

BOOKS

The strange story of the quantum, by Banesh Hoffmann (Harmondsworth, Penguin Books Ltd., 1965; 4s. 6d.), tells in a lively, readable way the story of the rise of the quantum theory, from its first unseen stirrings in the photoelectric experiments of Hertz in 1887 to its final acceptance as a basic philosophy of science some fifty years later.

Unlike most 'popular science' books, this one does not set out primarily to explain one of the current topics, such as nuclear fission and its uses, but selects instead a history of ideas. As the story is unfolded, explanations take their place in it, and understanding of the ideas — their basic nature if not their intimate detail — comes to the reader in much the same sequence as it came to the physicists at the time.

Also unusual is the fact that this book is written with an emphasis on people, allied to a personification of the various theories involved, which brings the whole thing to life. As with a good detective story, one is led from page to page, anxious to know what will happen next. At the same time, because the author is a mathematician and one-time collaborator of Einstein and Infeld, the story has a ring of authenticity about it. The approach may shock some of the more serious students of the subject, but it will attract many people who would otherwise regard such things as quantum mechanics as being far too mysterious to warrant their attention.

One advantage of a book written in this historical fashion is that it does not get out of date quite so easily as those that attempt to explain the latest technological advances. This one was written originally in 1947 and revised in 1959, yet it does not give the impression of being dated. True it

ends in the 'turmoil' of parity non-conservation and remarks that isotopic spin 'seems destined to play a significant role in future developments', there are no muon neutrinos, resonances, SU_3 or inexplicable K^0_2 decays, but these are only new discoveries in the field in which quantum mechanics is valid; they have not changed its fundamental nature, at least not yet.

The style, and viewpoint of the book are well illustrated by the following extracts, taken from the introductory preface:

'The story of the quantum is the story of a confused and groping search for knowledge... illumined by flashes of insight, aided by accidents and guesses and enlivened by coincidences such as one would expect to find only in fiction.

'It is a story of turbulent revolution; of the undermining of a complacent physics that had long ruled a limited domain, of a subsequent interregnum predestined for destruction by its own inherent contradictions, and of the tempestuous emergence of a much chastened régime — Quantum Mechanics.'...

'The magnificent rise of the quantum to a dominant position in science and philosophy is a story of drama and high adventure often well-nigh incredible. It is a chaotic tale, but amid the apparent chaos one gradually discerns a splendid architecture, each discovery, however seemingly irrelevant or nonsensical, falling cunningly into its appointed place till the whole intricate jigsaw is revealed as one of the major discoveries of the human mind.'

This drama of discovery is told in a Prologue, two Acts (divided by an Intermezzo) and an Epilogue, with a Post-

their member States. This is why their officials are subject to a constant tension, in trying to decide whether to accept the ideology of the State to which they belong, or a more or less agreed division of power between rival groups (which would render the organization ineffective) or whether to work for a closer cohesion in the organization and a consequent gain in its authority.

The international official's links with his country of origin are important, because they keep him in touch with everyday reality and assist his thoughts and discussions on the choice available in practice between the interests of the many and of the few.

In a world where nationalism still prospers, the international organizations lead a hard life, but they remain one of the only means of reconciling divergent views. In the end it is not the training of the international official that is of greatest importance, but his sense of vocation, which must feed the hope of peace inherent in the organizations themselves.

Contributions to the discussion

These two interesting talks were followed by a sustained discussion, under the chairmanship of

Mr. Pierre Zumbach. The rather strained relations existing at the time with a section of the local population were referred to by Prof. A. Babel, President of 'La Commission de la Genève internationale', who was nevertheless confident that the people of Geneva would adopt a more positive view of their connexions with the 'internationals' and thus produce a lasting improvement. On the same theme, it was suggested that international employees should join Swiss professional associations, or local sports clubs, or interest themselves in church affairs or other activities in Geneva. A point put very strongly was that it was absolutely essential to learn French. There was also a proposal for a public debate between 'Genevois' and 'Internationals', covering all the points at issue.

The healthy growth of the international organizations was also a subject of discussion. Whilst it was certainly necessary to eliminate any 'Parkinsonian' increase, there was a risk that the ceiling at present imposed on the non-governmental organizations would seriously hinder their work in some cases.

All in all, an intensely stimulating evening that deserved to be followed up.

Ursula Reich

script added for the second American edition of 1959 (of which the English edition is a reprint).

On the first page of the Prologue we see Heinrich Hertz at work on the first experiments to detect radio signals, with no thought of wireless telegraphy but just to prove the correctness of Maxwell's electromagnetic equations. And because he was more interested in the phenomenon itself than its practical utilization he noticed a small effect that was destined to overturn the whole structure of physics. How this first came about is told in the five chapters of Act 1; the 'violet catastrophe', the invention of the energy quantum. Einstein's explanation of the photoelectric effect and the beginnings of the 'wave or particle' controversy, the rise of Niels Bohr's atomic theory and its final collapse as a ruin of contradictions (a fact that will come as a surprise to many readers, and possibly writers, who still believe that the atom really is just a miniature solar system).

After the Intermezzo, which warns of things to come, the next seven chapters, forming Act 2, show how the chaos of the late nineteen twenties gradually resolved itself into a usable theory. Here we find the story of the idea and the experimental proof that electrons were waves as well as particles, the growth of matrix mechanics, the wave equation of Schrodinger and the fundamental formulation of quantum electrodynamics by Dirac, Heisenberg's indeterminacy principle and the abandonment of causality, culminating in a new outlook of physics so different from that of half a century earlier and exemplified by the statement of Dirac that 'the only object of theoretical physics is to calculate results that can be compared with experiment and it is quite unnecessary that any satisfying description of the whole course of the phenomena should be given'.

In the Epilogue we read of the successes of the quantum theory in describing the early experimental results on the physics of the atomic nucleus rather than of the atom as a whole, the discovery of the positron (the first 'antimatter' particle), the neutron, artificial radioactivity, the idea of the neutrino, exchange forces and mesons, fission — and the sudden realization that all this disinterested, fundamental research, 'science for its own sake', had enormous practical applications.

The Postscript carries the story of the fundamental research further forward into the field of sub-nuclear physics; starting with Powell's discovery of the pion, and stopping for a moment with the shell model of the nucleus, it deals with such things as the fundamental 'infinities' of the wave equations, the Lamb shift and 'virtual' particles, renormalization, Feynman diagrams, strange particles, the overthrow of parity conservation in weak interactions, and ends perhaps on an appropriate topic in view of current events — the postulate of CP invariance!

Anyone who doubts whether the happenings of this 'drama' are as important as they are said to be has only to tot up the number of characters who have been rewarded with the Nobel Prize — no less than thirty-seven of them are named, not counting those who appear in the Postscript prior to their award.

Those familiar with the work of CERN and similar high-energy-physics laboratories will also discover many parallels between the events of today and those of the quantum

story. There is the same feeling of uncertainty with present theories, the sense of impending discoveries, the theoretical successes (ω minus) and disappointments (intermediate boson); present day physicists have taken over the 'group' algebras of the previous century in the way that the quantum theorists adapted the older mathematics of matrices and the work of Hamilton, for example; and so on.

But Hoffmann's book has an interest for everyone. With some 220 pages of text, in 'pocket' format, it is incredibly good value for money, and for those who wish to use it also for reference it is particularly well indexed.

A. G. H.

New perspectives in physics, by Louis de Broglie (Edinburgh and London, Oliver and Boyd, 1962; 30s.), is a collection of essays by a notable contributor to the field of modern physics who, incidentally, can also be said to have had two major influences on the life of CERN. The first was in 1924, when he produced his theory showing that a moving particle was associated with the propagation of a wave, and thus set physicists off on the whole development of wave mechanics without which high-energy physics would not exist; the second was in 1949, when he proposed to the European Cultural Conference the creation of a regional research organization, and thereby set in motion the events that led to the formation of CERN.

The book tells us quite a lot about the principles of wave mechanics, but much more about de Broglie, though this may not necessarily have been the author's intention. It is thus of interest not only to the student of physics, but also to the student of physicists (using 'student' in its broadest sense). Again, although it cannot be compared directly to Banesh Hoffmann's book (reviewed above), it forms an interesting commentary on the latter, from two points of view. Firstly, it shows that the rather light-hearted 'wars' between theories, and theorists, portrayed by Hoffmann were in many cases deep psychological struggles, in the search for both truth and self respect; secondly, it highlights in a very personal way the fact that there are some weaknesses in the foundations on which the edifice of quantum mechanics has been built.

For de Broglie himself has become a rebel against the 'establishment'. After agreeing with the accepted notions of wave mechanics for nearly 25 years he reverted to his own earlier interpretation of the theory, which he has struggled to develop ever since. Two thirds of this book are devoted to the story of this change of heart, its meaning for physics and its meaning for himself.

It is not a continuous account. Each chapter is the text of a paper or lecture dealing with the history and philosophy of science, written in the period 1950 to 1956. They have all presumably been published elsewhere but it is one criticism of this book that very little, if any, information is given to enable the originals to be traced. Since each paper is self-contained and covers much the same subject matter as a number of others, there is a considerable amount of repetition of the main points. However, this does not spoil the interest of what the author has to say; indeed it is probably a help for those who are not very familiar with the quantum theory in any form.

The first six chapters deal with various aspects of the 'orthodox' quantum theories, including a discussion of the essential difference between 'boson' and 'fermion' waves and the theory of 'second quantization', the Lamb-Rutherford experiment on the hyperfine structure of the lines in the hydrogen spectrum, the nuclear field, and atomic particles. In dealing with the latter the author develops the idea that only particles with spin $1/2$ can be 'fundamental', all others being combinations, a proposition that now appears very simple beside the multitude of 'particles', 'resonances', etc. that have since been discovered and the symmetry theories (SU_3 , SU_6 and so on) that have been invoked to give their classification a semblance of order. Discussions of cybernetics and crystal structure, both from the point of view of quantum theory and wave mechanics, ends this first section, written before 1951.

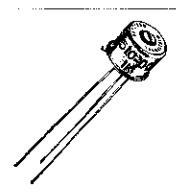
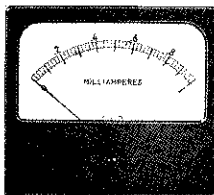
In the next four chapters, which provide perhaps the main point of the book, de Broglie describes, in varying ways, his changing attitude towards wave mechanics. At first he strove to interpret it in a manner that would be in keeping with traditional physics and the idea of causality, enabling physical reality to be represented by means of precise images in space and time. By 1927 he had arrived at the idea of the 'double solution', which postulated that there should be two solutions to the wave equation of a particle; one being that which is generally supposed to be the *only* solution, the other giving a full description of the motion of the particle for all time. At the Fifth Solvay Congress in 1927, however, this theory met with little recognition in the face of the probability ideas put forward by Bohr, Heisenberg, Born, Pauli and Dirac. As a result, de Broglie dropped his own approach and lent his support to the development of the 'orthodox' theory which proceeded to dismiss causality as a nineteenth-century dream and accept complementarity as a proven fact. In 1950-51, however, after a critical review of the statistical interpretation undertaken for a course of lectures he was giving, his doubts returned, and they were reinforced by the work of Bohm and Vigier*. Since then he has worked with Vigier to find an explanation of the wave-particle dualism which would not only be consistent with the present views, and particularly the experimental results, but supply the connexion that is still missing between the theory of general relativity and that of quanta.

Their main approach has been through the theory of the double solution, one advance being the postulate that the 'u-wave', which would describe the physically real particle, obeys a non-linear equation which is identical with the linear equation of the ' ψ -wave' — the normal probability wave — outside the immediate region of the particle. In this way the ψ -wave solution would still appear to 'guide' the particle, providing a probability distribution for its appearance at any point in space and time, whilst the u-wave would actually give the trajectory of the individual particle. To take the example of the diffraction pattern produced by light passing through two slits, the ψ -waves show what the pattern will look like, the u-waves show which slit each individual particle goes through — a determination that is regarded as impossible by complementarity.

De Broglie's attitude is obviously conditioned by the fact that right from the beginning he has 'preferred to interpret the whole problem by means of intuitive physical images

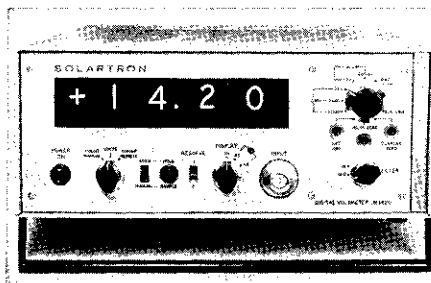
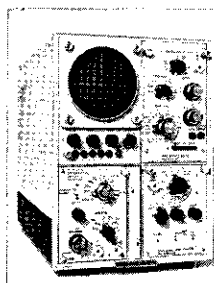
* See, for example, **Quanta and reality**, reviewed in CERN COURIER, vol. 4, p. 124, September 1964.

WESTON



Weston connu dans le monde entier comme le plus ancien producteur d'appareils de mesures électriques de haute qualité s'est spécialisé également dans la production d'éléments de précision pour utilisation en électronique. Instruments pour tableaux électriques, appareils portatifs de laboratoire et de service, pinces volt-ampérométriques photo-cellules de mesure, relais, potentiomètres-Trimmer, éléments de servo-mécanisme.

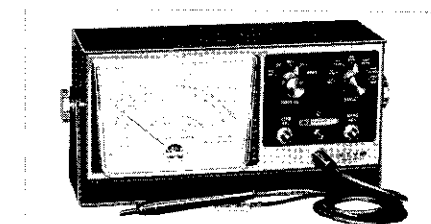
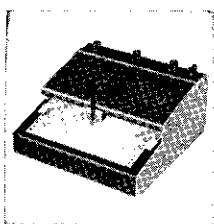
SOLARTRON



SOLARTRON compte parmi les plus importants producteurs européens d'appareils électroniques. La nouvelle série d'instruments se signale par une haute précision, une construction robuste et moderne ainsi que par des prix avantageux.

Oscilloscopes, voltmètres numériques, alimentations stabilisées, générateurs d'impulsions, oscillateurs, amplificateurs de mesure, calculateurs analogiques, installations de surveillance pour utilisation industrielle.

HEATH



HEATH est le plus grand fabricant du monde d'appareils électroniques «Construisez vous-même». Les appareils Heathkit sont appréciés depuis des années par une clientèle de plus en plus nombreuse et sont comparables à tout produit fini au point de vue qualité.

Le programme de fabrication est très vaste, plus de 250 appareils de mesures électroniques, émetteurs, récepteurs, radiotéléphones, ensemble de haute-fidélité, matériel didactique, appareils destinés aux navigateurs de plaisance, aux automobilistes, etc.

Tous les appareils sont livrables en boîtes de construction ou prêts à l'emploi.

Par ailleurs, en tant que Société Suisse du Groupement Schlumberger, nous représentons également les intérêts des Sociétés suivantes: EMR - ROCHAR - ACB - SEMAC - TOLANA - LEGPA - LE BOEUF.

Vente et service

DAYSTROM SA GENÈVE ZÜRICH

8, avenue de Frontenex, 1211 Genève 6, tél (022) 35 99 50.
333, Badenerstrasse, 8040 Zurich tél. (051) 52 88 80.

rather than by mathematical abstractions', though of the later work he says: 'We have drawn a clear distinction between subjective and objective reality, a distinction which seems to have gone by the wayside in the usual statistical interpretation of wave mechanics'. At the same time, he recognizes that the mathematical difficulties are almost insuperable, and that we might in the end have to be content with the purely statistical view, though he nevertheless thinks that the attempt to find an alternative explanation is worth making.

To conclude this second section of the book there is a personal account of the author's meeting with Einstein, for whom he obviously had a great respect, at the Solvay Conference. The remaining pages contain comparatively light-weight pieces on 'questions of general interest' and the history of science. Although intended by the author as a 'reward for the reader's patience' they do not have the interest of the earlier papers.

The whole book has been translated from the original French by A. J. Pomerans, who has produced an English text whose style is exactly in keeping with its content. This is a volume that contains much of interest, whether one accepts de Broglie's views or not, or even if one is in no position to decide.

A. G. H.

The world nuclear directory (London, Harrap Research Publications Ltd., 2nd edition, revised and enlarged, 1963;

£10 10s.) is a handsomely bound big book that covers 76 countries as well as international nuclear organizations.

Information is given concerning national atomic energy agencies, authorities, boards and commissions; other government departments including the armed services; privately sponsored research organizations; universities and colleges with research departments; professional and learned societies and trade associations; medical bodies and societies; insurance groups and companies; conferences, congresses and exhibitions; industrial firms consortia; and industrial firms. The entries are arranged in this order under each country, the book being in alphabetical order of countries. In its 544 pages, the volume also lists nuclear periodicals published throughout the world. The index of firms, institutions, organizations and periodicals that concludes the volume will certainly be appreciated by many users of the book.

No such work can possibly claim to be altogether complete and up to date and the publishers are fully aware of this, as expressed in their introduction. Conspicuous, for instance, is the absence of *Physical Review* and other publications of the American Institute of Physics, and many entries are obviously based on information supplied a year previously, as is the case for CERN and the Centre d'Etudes de l'Energie Nucléaire in Belgium. Nonetheless, the volume can be recommended as an extremely useful addition to the shelves of all libraries, offices or individuals whose activities are related with the rapidly expanding field of nuclear matters.

R.A.

Heraeus Vacuum Pumps small sizes for laboratory use

have been extremely successful.

The engineers of HERAEUS adopted the 3-vane principle and practical use has proved the suitability of their choice. The steadiness of the final pressure and the quiet run of these pumps are excellent. Wear is extremely slight because of the built-in oil filter.

Type E 2	1 stage	2 m ³ /h
Type DS 1	2 stages	1 m ³ /h

WISMER AG

Oerlikonerstrasse 88, 8057 Zurich, Tel. 051 46 40 40



has a vacancy for a

Senior Electronic Engineer

Graduate physicist or engineer with at least five years' experience in practical and theoretical digital electronics and computer logic. Experience in leading a group of electronic engineers and technicians doing development and maintenance work on a variety of electronic equipment is essential. Good knowledge of English or French essential, some knowledge of the other language desirable.

His assignment will be to design and construct special-purpose equipment for local and remote connection to a CDC 6600 computer. The equipment concerned will include local and remote consoles and apparatus for the analysis of data from nuclear-physics experiments. This work will include collaboration with electronic engineers in other Divisions on all questions relative to connection of experimental equipment to the computer.

To co-ordinate the work of the various electronic projects undertaken by the Data Handling Division, which includes development of flying-spot digitizers to be used on-line with the CDC 6600 for the automatic measurement of bubble-chamber and spark-chamber films, as well as modification and maintenance of existing equipment.

CERN plans at present to take over the maintenance of the CDC 6600 computer during 1966 or 1967. In this case, the building up and supervision of a suitable maintenance team will also be part of the job assignment.

Candidates (who must be nationals of CERN Member States) are invited to write for an application form, quoting reference CC/65/6 to:

Personnel Division, CERN, 1211 Geneva 23, Switzerland

3 more Plug- ins

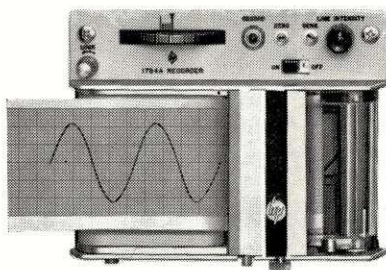
FOR YOUR
hp 175A
OSCILLOSCOPE
SYSTEM

hp 1784A

Strip Chart Recorder

Just push a button to automatically record repetitive waveforms to 30 mc. Cost is $\frac{1}{20}$ th that of standard photograph.

Price: Fr. 3576.-

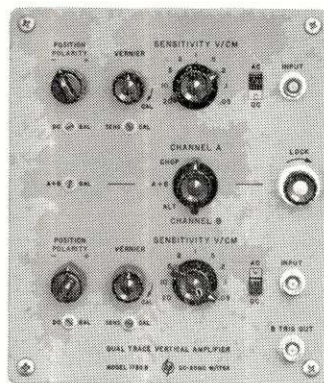


hp 1750 B

50 mc Dual Trace

Maximum Sensitivity is 50 mV/cm. Simplified triggering insures stable dual trace display.

Price: Fr. 1488.-

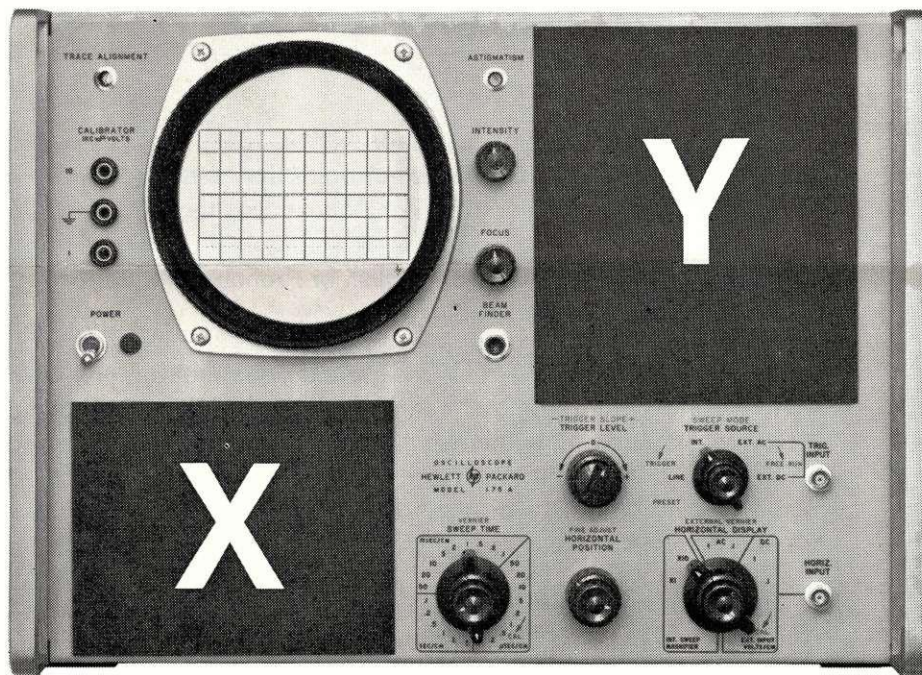
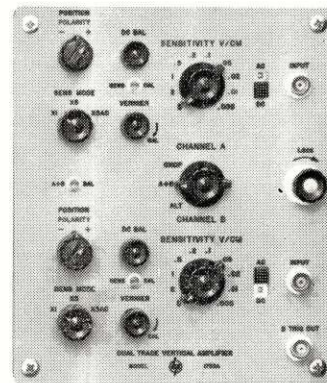


hp 1755A

High Sensitivity Dual Trace

With one plug-in: High Frequency (50mc, 10mV/cm) or Low Level (20mc, 1mV/cm) operation. DC or AC coupled. Simplified triggering as in 1750B.

Price: Fr. 2652.-



Y	175A Oscilloscope	(without plug-ins)		Fr. 6082.-
	ADDITIONAL PLUG-INS FOR Y 175A OSCILLOSCOPE			
	1751A Single Channel Amplifier	50 mc	50 mV/cm	Fr. 746.-
	1752B High Gain Amplifier	30 mc (or 40 mc)	5 mV/cm (50 mV/cm)	Fr. 1308.-
	1754A Four Channel Amplifier	40 mc	50 mV/cm	Fr. 2711.-
X	1781B Sweep Delay Generator	offers four different sweep modes		Fr. 1488.-
	1782A Display Scanner	for transferring CRT picture to x-y-recorder		Fr. 1937.-
	1783A Time Mark Generator	supplies 10 μ sec, 1 μ sec, 0.1 μ sec markers with 0.5% accuracy		Fr. 606.-
	Prices are subject to change without notice.			

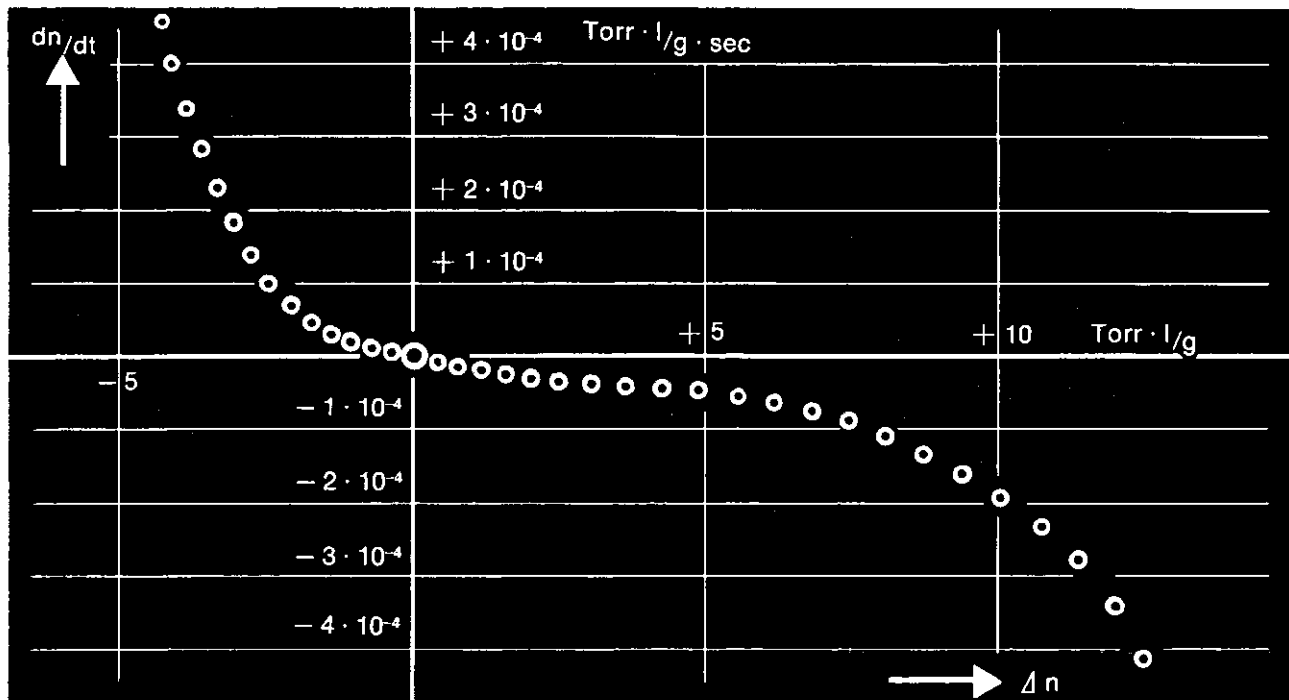
HEWLETT  **PACKARD**

Distributor for Switzerland:
Ingenieurbüro M. P. Frey, Wankdorfstrasse 66, Bern, Telefon 031/42 00 78

Headquarters in USA:
Palo Alto (Calif.)
European Headquarters:
Geneva (Switzerland)
European Plants:
Bedford (England)
Böblingen (Germany)

Adsorption and Desorption of Water Vapour on «Molecular Sieve 5 A»

$p_1 = 0.060$ torr, $p_2 = 0.085$ torr, $T = 320$ °K



SORBOPRINT SPG 1

A complete measuring equipment for:

Adsorption

Isobar measurement of the adsorption or desorption rate. Also determination of adsorbed or desorbed gas quantities.

Absorption

Determination of coefficients of diffusion and of gas solubility.

Permeability

Determination of the penetration times. Measurement of diffused gas quantities.

Drying

Determination of the solvent content. Measurement of the drying speed.

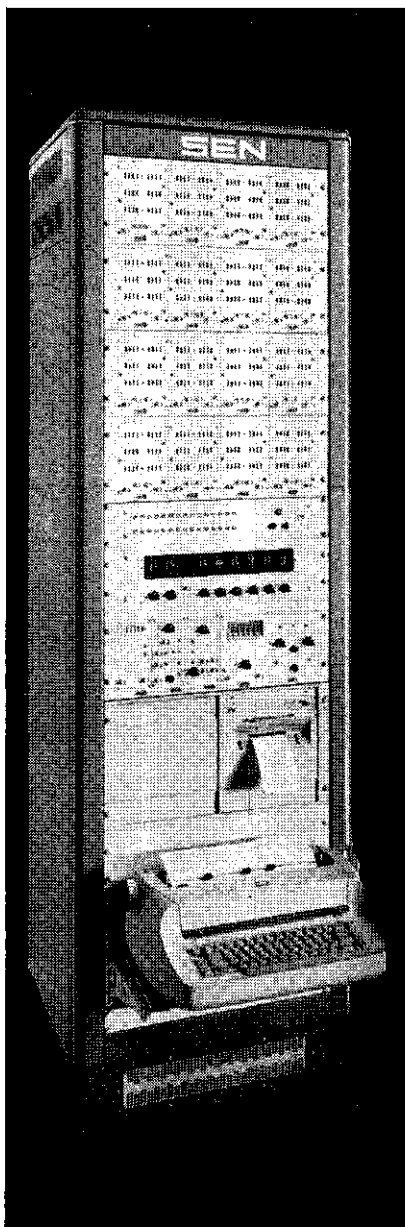
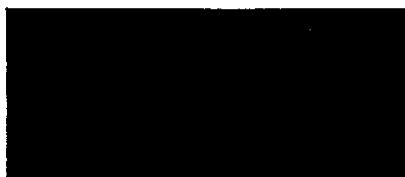
BET-isotherms

Determination of specific surfaces.

BALZERS®

BALZERS AKTIENGESELLSCHAFT FÜR HOCHVAKUUMTECHNIK UND DÜNNE SCHICHTEN
FL-9496 BALZERS • PRINCIPALITY OF LIECHTENSTEIN

DISTRIBUTED BY BENDIX-BALZERS VACUUM, INC. ROCHESTER, NEW YORK



35 Mc MULTISCALER SYSTEM

WITH AUTOMATIC RECORDING OF INFORMATION

Completely transistorised
Guaranteed to work up to 55° C (131° F)
version of the system developed at CERN - the European
Organisation for Nuclear Research.
Compatible with CERN standard systems.
Results recorded by print, punch or magnetic tape.
Rapid adaptation by general control unit to all usual recording
systems.
Scaler input level : 500 mV min., 12 V max. Resolution better than
30ns with triple pulsing.

ACCESSORY PLUG-IN UNITS :

- Code converter
- Time base
- Delay unit
- Control unit
- Scaler convertible from 2 × 3 to 1 × 6 decades
- 10 channel pattern unit
- Parameter indicator
- Remote control box

OTHER PRODUCTS :

- Fast discriminators
- Fast linear gates
- Triple coincidence units
- Delay boxes
- Attenuators
- Photomultiplier bases
- Transistorised power supplies

STUDY AND DEVELOPMENT OF SPECIAL APPARATUS

PLANNING AND PRODUCTION OF EQUIPMENT FOR INDUSTRIAL AUTOMATISATION AND DATA HANDLING

SEN

SOCIÉTÉ D'ÉLECTRONIQUE NUCLÉAIRE

73, RUE DE LYON - GENÈVE/SUISSE - TÉLÉPHONE : (022) 44 29 40

AGENTS : ZÜRICH OFFICE : M. Georges HERREN, Dipl. Ing. ETH. ● FRANCE : S.A.I.P. MALAKOFF (Seine) ● ITALY : SOC. EL. LOMBARDA-SELO MILAN ● GERMANY : HERFURTH GmbH. HAMBURG-ALTONA ● HOLLAND : DESSING-ELECTRONICA AMSTERDAM-Z ● SWEDEN : OLTRONIX A.B. VÄLLINGBY/STOCKHOLM ● U.S.A. : NUMINCO APOLLO, Pa. ● ISRAEL : PALEC LTD. TEL-AVIV ● AUSTRALIA : A.A. GUTHRIE PTY, Ltd. MARRICKVILLE, N.S.W. ●