineer with new problems : radiation damage and activation of materials, remote handling of active components, special process measurements. All these problems are already familiar to the nuclear engineer, although the list of common interests is still a rather small one.

The situation is demonstrated by scanning the book under review. It contains many (18) contributions on different topics in nuclear engineering, each by a specialist. The largest chapter, the one on process technology, contains six contributions : 'Radiometric techniques and instrumentation of in-line process monitoring', 'The separation of plutonium isotopes', 'Development of a production process for radio-krypton recovery by fractional absorption', 'The

preparation of UO_2PuO_2 powders for nuclear fuels', 'Gas-solid contacting', 'Corrosion and materials of construction in chemical processing of reactor fuels'. The first of these could be useful when building a gamma-ray monitor in the circuit of a magnet ; the others describe interesting techniques (the one on gas-solid contacting in particular) but can hardly be included in the 'common list'. An article on methods of measuring temperature in nuclear reactors and the excellent review on the filtration of radioactive particulates might, however, be eligible for inclusion. At least the common interests are there ; the book satisfies a little in this respect.

The scope of the contributions is not equal, some dealing with specialized subjects, giving theoretical and practical information, while others cover a broad field and are kept in general terms only. For example, the author of 'The response of containment structures to transient pressures caused by nuclear reactor runaway' characterized his paper as a survey of the current literature on the subject (54 references included). However, some disequilibrium in a book of this kind can hardly be avoided.

In general terms, the book supplies up-to-date information on some rather specialized subjects, together with extensive reference lists. Its value should be judged also, with reference to its place in the impressive series of *Progress in nuclear energy*.

J.H.B. Madsen

Application of ultrasonics in molecular physics, by V.F. Nozdrev, translated from the Russian by Scripta Technica, Inc. (New York, Gordon and Breach Science Publishers Inc., 1963 ; \$ 27.50).

The fact that it is now possible to produce very high ultrasonic frequencies, of the order of 10^9 oscillations per second, has led to a considerable expansion of the field of experimental ultrasonics. In particular, the use of small-amplitude oscillations enables an accurate determination to be made of the kinetic molecular behaviour and the thermodynamic properties of gases, liquids and solids.

In this book, the author states that he "does not pretend to generalize all the experimental and theoretical material in this field. Rather, this book represents the results of many years work by the collective of the Laboratory of Molecular Acoustics, the N.K. Krupskaya Pedagogical Institute of Moscow Oblast' (MOPI) and, in part, by the Molecular Physics Department of Moscow State University (MGU)." The results of work done by other scientific bodies have been included, but generally only as brief references.

The diagrams tend to be cramped, but the text is well presented. Although concerned primarily with the practical details of the work carried out at MOPI and MGU, care has been taken to give the necessary theoretical background and there is an extensive list of references, although most of these are to Russian publications. To avoid interference with the main text, the experimental data obtained in the laboratories are tabulated separately in an appendix, following the same sequence as the material of the book.

The first two chapters explain the theoretical bases for the optical methods and the pulse methods for studying the

propagation and absorption of ultrasonic waves in liquids and gases. General techniques and various kinds of equipment used and developed at the laboratories are described and explained, together with an analysis of the possible experimental errors. The remaining four chapters deal with specific experimental results and the conclusions that can be drawn from them, as follows :

Chapter III describes the study of the propagation of ultrasonic waves in liquids from the solidification point to the critical state, using both optical and pulse methods.

Chapter IV describes the properties of ultrasonic waves in individual substances and binary mixtures in the critical region. For a large number of substances, two-phase and three-phase regions were studied, and also the single-phase region (vapour) close to the critical point. The substances used were the saturated and aromatic hydrocarbons, alcohols, acetates and formates which, in the author's opinion, present the greatest scientific and practical interest.

Chapter V describes the propagation of ultrasonic waves in saturated and superheated vapours of organic liquids. This research furthers the development of the theory of a gaseous state and also finds applications in modern technology (thermal engineering, the petroleum industry, etc.). Special attention is devoted to the computation of energy and force characteristics, specific heat, and compressibility.

Chapter VI discusses the study of the absorption of ultrasonic waves in pure and mixed organic liquids over

a wide range of temperatures, concentrations and frequencies. Experiments using saturated and aromatic hydrocarbons are described and the relaxation processes in liquids are discussed.

To sum up, the author has succeeded quite well in producing a laboratory text book that is interesting to read and easy to digest. Against this, it is unfortunate that the translators did not give a little more forethought to the electronic circuits and, in a few places, to the English.

R.J. Wilton

The analytical chemistry of thorium, by D.I. Ryabchikov and E.K. Gol'braikh (Oxford, Pergamon Press Ltd., 1963 ; £ 5), has been translated by A. Norris from the original Russian text.

It is an extensive book, primarily for chemists interested in the analytical procedures for the determination of thorium. Many methods are given for use under a great variety of circumstances, and over 2000 references are quoted.

In spite of this, however, there is little on the ion-exchange behaviour of thorium, which is the basis of a rather important method today. For the specialist in radiochemistry, the corresponding booklet in the *Nuclear Science Series* published by the U.S. National Academy of Sciences and the National Research Council, *Radiochemistry of Thorium*, by E.K. Hyde, would seem to be more concise and practical.

R. Brandt

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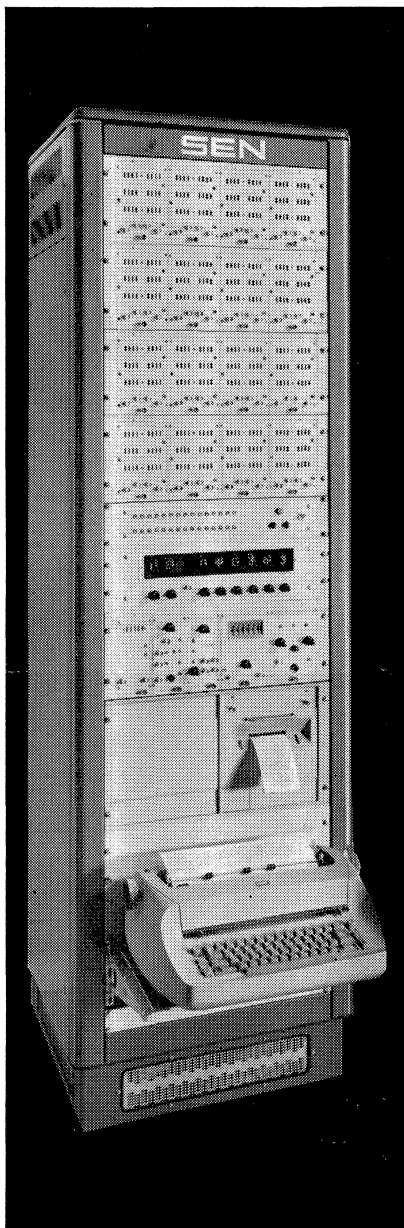
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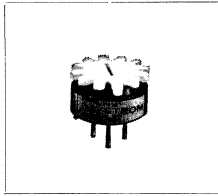
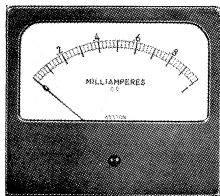
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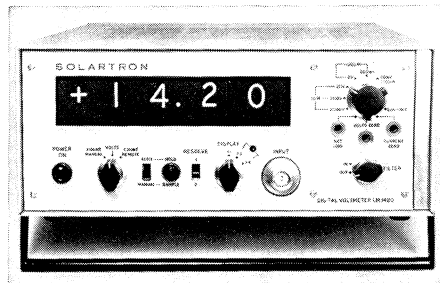
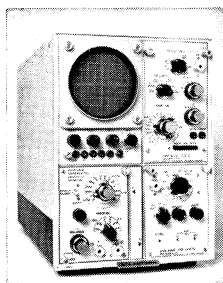
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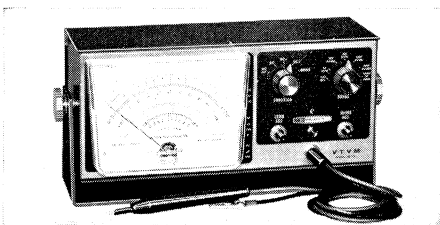
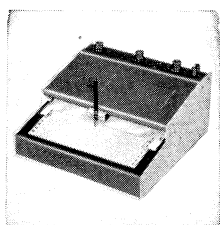
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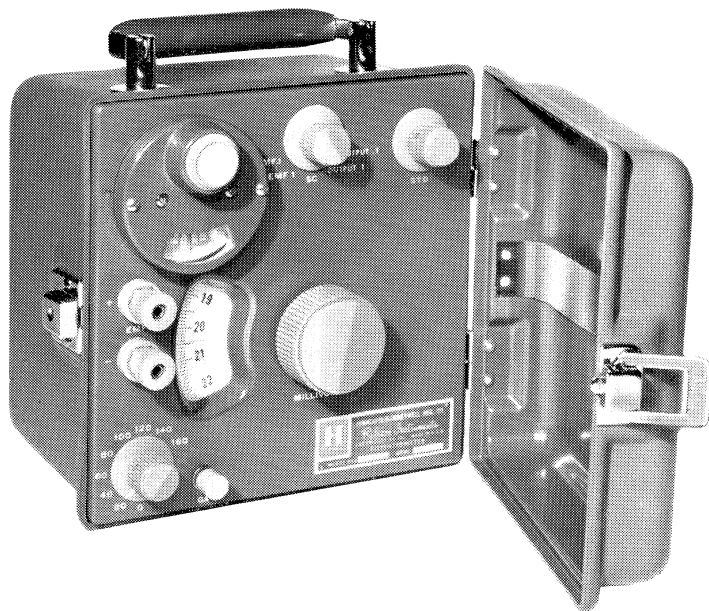
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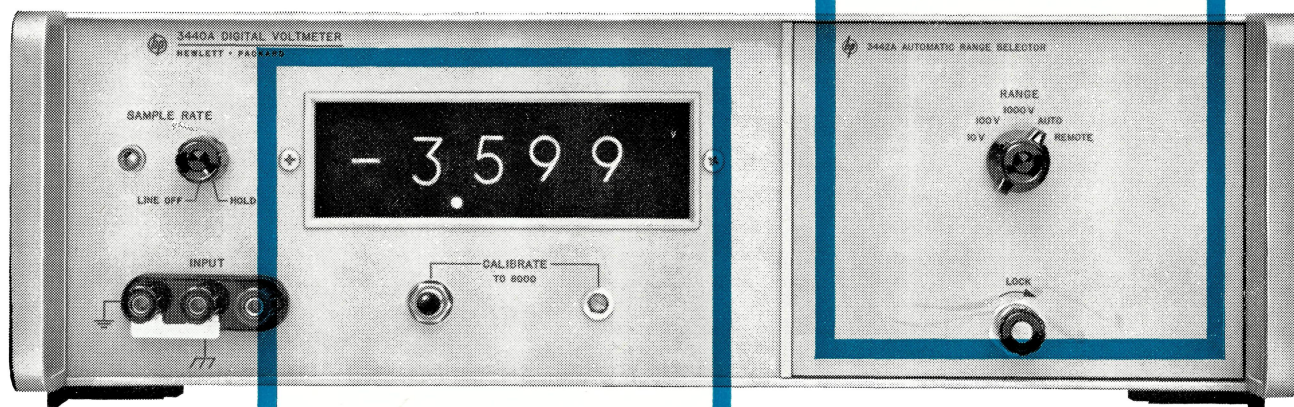


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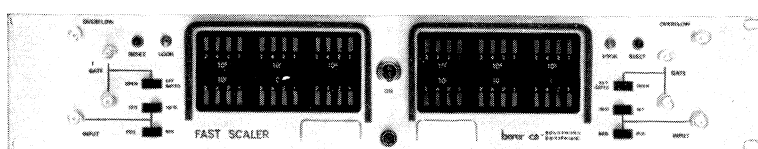
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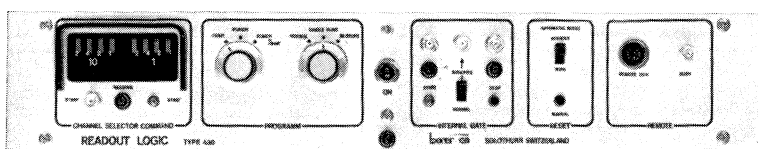
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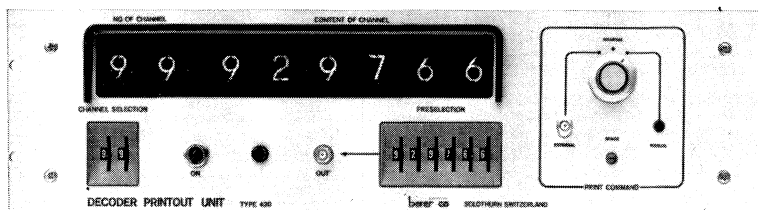
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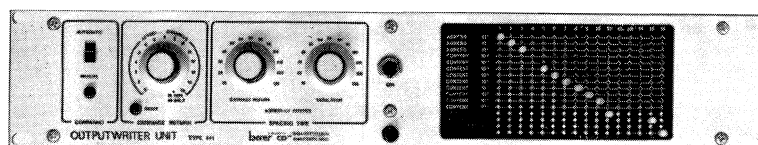
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Present staff members are invited to bring this notice to the attention of suitable potential candidates.

Application forms may be obtained from

Personnel Division (CC/64/11), CERN, Geneva 23, Switzerland