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asked for equal temperament. This writer's advice is to nod agreeably, and tune something like Werckmeister III or Young. It is unlikely anyone who insists on equal temperament will know the difference.

For those who have not acquired the Jorgensen book, there are several very satisfactory and less costly alternatives, of which the best is the pamphlet *Harpsichord Tuning* by G. C. Klop (Garderen, Holland: Werkplaats voor Clavecimbelbouw, 1974). (The temperament names treated as standard in this review are those used in Klop.) The article "Instructions for the Clavier Diversely Tempered" by Mark Lindley, *Early Music* 5 (1977): 18-23, is also very good, as is that by Dale Carr, "A Practical Introduction to Unequal Temperament," *The Diapason*, 65th year, no. 3 (February 1974), pp. 6-8. Historical temperaments are now an integral part of all serious study and performance of early music. May we hope that Jorgensen will publish an abridged, selectively edited handbook of tuning and temperament suitable for the practical use of the increasing number of early musicians?

DOUGLAS LEEDY

Earle L. Kent, ed. *Musical Acoustics: Piano and Wind Instruments*. Benchmark Papers in Acoustics, vol. 9. Stroudsburg, Pa.: Dowden, Hutchinson & Ross, Inc., 1977. xiii, 367 pp. \$34.00.

The affinity between science and music had its earliest recorded expression in the experiments of Pythagoras in the sixth century B.C. He demonstrated that the lengths of strings necessary to give harmonious notes could be expressed as ratios of simple integers, and he established the mathematical basis for the musical scales then in use. Since then, scientific knowledge has flourished and grown to an enormous extent, while musical instruments have evolved very slowly. Nevertheless, the scientist is still trying to identify and explain the many acoustical phenomena that the musician and the instrument maker have learned empirically to handle so skillfully.

This volume of collected papers in musical acoustics is directed to the scientist or engineer. It will be of interest also to musicians or

those for whom music is an avocation, if they have some grounding in science. It constitutes volume 9 of a series, Benchmark Papers in Acoustics, that is intended to provide a practical introduction to the literature of acoustics. Two previous books in this series by Carleen Hutchins have covered the violin family. In this work, Earle Kent, a consulting engineer with long professional experience in musical acoustics, has selected twenty-eight technical articles that represent the substantial advances in scientific understanding of the piano and wind instruments made in the past thirty years.

The book has three major parts: "Piano Acoustics," "Acoustics of Brass Instruments," and "Acoustics of Woodwinds." Each of these parts leads off with a tutorial paper reprinted from the *Scientific American*. For those who want an introduction to the subject of the acoustics of musical instruments, these introductory papers will provide a fairly deep understanding without going so far into technicalities as to discourage those without training in physics. For this purpose, however, the interested reader might better obtain the paperback book published by the *Scientific American* (*The Physics of Music* [San Francisco: W. H. Freeman and Co., 1978]), in which these three articles appear in their original (and much more legible) two-color large format. The *Scientific American* book also includes articles on stringed instruments, voice, architectural acoustics, and the physics of music in general.

The scientific papers (and one or two patents) comprising the remaining selections have been grouped together logically into sections. These are preceded by comments by the editor, who briefly abstracts the contents, gives biographical data on the authors, and sometimes describes the context in which the reported research was carried out.

The first set of papers deals with the vibrations of piano strings. The fact that the higher modes (or partials) of a freely vibrating string are not exact harmonics has long been recognized, but detailed information on this phenomenon has been elicited only in the last few decades. The influence of this inharmonicity on the manner in which pianos are tuned (Schuck and Young, Kent) will be of much more interest to the musician than the mathematical treatments which show how the inharmonicity depends on the characteristics of the

strings themselves (Fletcher, Shankland and Coltman). The second set of papers concerns the correlation of the subjective "quality" of piano tones with physically observable quantities such as the differing rates of decay of the various partials, the exactness of tuning of the unison string groups, and the structure of the soundboard. Of particular interest is the work of Fletcher, Blackham, and Stratton, who synthesized piano tones and tested the ability of listeners to distinguish them from recorded piano tones. Such studies reveal which physical aspects, such as attack times, decay rates of partials, and inharmonicity of partials, give rise to the features one recognizes as characteristic of the piano. Similar researches using synthetic string and wind instrument tones have been reported in recent society meetings. Unfortunately, this volume contains only a very little about what the listener hears, perhaps because this is a subject more often categorized as psychoacoustics and Kent has chosen to stay very close to physical acoustics.

While the mechanism of excitation in the piano is rather well described physically, the same is not true of the wind instruments. Qualitative descriptions of the feed-back mechanisms in which a puff of air is introduced into the instrument, is reflected from the far end, and in turn causes the introduction of another puff of air have been hypothesized for over a century. More specific studies are relatively recent. Martin's classic observations on lip vibrations in a cornet mouthpiece, Backus's paper on the small vibration theory of the clarinet, and Coltman's paper on the sounding mechanism of the flute and organ pipe are examples that are included in this volume. This subject, however, is still in its early stages of development. While the basic mechanisms of sustained oscillation in wind instruments seem now to be reasonably well established, the very important question of tone quality (or harmonic content) is in a relatively primitive state. Benade in his introductory paper emphasizes the importance of matching the natural vibrational modes of the air column to the harmonics that will be produced by nonlinear excitation. Toward this end, the editor has included a number of papers discussing how these natural modes are affected by the bore of the instrument. (This question also bears directly on the question of intonation in the brass instruments, whose various notes are selected from among the higher

natural modes of a long pipe.) Most of these papers are highly mathematical and would be rewarding only to the specialist. Only Neville Fletcher's paper on nonlinear interactions in organ flue pipes attacks directly the problem of a physical basis for the tone color of a wind instrument. The qualitative agreement with observation gives encouragement to the approach taken, but it is fair to state that in this area musical acousticians are still groping.

The serious student or professional in musical acoustics, and those who wish to pursue the acoustical behavior of instruments in more depth of detail than the *Scientific American* tutorial papers permit, will find Kent's volume an up-to-date account of the state of knowledge in this field. The book will also serve as a valuable reference foundation for future work.

JOHN W. COLTMAN

Bernhard Bröchle and Kurt Janetzky. *Kulturgeschichte des Horns: Ein Bildsachbuch / A Pictorial History of the Horn*. English text by Cecilia Baumann. Tutzing: Hans Schneider, 1976. 303 pp. plus 17 color and 257 black-and-white plates. DM160.

Although a lot of delightful material is offered in this book, one has trouble figuring out what it is really about. Even the title is an enigma, thanks to the many meanings of the word *horn* and the difference between the German and English renditions.

In a lengthy foreword, the authors seem to be describing their work as a history of the French horn told with instruments, works of art, documents, and quotations. The first part of the book, however, includes almost every kind of lip-vibrated animal horn, conch shell, or pottery instrument known—the horn in its broadest meaning. By the seventeenth century, instruments with fingerholes are excluded, and during the eighteenth century those not two-thirds conical are left out. By the nineteenth century, the scope of the work has narrowed to the French horn and the post horn. Although the French horn survives this thinning to reach its modern form in the final pages,