

BOOKS

'Irreducible Representations of the Space Groups', by O. V. Kovalev (New York, Gordon and Breach Science Publishers Inc., 1965) — translation from the Russian.

This book contains tables for one-valued and two-valued representations of space groups. The knowledge of these representations is necessary for the solution of problems in the physics of crystals in which microscopic symmetry is assumed.

The book starts with a list of elements of all 230 space groups which fixes the notations used later on, and then briefly explains the method of constructing the representations. This method applies to all space groups even if screw axes and glide planes are included. It makes use of loaded representations (or weighted representations depending on the translator) of certain point groups. The loaded representations were introduced into the discussion of crystal symmetries by G. Ya. Lyubarskii; they are dealt with in his textbook 'Group Theory and Its Application to Physics' (English translation from Pergamon Press).

If we call two momentum vectors equivalent when they differ only by a vector of the reciprocal lattice, the set of momentum vectors involved in a representation can be decomposed into equivalence classes. To each equivalence class, a stationary sub-group of the space group can be allocated. The representations of the space group can then be constructed simply by means of the representations, generally called 'small representations', of one of its stationary sub-groups. They are trivial and one-to-one related to loaded representations of the point group which corresponds to the sub-group.

Part two of the book contains tables of momentum vectors which characterize the equivalence classes and gives the corresponding stationary sub-groups. Parts three and four contain, respectively, single valued and, two-valued representations of the point groups in matrix form.

W. Rühl

New Foundations of Quantum Mechanics, by A. Landé (Cambridge University Press, 1965), is a lucid, demystifying and courageous attempt to sort out the jumble of pseudo-explanations, prejudices and valid ideas which underlie quantum mechanics and its teaching. The book is thoughtfully presented; at the end of each of the eight chapters there is a summary of its essential points. The style is lively and the book is pleasant to read.

The author's avowed aim is to solve what has for long been known as the 'Quantum Riddle', namely the derivation of quantum principles from the still more elementary foundations of pre-quantal physics without the aid of ad hoc assumptions.

While recalling that Einstein, in order to deduce his law of special relativity, had to apply invariance and symmetry postulates to a combination of mechanics and optics in which the velocity of light is the measure of space and time, the author deduces the different quantal rules as the necessary consequence of the application of general invariance and symmetry postulates to the structure of a metric of probabilities. This problem is dealt with in the chapters on 'Transition Probabilities' and 'Interference of Probabilities'. In these two chapters, Landé succeeds in over-

coming his critical attitude to the unsatisfactory language used by the pioneers of quantum mechanics to express new ideas. In fact, he adopts (apparently involuntarily) a point of view already envisaged by Von Neumann on transition probabilities. Unlike his predecessor, he uses an extremely elementary mathematical formalism, which has the advantage of avoiding confusion while preserving the attractions of the method.

Let us follow the main stages of his argument. Starting with Leibniz's principle of continuity and the postulate that a test result is reproducible, he comes first to the theorem of two-way symmetry, which maintains that the probability that the state A of a system, certified by an A-meter, will change into a state B after measurement by a B-meter is equal to the probability of the opposite process. Then follows the non-quantal postulate that Nature prefers order to chaos; this leads him to construct a theorem of the interdependence of probability matrices (the so-called 'principle of superposition', which is too often used in textbooks as a starting point, is then shown to be a special application of the theorem). Here he shows that a unitary transformation via probability amplitudes is the only possible way to connect the quantities P, positive probability and 'two-way symmetry'; in other words, unitarity is not the curious consequence of wave-particle duality, but the only possible way in which transition probabilities can satisfy an interdependence law.

The last step consists in showing that it is possible to derive the periodic form of the probability amplitude function and the need to use complex unitarity (and not real orthogonal transformations) from the postulate of the invariance of dynamics in relation to zero shift. It should be noted, however, that the author succeeds in demonstrating this highly intriguing point only for a pair of canonically conjugate variables by coming very close to the ad hoc procedure, and makes no general demonstration. Landé has then achieved his aim of deducing Planck's law on energy exchange and Sommerfeld-Wilson's law on the exchange of kinetic momenta from non-quantal considerations. It should also be mentioned that he rehabilitates, with a great flourish, Duane's rule concerning the variations of linear momentum in solids with spatial periodicity. This rule gives the author the opportunity to show that there is no need for 'wavicle' duality to explain the phenomena of diffraction by a crystal or a slit. He is, however, far from denying the practical aspect of wave formalism which, although it is not physical, can be used for many rapid calculations.

A large part of the book is devoted to a violent criticism of the philosophy of certain schools which, in Landé's opinion, try to reduce science to a verbal exercise, paying no attention to the phenomena themselves but only to the way in which they are described. Among others, he quotes the Copenhagen school, for which the materiality of particles does not give an adequate description of phenomena, diffraction for instance. Heisenberg's probabilism, which he considers an excellent example of an idealistic conception of Nature, and the hydrodynamic models of Bohm, de Broglie and Vigier are also dissected. However, in the end, while rejecting the rigid attitude of Laplace's determinism, the author finds no way out of the empirico-critical impasse. The hidden purpose of the discussion seems to be Landé's desire to defend his method of approach to quantum mechanics, but this makes for heavy reading.

L. Dubal

Ionic Bombardment — Theory and Applications,
International Symposium of the National Scientific Research
Center, December 1962 (New York, Gordon and Breach
Science Publishers Inc., 1964).

This book, which is of practical help to physicists engaged in the study of ionic bombardment in the energy range known as 'intermediate' (a few keV to 100 keV), is a collection of the papers presented by the most outstanding experts in this branch of solid state physics, at an international symposium organized in France by the C.N.R.S. at the end of 1962.

The research in this field can be divided into two categories:

- the first, experimental, is the study of how to produce and control ion beams of intermediate energy, and to use them to examine their physical and chemical effects on a wide range of materials, which may be divided into three types — metals, semi-conductors and insulators.
- the other, more theoretical, is the study of the fundamental mechanisms of the interaction of ions and matter, and particularly the energy exchanges between the incident ions and the crystal lattice.

An extremely well written introductory article provides the uninitiated with a clear and concise description of the main factors affecting the result of ionic bombardment of a solid surface, and of the effects of such bombardment and the ways in which they have been applied. These effects may be divided into purely physical effects, and chemical and physico-chemical effects.

Some of the applications based on the physical effects of ionic bombardment are: the cleaning of surfaces in a controlled atmosphere, or under vacuum or ultra-high vacuum, the preparation of very thin films, the study of recrystallization, crystal faults, sliding planes and diffusion between two metals. By using an ion beam which is also capable of reacting chemically with the atoms or molecules of the target material, one can for instance oxidize metal surfaces in a few seconds or neutralize certain metals to obtain a surface which resists oxidization (bombarding an aluminium surface with a helium beam gives a kind of 'alloy' coating which has great resistance to oxidization). The chemical effects of this type of ionic bombardment are also used to improve certain properties of textiles and synthetic fibres, such as resistance to wear, colour-fastness and dimensional stability.

The book also gives numerous results, unfortunately sometimes contradictory, concerning cathode-sputtering coefficients as a function of the type, energy and angle of incidence of the ion beam, and also some data on the energy spectra of the ejected atoms. The text is illustrated by some excellent photographs of surfaces subjected to various types of ionic bombardment, which make many of the articles easier to read. Every article is followed by a lively and sometimes very long discussion, which often throws more light on certain aspects of the problems.

To read this book, including the final remarks, is to realize that in the field of the solid state physics of surfaces,

discoveries are still being made and that many of the phenomena are not yet understood.

From a theoretical point of view, the calculations are always based on models which are simplified representations of the supposed mechanisms of cathode sputtering. Numerous models have been proposed and all the resulting theories agree roughly with experiment, if one restricts oneself to a consideration of the general behaviour of the cathode sputtering coefficients as a function of the main parameters (such as the mass of the target atoms and of the ions, and the energy and angle of incidence of the ion beam). In no case, however, do the formulae give the absolute values of these coefficients. Experimentally there is still considerable disagreement over the results obtained. For example, in the case of the variation of the cathode sputtering coefficient as a function of the angle of incidence, a speaker reported that his results showed a very pronounced maximum at an angle of 75° . One of the audience objected that his own measurements showed that the coefficient increased continuously until grazing incidence was reached. The answer was simply: 'Our measurements were made every 5° from 45° to 85° '. No firm conclusion can therefore be reached at this stage.

To sum up, this book on ionic bombardment will give the uninitiated a good knowledge of the subject without too much effort, and give the initiated a more wary attitude to what he already knows.

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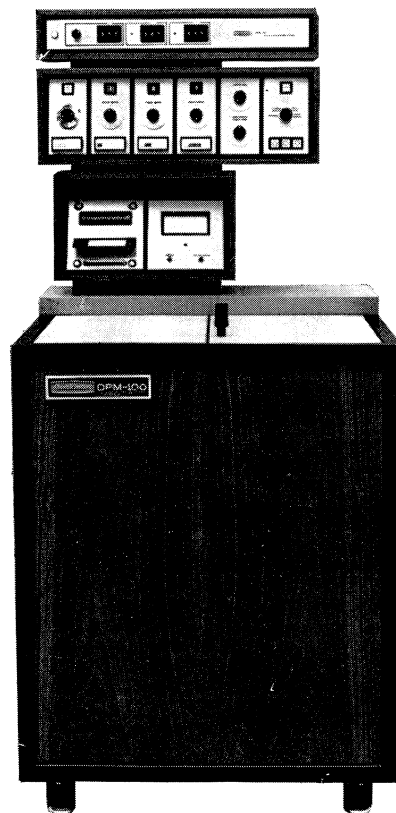
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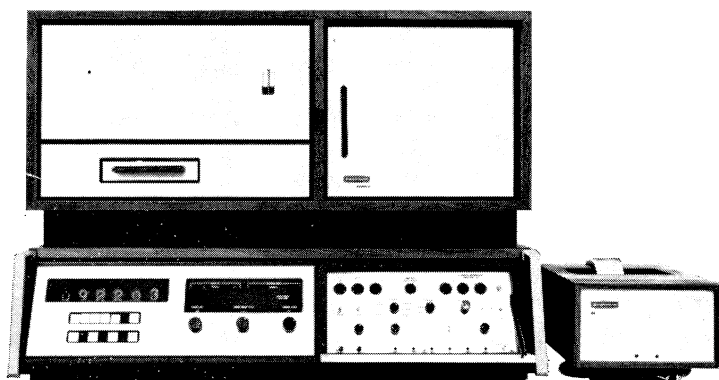


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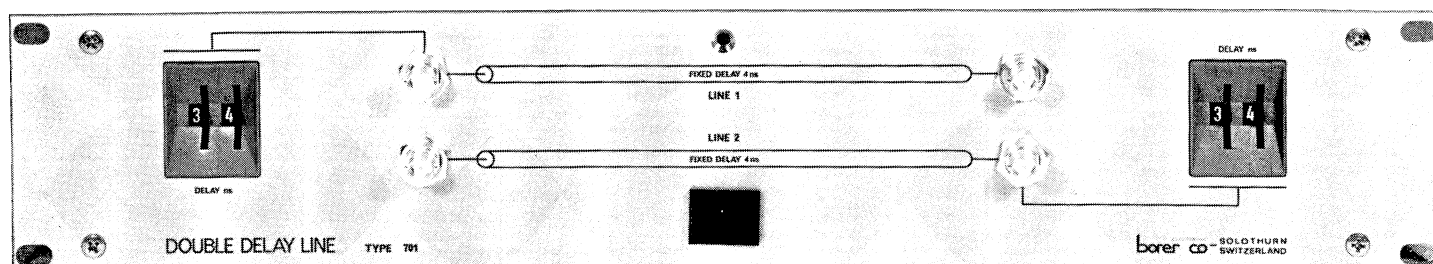
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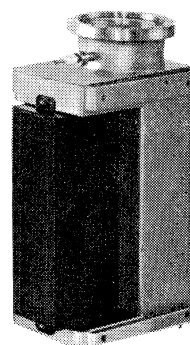
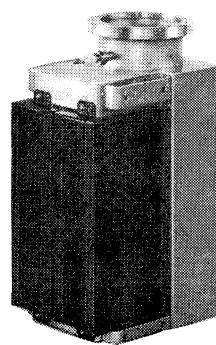
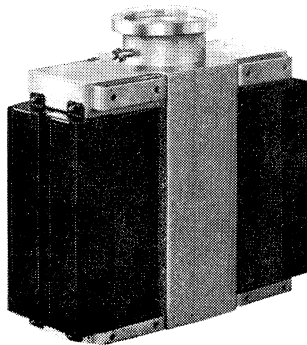
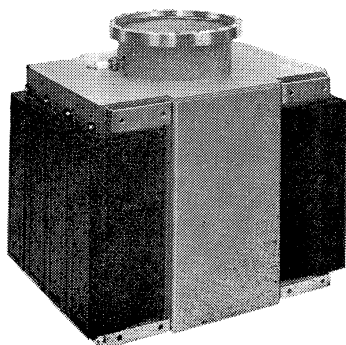
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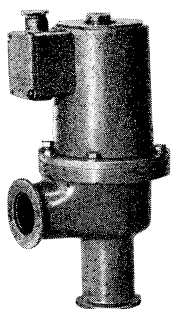
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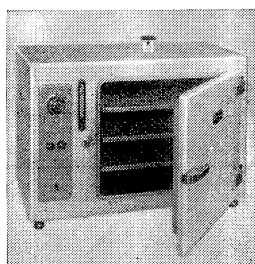
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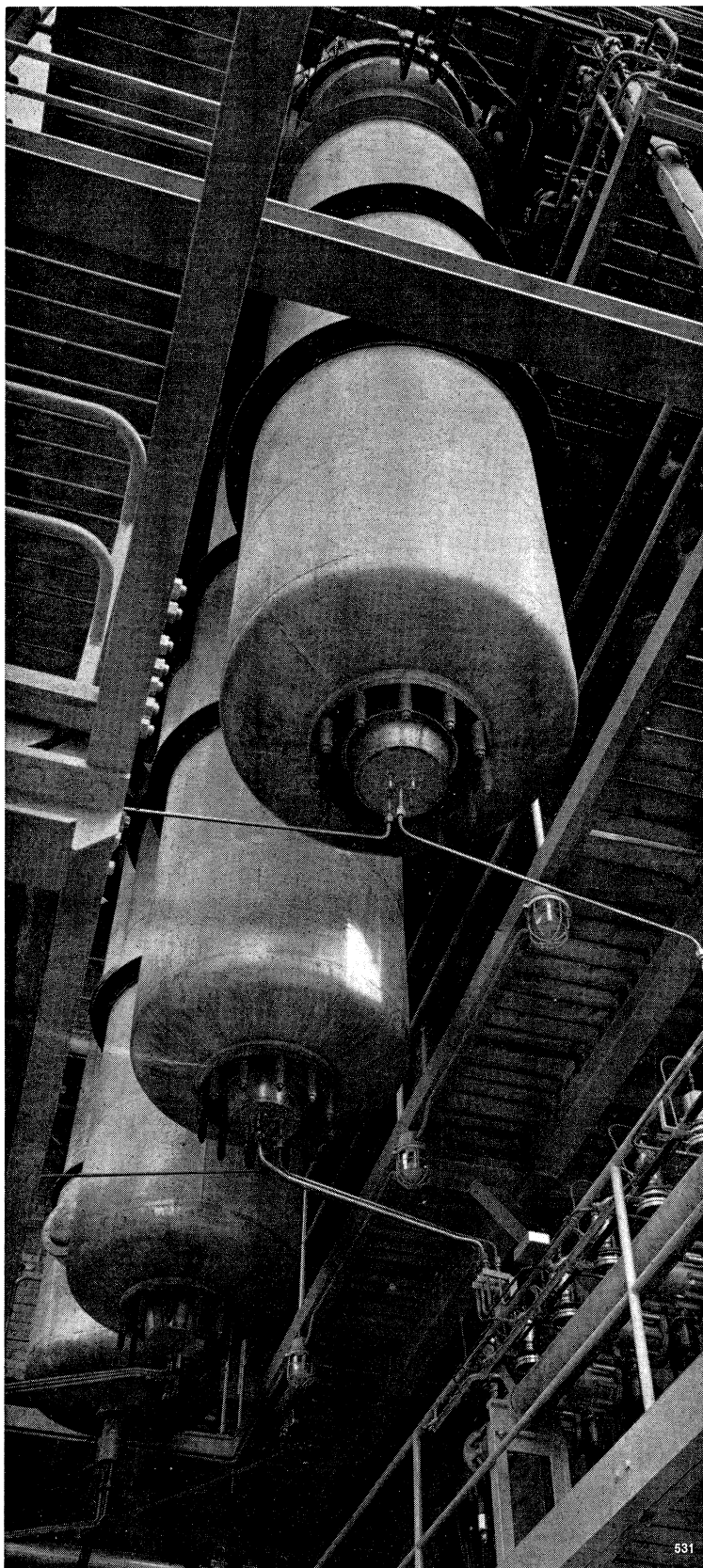
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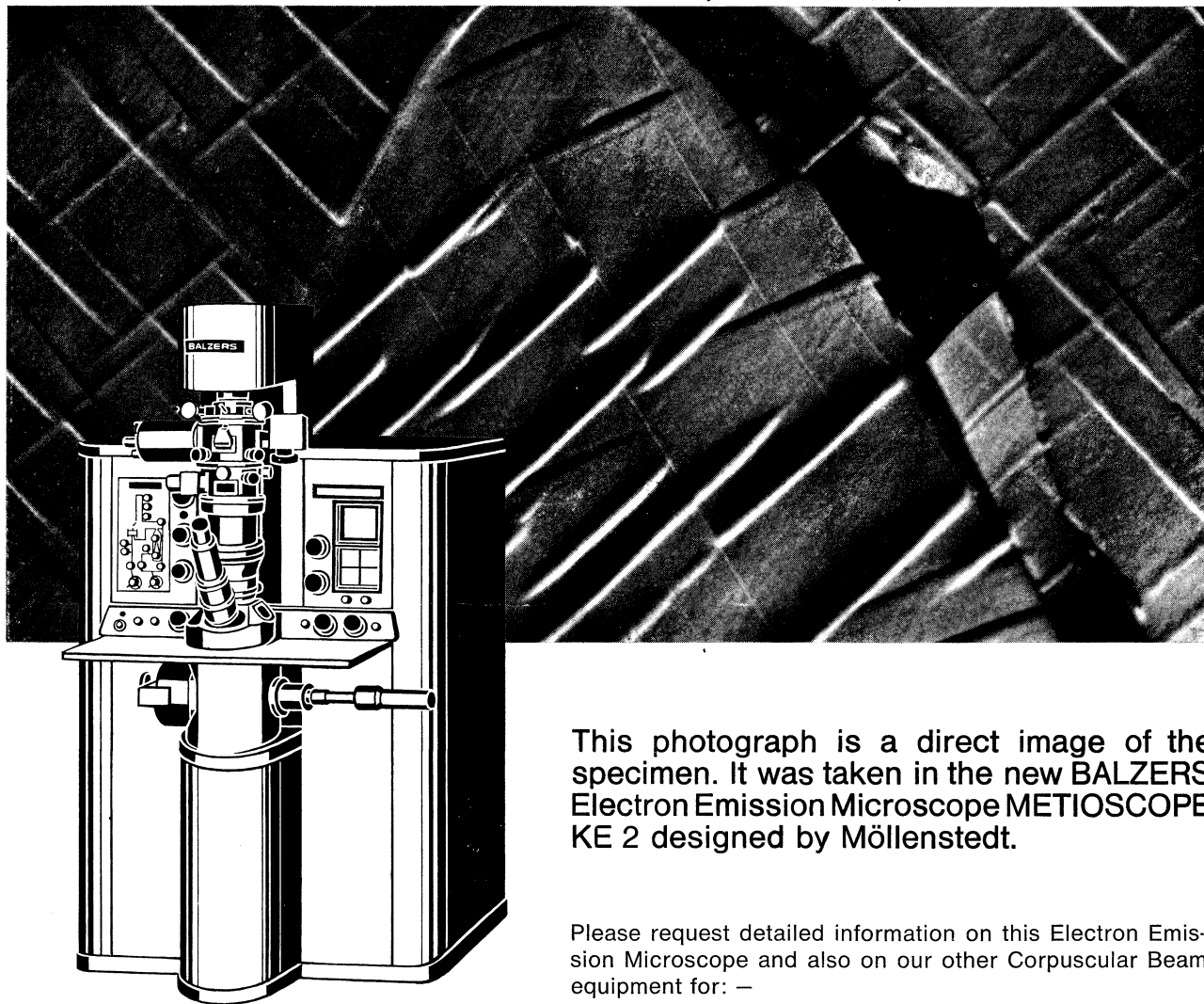
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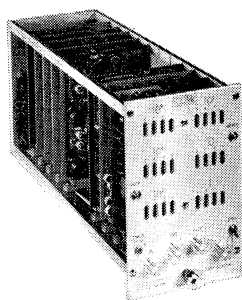
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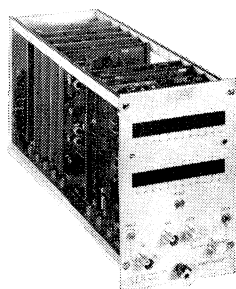
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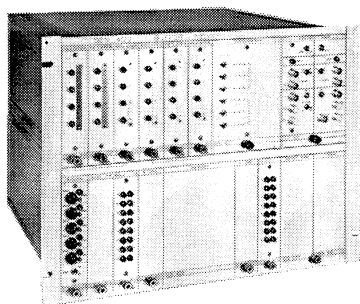
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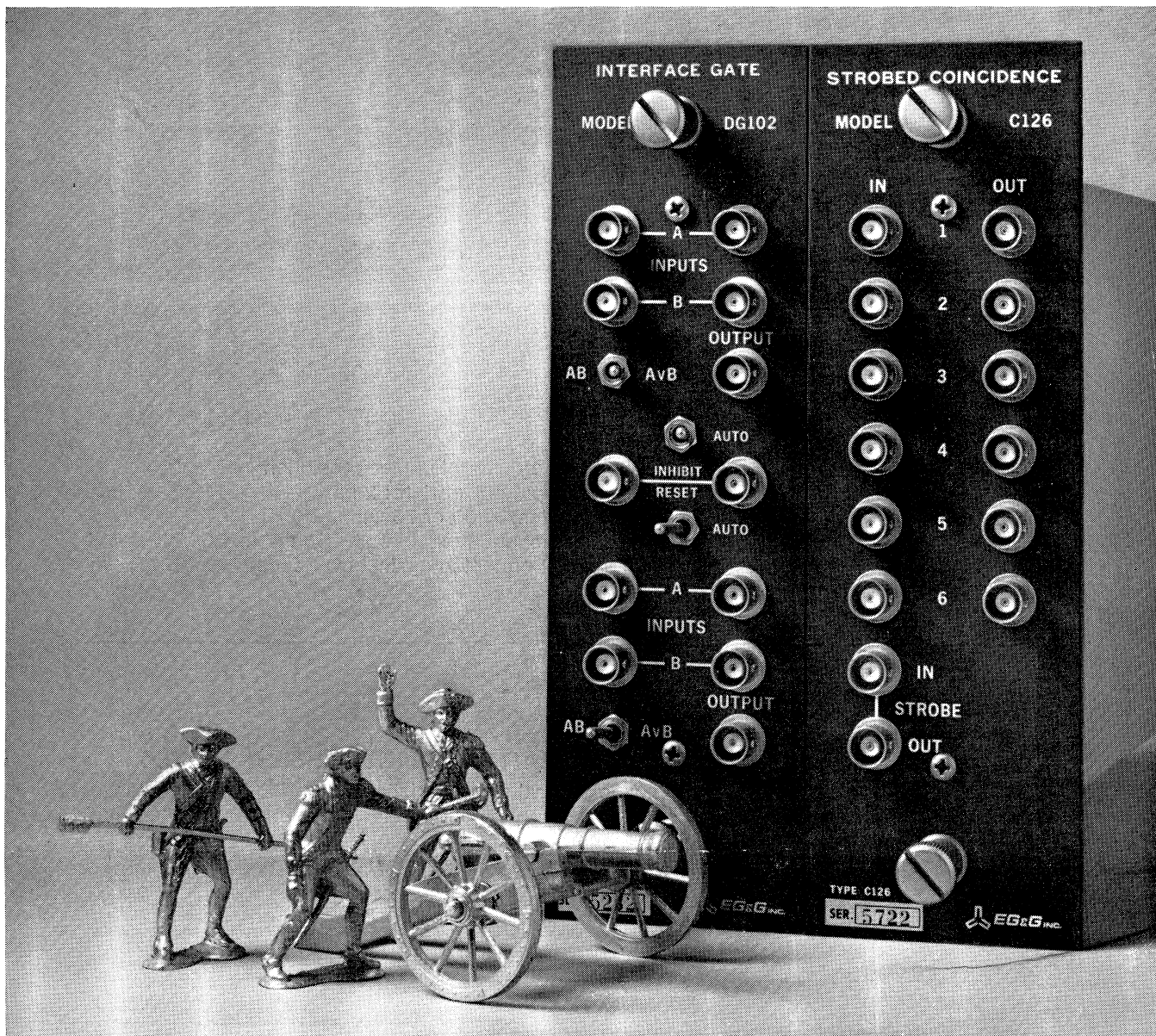
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