not really know which of its predictions are just that, and which are artefacts produced by the approximation methods used. This does not reflect a lack of skill in using quantum field theory. In fact, much of the ingenuity displayed by others who work in conventional quantum field theory is devoted to avoiding issues that the author runs into head-on. Examples of such unsettled issues are these: To what extent is the degeneracy and asymmetric character of the vacuum a consequence of the equations of motion? Are there also solutions without degeneracy and asymmetry? Do these phenomena appear only within a formalism that uses indefinite metric or are there analogous solutions in the conventional Hilbert space theory?

In the sense indicated by these questions the book is clearly premature, but it is premature in the grand style. It will no doubt serve as an inspiration for years to come.

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Within both cultures

THE PHYSICS OF MUSICAL SOUND. By Jess J. Josephs. 165 pp. Van Nostrand, Princeton, N. J., 1967. Paper $1.75

by Lawrence Slifkin

Although physicists often have a hearty appreciation of music, they exhibit little active interest in the physics of music and musical instruments. Delight in music is more or less universal, and the application of physics to musical phenomena appeals to one's curiosity; nevertheless there are few modern books on the subject. This neglect is especially surprising since most of the physical arguments, because of their essentially geometric nature, can be appreciated by a rather wide audience. Moreover, in the border region between physiology, psychology and physics there are many intriguing questions. Are "melodic" sequences pleasing when played backwards? What determines the time and pitch resolutions of human hearing? Why is the octave a special interval? How might one construct a time-varying visual analog to music?

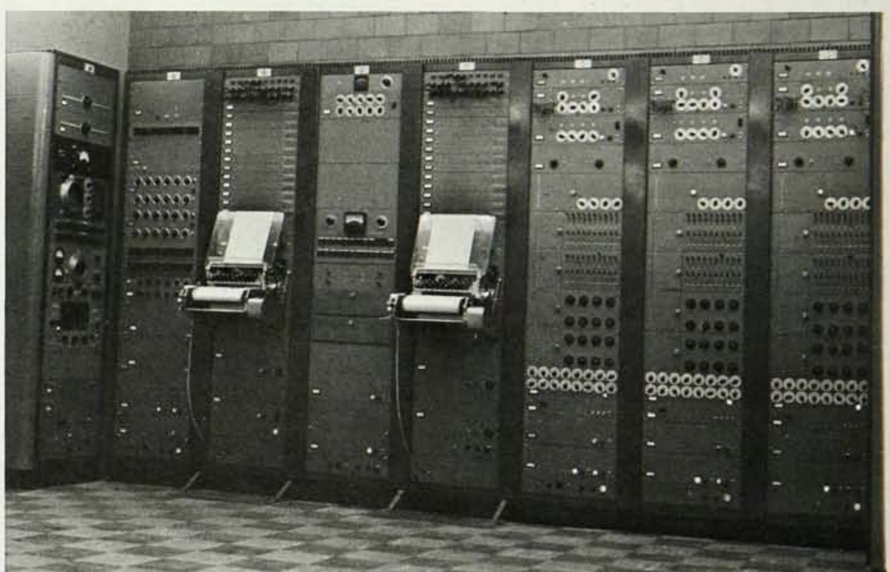
In *The Physics of Musical Sound,* Jess Josephs, a physics professor at Smith College and an expert on electronic sound reproduction, has prepared an introduction to the subject that will be instructive to both physics student and musician. One hopes that the integral equation appearing on the first page will not frighten off the nontechnical reader, as there is very little mathematics in the remainder of the book. Moreover, brief summaries of the essential physics, in most simple terms, are introduced as needed so that one can honestly say that intelligent curiosity is the only prerequisite to the enjoyment of this book.

Josephs begins with a description of simple harmonic motion, leading naturally into a discussion of the physical characteristics of sound and the physiology and psychology of hearing. He then treats musical scales and tone quality. There is considerable discussion of stringed and percussion instruments, organ pipes and the human voice although little is said about the brass and woodwind instruments. Treatments of electronic sound reproduction and room acoustics are also included. In addition, many simple experiments are described whereby the reader can perform his own investigations.

The style is rather business-like and often terse, in contrast to the somewhat more romantic presentation of Jeans' older *Science and Music* and to Benade's rather informal *Horns, Strings, and Harmony.* Occasionally Josephs abruptly terminates the discussion just when the reader's interest has been aroused, as on page 154, where it is simply mentioned that the acoustical absorptances of a man and woman were evaluated. How different are they? And which is greater? The index is somewhat skimpy: For example, although the just scale, intermodulation distortion, phase effects and instrumental response are described, none of these terms can be found in the index. The book could be improved by removal of several obscurities and minor errors, mostly grammatical and syntactical. Furthermore, a book designed to stimulate further inquiry into the subject should surely have made deliberate reference to three other paperbacks currently available: those mentioned above and *Waves and the Ear* by van Bergeijk, Pierce and David.

These criticisms, however, are minor and readily corrected. *The Physics of*

RCA ELECTRONIC MUSIC SYNTHESIZER constructs tones according to specifications of frequency, intensity, growth, duration, decay, portamento, timbre, vibrato and deviations. Punched-paper records control the Synthesizer functions. (Photo: Columbia-Princeton Electronic Music Center.)



Musical Sound must on the whole be considered an adult, contemporary, well organized and interesting presentation. It is a book that will be read with pleasure and gain by a variety of audience ranging from the nonscientist and beginning physics student to the experienced nuclear physicist, who may have happened to wonder what an increase in pressure on the violin bow does to the distribution of overtones.

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Pleasurable and useful

WAVE PHENOMENA. By Dudley H. Towne, 482 pp. Addison-Wesley, Reading, Mass., 1967. $12.50

by Howard B. Levine

The diversity of physical phenomena described by the wave equation is so great as to defy listing. Although experienced physicists are aware of this, and recognize the consequent common thread uniting many fields, the undergraduate physics student cannot be expected to be similarly aware. To remedy this defect, a required one-semester course on wave phenomena is taught at Amherst College in the second half of the junior year. The primary emphases are on optics and acoustics. Dudley H. Towne's book was written for this course, although the quantity of material in it is sufficient for a two-semester course if one wants coverage that is more detailed.

Beginning from an inductive derivation of the equation for transverse waves on a string, the student is led through successively more complex subjects such as acoustic plane waves, boundary-value problems, energy content of a wave, electromagnetic plane waves, polarization, optical anisotropy, interference, diffraction, dispersion, three-dimensional waves, and many others too numerous to mention.

The material is superbly chosen and brilliantly written. The language is clear, direct and rigorous. The discussions are full of physical insights, which serve a reader well in developing that "feel" for the material that is of first importance. The derivations at the same time are concise and precise. The large number of problems at the end of each chapter are excellent, and in fact are in themselves a pleasure to study. Answers to about half of them are provided in the back of the book. The figures are well done and the typography first rate.

This reviewer has been out of school many years, and does not know how many courses presently are being given that might use this book, but was so taken with it that he finds it an argument in itself for introducing such courses. Aside from that, it can also perform a useful function on the shelf of almost any physicist who needs to reintroduce himself to optics or acoustics from time to time. It seems so good in this latter respect that the only point on which the author and publisher might be chided is their excessive modesty in suggesting potential audiences for it. In fact it would be the exceptional individual who would not find it useful, or at least pleasurable, to have this beautifully written book at hand for use from time to time. It is one of those books that are fun just to open to a random page and read. Altogether, Towne's *Wave Phenomena* would be a superb addition to the library of any physicist.

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Thoroughly modern relativity

PRINCIPLES OF RELATIVITY PHYSICS. By James L. Anderson. 484 pp. Academic Press, New York, 1967. $14.75

by Peter G. Bergmann

This book is intended for graduate students of special and general relativity who have acquired the basic knowledge and sophistication implied by the customary first two years of graduate work. It is a thoroughly modern presentation, both as regards approach and selection of topics. In some respects it is unconventional, but the departures from the well trodden paths are always thoughtful. Certainly, Anderson's text is a valuable addition to the textbook literature of the subject.

The book is divided into three parts, of which part I represents background material. To the reviewer this part contains some of the most interesting discussion of the book; though probably a student will not discover some of its motivation until a second or third round of study. In addition to providing the material on differential geometry that is needed for relativity but usually not taught to physics students beforehand, the first part discusses with considerable care basic aspects of physical theories in general. In assessing the real contents of the requirement of "general covariance," which played such a decisive heuristic role in the creation of the general theory of relativity, Anderson is led to distinguish between "absolute" and "dynamical" objects of a theory. The former are variables whose values, though not necessarily the same in all frames of reference, have no part in the identification of a particular physical situation.

Proceeding from this separation of the variables into two classes, Ander-