

BOOKS

The boundaries of science, by Magnus Pyke (Harmondsworth, Pelican Books Ltd., 1963; 4s. 6d.), is an essay in the philosophy of science rather than a 'popular science' book of the usual kind. Instead of explaining a particular scientific topic it sets out to show something of what science itself is, using examples drawn mainly from the fields of chemistry, physics, biology and astronomy. On the whole, it fulfils this task extremely well, and the book can be read with profit not only by the 'layman' but by many scientists and engineers who have become a little lost in the day-to-day progress of their own speciality.

The author, a biochemist and director of a large industrial research station, begins by denying the short dictionary definition of science as 'ordered knowledge' and substituting for it 'a way of thinking'. Science, he believes, comprises two main tenets; the first has three parts — the collection of facts, the construction of hypotheses, and the selection of further observations to test the hypotheses; the second is the assumption that the universe is a systematic and ordered place and that every observation is eventually capable of rational explanation.

One of the legacies of the former view of science has been its sub-division into the branches of physics, chemistry, biology, etc., but more than sufficient evidence is given in the first chapter of this book to show that such sub-divisions are no longer tenable. Even professional specializations, although usually narrower in scope, cut across the former boundaries.

In the second chapter, the author shows how modern chemistry falls much more naturally under the old heading of physics, even if the chemist still has to learn his own

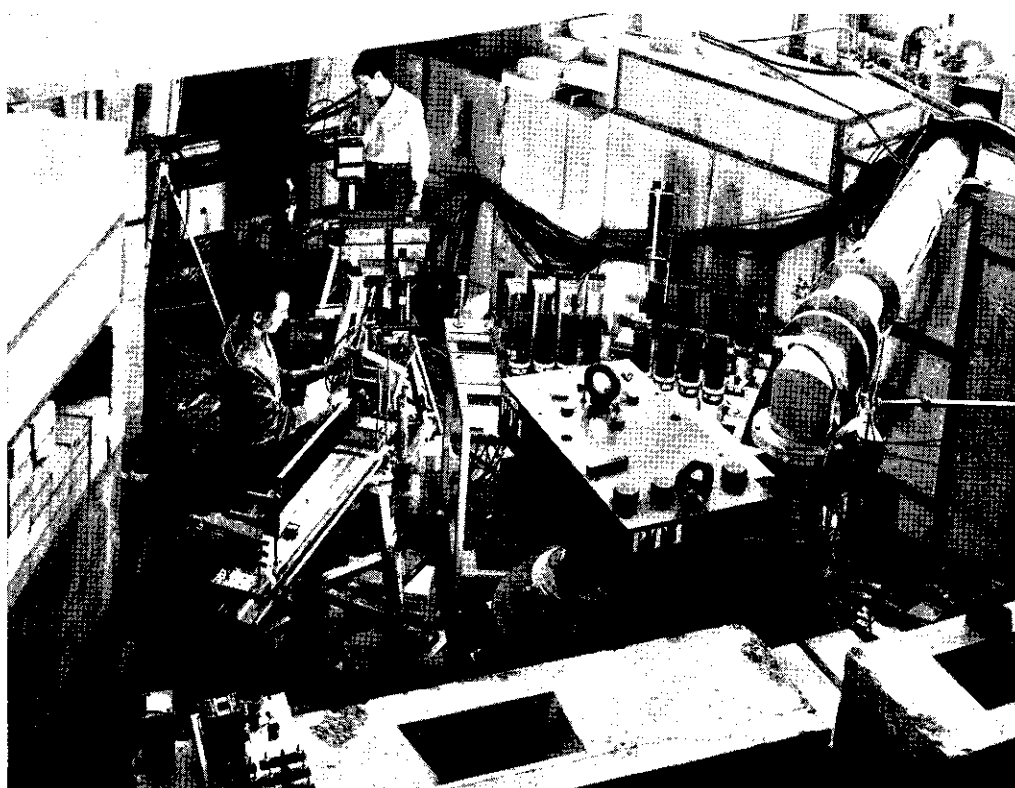
particular trade, and physics itself is taken up in the following pages. Is biology chemistry? the author then asks, and proceeds to prove that in many respects it is — but as chemistry it is therefore physics! A common link in all three subjects is the concept of energy, and the next chapter deals with this in its various forms.

If this first half of the book is concerned more with a much needed re-interpretation of established ideas, the second part goes further into the realms of philosophy. The chapter on 'evolution: animate and inanimate' introduces the idea that our present way of thinking about science represents an evolutionary advance, compared with the attitude of Galileo's time, for instance, and goes further to suggest that higher evolutionary steps may be in store. This leads the way to a discussion of the brain as an electronic machine, in the course of which an important distinction is made between 'reflex' actions, which can also be done by electronic computers, and the seeing of new and unexpected purposes, of which only brains are capable. This kind of distinction, between the careful routine of applied science for instance, and the flash of intuition of a Newton, an Einstein or a Heisenberg, is brought more than once into the book.

The traditional 'layman's' idea of science as something exact, with predictable applications, is further undermined in the next chapter, which deals with the lack of precision inherent in words, or even in numbers, the difficulties of ascribing an exact cause to a particular event, the corresponding ease of drawing wrong conclusions because of preconceived notions, and the ideas of statistics. The subject of astronomy is then used as an example to carry the argument forward, concluding with an interesting commentary on the true nature of science: 'Astronomers are not

This photograph gives a general idea of the scintillation-counter lay-out for the SC experiment on the scattering of polarized protons reported on p. 116. The polarized-proton target is hidden by its magnet (marked PT 1); incident protons reach the target through apertures in the concrete shielding (foreground) and the magnet yoke. Protons scattered to the right at any one of eight chosen angles are detected by means of coincidences between the signals from the corresponding pair (one behind the other) of plastic scintillation counters, clearly visible; absorbers between some of the pairs are for energy measurements. To the left of the target can be seen a long plastic scintillation counter, with two photomultipliers, of the type mentioned by Prof. Cocconi in last month's CERN COURIER (p. 105). Protons recoiling from the target travel in this direction and the position of each one as it strikes the counter is measured, thus defining its direction of travel. In this way each scattered proton can be associated with its corresponding recoil proton, separated from the general background. Other counters in the background are used in lining up the beam. G. Goignat is adjusting the counter on the left and J. Monmejat is at the back.

CERN/PI 97.7.65



really interested in firing ironmongery round the moon, what excites them is the fact that they feel themselves to be on the verge of learning something fundamental about form, order, and change in the world at large'. It would be easy to substitute 'high-energy physicists' for 'astronomers' in this statement.

The boundaries of science are reached in the last chapter, which summarizes many of the foregoing arguments and introduces Gödel's 'incompleteness theorem' to show that there is an absolute philosophical limit to physical thought — human reason is incapable of achieving a watertight proof of its own rationality. One of the boundaries of science is thus the mind of the scientist; the simplicity of the final atomic particle (assuming it to exist) is the end and the unprovable mathematical principles by which it is governed is the boundary. On the other side, the frontier is the complexity of biological chemistry. 'It is inconceivable that anyone ever will be able to make a shearwater', says the author, and who will disagree with him? The third boundary is of a different nature, but just as real: 'Purpose, aesthetics, impulsiveness, ethics — these are outside the boundaries of science', is the last sentence in a well-written, intelligent and thought-provoking book which, with 200 closely printed pages, 'pocket' format, for 4/6, is very good value for money. There are a few errors of fact, and the discussion of elementary particles is now out of date, but in this context such things are not so very important.

A.G.H.

Plutonium, by M. Taube (Oxford, Pergamon Press Ltd., 1964; 60 s.).

Only twenty years ago, in the course of a piece of pure scientific research, the first man-made elements, with atomic numbers 93 and 94, were produced. Now we have a book surveying the tremendous wealth of detailed knowledge that has been accumulated concerning the physics, chemistry and metallurgy of the element plutonium, an element which is now produced in a few countries in ton quantities annually and whose appearance has meant multiplying by a large factor the world's known reserves of energy, both those for peaceful purposes and those for self-destruction. Until the last few years all of this knowledge was a matter of tightly held secrets for these few countries, but at the 1958 U.N. Conference on the Peaceful Uses of Atomic Energy there was a sudden rush to release this information.

The present book unfortunately contains no references later than 1961, but nevertheless provides a useful broad outline of the subject and a very large list of references for those who wish to know more. The opening chapter describes the physical properties of plutonium and, in particular, the characteristics of the neutron interactions with the various isotopes. The author is a chemist, however, and it is on the chemistry of plutonium that he is at his best and goes into the greatest detail. Many block diagrams and tables are used to describe the various processes for the separation of plutonium from uranium and fission products, its analysis, and general chemistry. Plutonium is one of the most toxic substances known and a special chapter is devoted to the physiological effects of plutonium, and its health physics. The later chapters deal in detail with the metallurgy of plutonium, its preparation

into fuel elements for nuclear reactors, and its influence on the economics of nuclear power.

This edition is a translation from the original Polish one. The result of the translation is a quite readable work and only one serious error was noticed — the confusion between the use of 'delayed' as applied to neutrons resulting from the time-delayed radioactive decay of fission products and its wrong use when applied to neutrons which are really 'slowed' (on a velocity scale) by collision. In his efforts to be as complete as possible, the author has unfortunately dragged in a variety of irrelevant pieces of information, such as the photograph of a large white building with a chimney which is supposedly a plutonium factory but could equally well be a gas work. This is a minor criticism, however. The book is a useful work.

C. R. Symons

The structure of atoms and molecules, by V. Kondratyev (Groningen, P. Noordhoff N.V.; Dfl. 30).

This book, translated from the Russian into English by G. Yankovsky, covers a great deal of ground: experimental methods, numerical results, models that explain the results, and quantum theory for the derivation of the models. Such a method of presenting experiment and theory at the same time emphasizes the physical concepts and makes the book easy to read.

The main topic of the book is, as might be expected, atomic and molecular spectroscopy, and the chapter headings are: electrons and quanta, atomic nucleus, electronic structure of atoms, the quantum-mechanical theory of the atom, the spectroscopy of atoms, the atom in a force field, the nature of chemical forces, molecular spectra, electrical and magnetic properties of atoms and molecules, molecular constants. An idea of the level at which the book is written can be gained from the fact that the second chapter, covering the whole range of nuclear physics, does not include any quantum mechanics. Bohr's quantum condition comes in the middle of chapter 3.

A theoretical physicist may be slightly disappointed: Dirac's equation, the Hartree-Fock method, and the theory of radiative transitions, for example, are omitted; the method of adding angular momenta is not properly derived. Such things as the periodic system of the elements, on the other hand, are nicely explained. The book contains numerous figures and tables, but unfortunately there is no author index and the subject index is very short.

H.P.

Radiation sources, edited by A. Charlesby (Oxford, Pergamon Press Ltd., 1964; 80 s.).

This volume (which includes the work of several authors) describes the sources of ionizing radiation that are used particularly in the field of applied radiation and in industry,

either for chemical, biological, medical or agricultural research, or for sterilizing food.

The various chapters deal briefly but clearly with the following subjects: nuclear reactors (with the exception of very powerful ones or those used for military purposes); high-intensity isotopic radiation sources; Van de Graaff accelerators; electrostatic-cylinder generators; resonant-transformer electron-beam generators; powerful sources for industrial irradiation; and linear accelerators. Technical details concerning installation in a laboratory, as well as capital and operating costs of the equipment, are given for each type.

A chapter is included on radiation protection in the laboratory and in industrial plants, and another (very short) on measuring energy and neutron fluxes.

The book is obviously a practical one, intended to serve as a guide for those wishing to instal radiation sources of a certain power for research, clinical or industrial purposes. It consists of 268 richly illustrated pages covering the various types of equipment and their installation, and there is a wealth of diagrams and tables. The bibliography, which is given separately for each chapter, has been brought up to about 1961.

Antonio Pasinetti

Last month at CERN (cont.)

promising technique for experimental physicists, from the points of view of both ease of transport and ease of operation.

Annual General Meeting of CERN Staff Association

On Wednesday 2 June the Main Auditorium at CERN was well filled for this year's Annual General Meeting of the Staff Association. Representatives from the Staff Council of the United Nations were also present and messages were received from the Staff Associations of the World Health Organization and the International Telecommunications Union, who were unable to send observers.

A summary of the activities of the previous year was given by Dr. G. Vanderhaeghe, the retiring Chairman of the Association, and both this report and the financial report were unanimously approved by the meeting. An important task of the Committee had been to make a careful examination of the **Statutes of the Association**, in the light of experience since it was set up and of the growth and consequent changes that have taken place in CERN as a whole. As a result, a completely revised set of Statutes had been produced and circulated before the meeting. These were adopted in principal, but a committee is to be charged with their final drafting, in the two official languages of the Organization, before final submission to the members of the Staff Association for approval.

An important organizational change adopted in the new Statutes was that in future, instead of the separately elected Committee and Chairman, there will be an elected Staff Council, which will itself elect an Executive Committee, including a Chairman, from

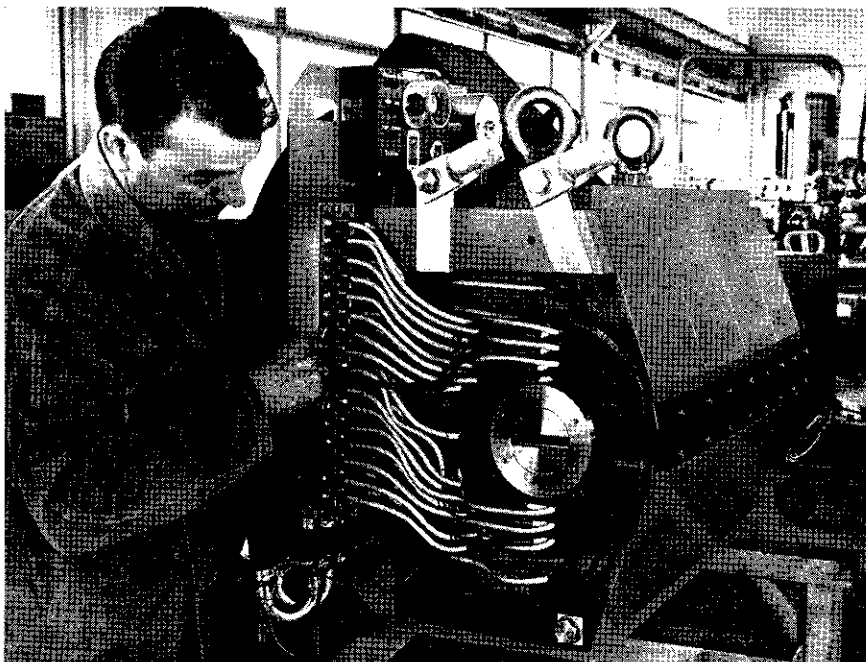
among its own members. Moreover, to provide continuity, only half the Council will retire each year, each member being elected for a 2-year period. Among other things discussed at the meeting, the previous Committee's proposals for new electoral groups for the election of the Council were approved unanimously. The proposal to maintain annual subscriptions on a voluntary basis and at the previous levels (Fr. 5.— for grades 2 to 5, Fr. 10.— for grades 6 to 9 and Fr. 15.— for grades 10 to 14) was also approved, after

various other suggestions had been put forward.

In the **elections** that took place later in the month, 44 members were appointed to the Council, with 32 deputies. The **Executive Committee** has been appointed as follows:

Pierre Lazeyras	President
Jacques Gioria	Vice-president
Aldo Michelini	Vice-president
Joan Rice	Secretary
Claude Degrange	Treasurer
Eugénie Iseli	Journal

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Because particles such as protons, pions and kaons can be guided from one place to another and 'sorted' in momentum by magnetic fields, in much the same way as light can be sent from place to place (and 'sorted' into different colours) by means of prisms and lenses, the design and construction of suitable electromagnets plays a large part in the technology of sub-nuclear physics. In this photograph, Antoine Magouriot, of CERN's TC Division, is seen with a new magnet (TC 15) developed in the Division and now installed at the beginning of the m_s beam line which provides antiprotons, pions or kaons for the 81-cm Saclay/Ecole Polytechnique (Paris) hydrogen bubble chamber. It is this magnet which directs the particles away from the synchrotron towards the next magnet in the beam line. It is small, so that it can be fitted close in to the target, and powerful since it has to bend the particles as soon as possible in the direction of the bubble chamber. The distance between the poles is 21 mm and the pole length 840 mm (effective length 870 mm). A field of 21 300 gauss is produced, using a total current through the coils of 800A with a current density of 50A/mm². This exceptionally high value is obtained by using an advanced system of cooling for the coils, and the connecting pipes for the many parallel circuits are clearly seen in the photograph; it is of interest to compare the thickness of the bus bars carrying the current to and from the coils with the thickness of the coil conductor itself.



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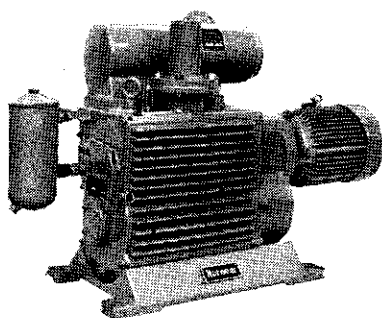
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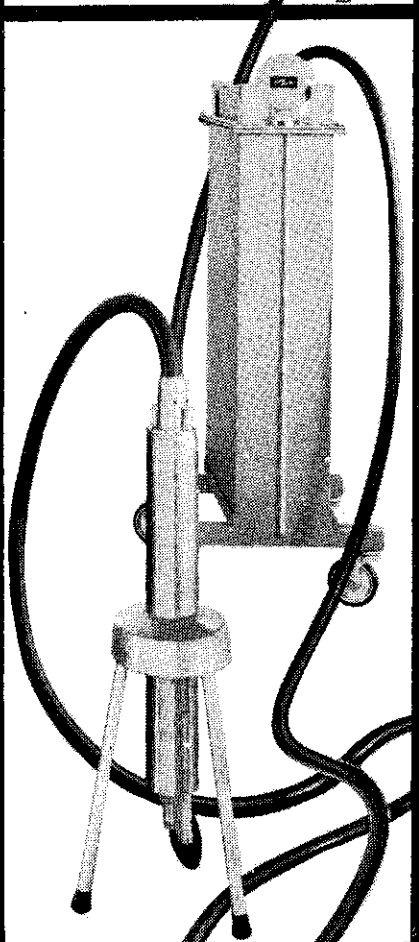
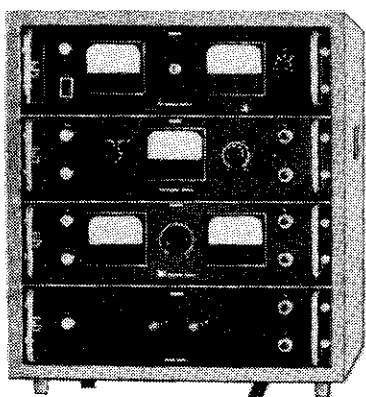
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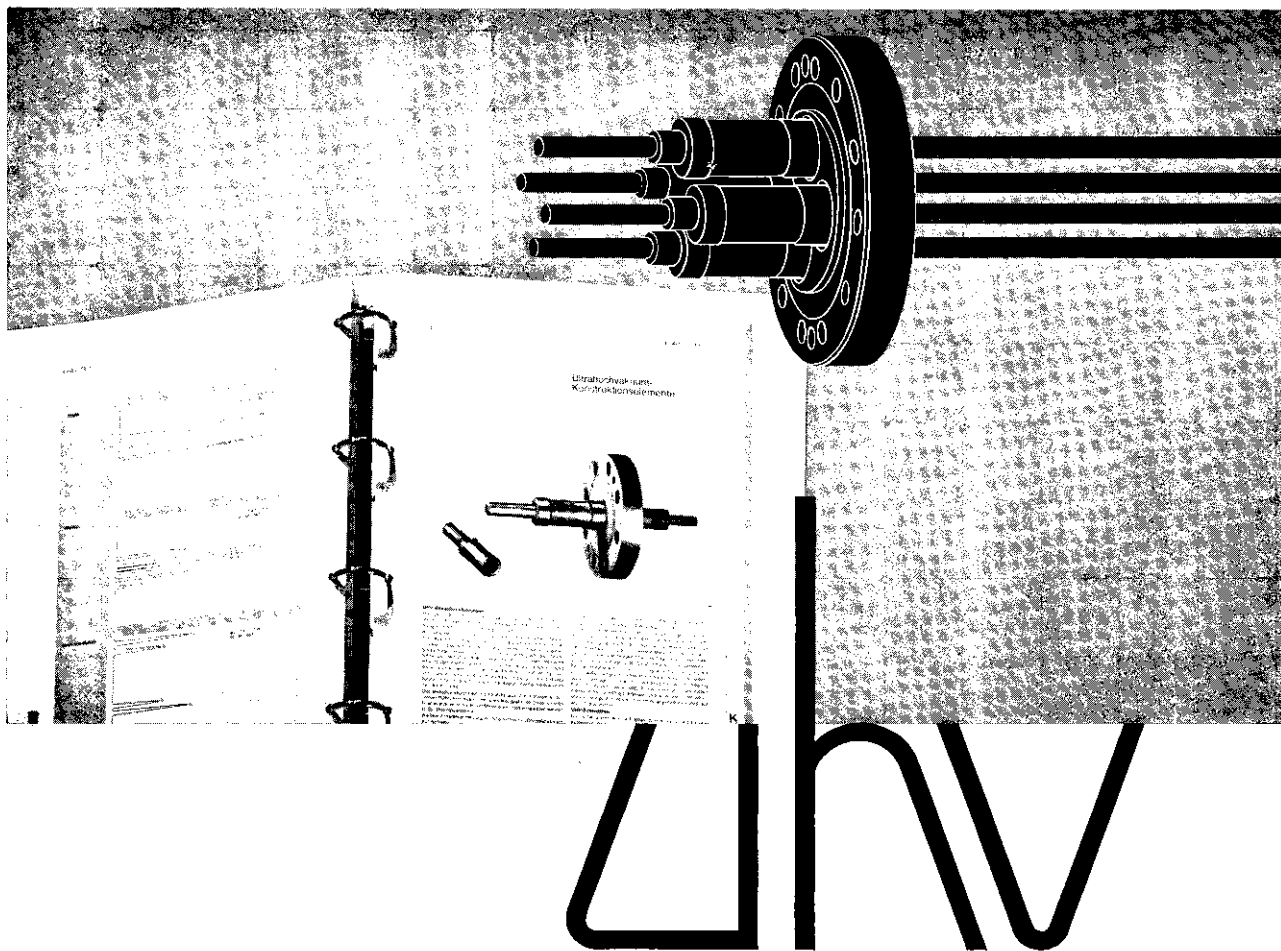
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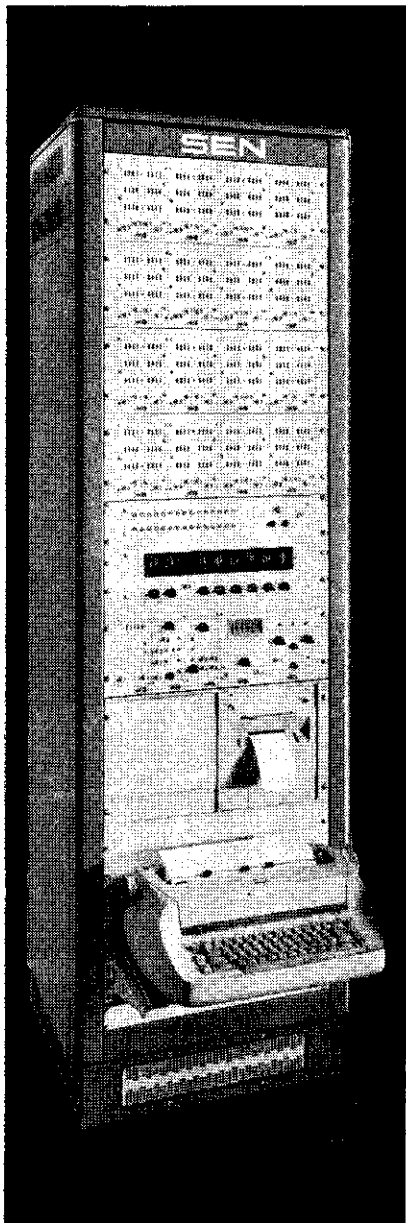
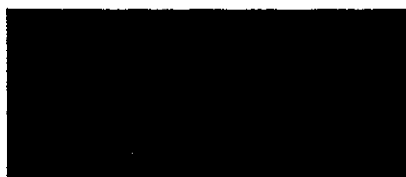
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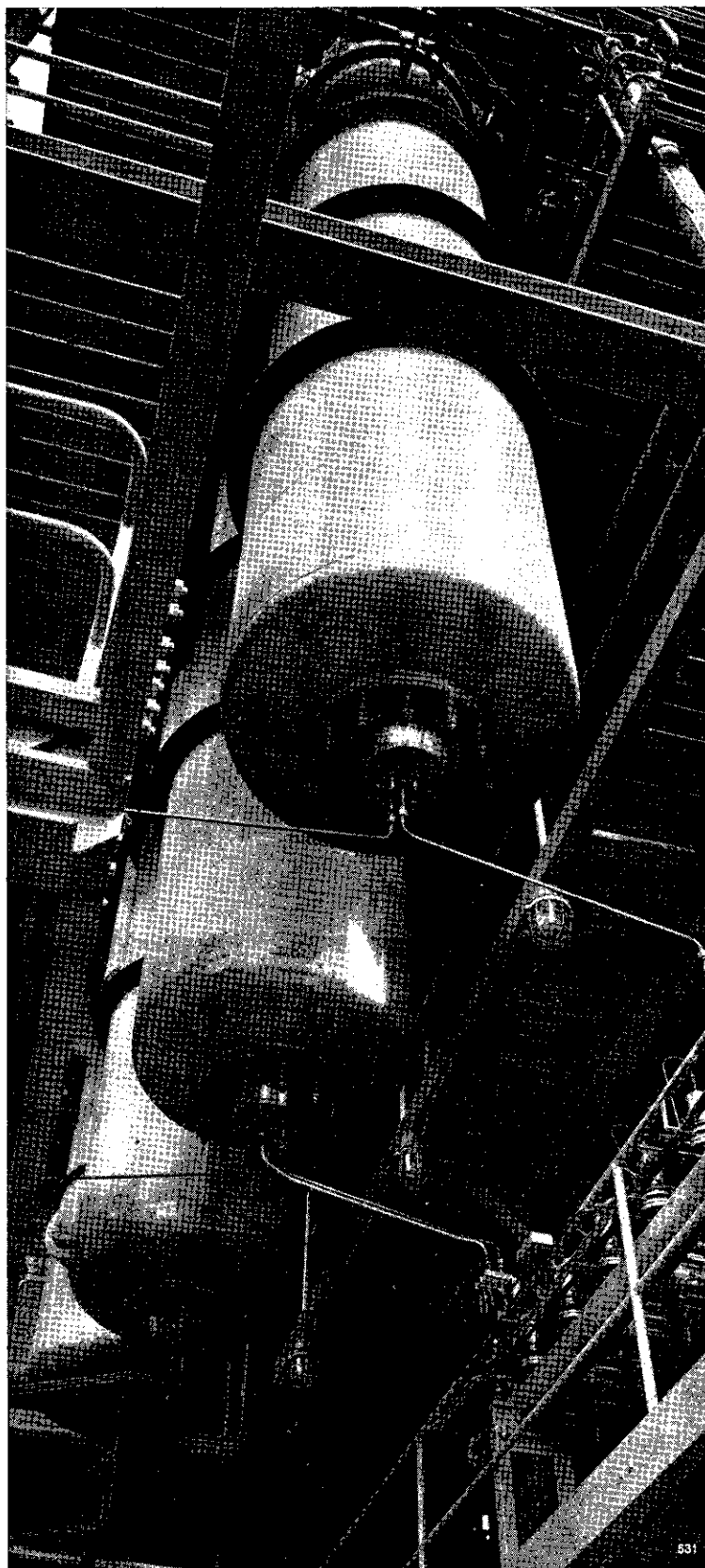
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