AN INTRODUCTION TO MUSICAL ARITHMETIC; WITH ITS APPLICATION TO TEMPERAMENT

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BY

ROBERT BROWN.

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PREFACE.

ARITHMETICAL proportion has been so sparingly introduced in works on Music, that this little treatise may lay claim to some measure of novelty. The first principles have long been before the public, in Dr. Holder's interesting "Treatise on the Natural Grounds and Principles of Harmony," published in 1694; but, so far as appears, they have never yet been applied to the illustration of Musical Chords, much less to the tuning of Instruments by Temperament. It is now attempted to accommodate them to both of these purposes: with what success must be left to the judgment of the intelligent reader.

Musical Intervals take their names from the number of degrees which they occupy on the staff. This has been found sufficient for the purposes of writing and reading music, and treating of it in a practical way; but when accurate measurement is required for theoretical purposes, they are expressed by double numbers, denoting the comparative rate of vibration in the two sounds of the Interval. Thus the Octave, in which the upper note vibrates twice while the lower vibrates once, is represented by the figures 1, 2.

As these terms denote merely the proportion of one note to another, it is evident that, in that form, Intervals cannot be added together as real quantities. But if they be expressed by single, instead of double numbers, they may be added and subtracted like other sums. This is done to our hand, in the method of tuning keyed Instruments by what is called the Equal Temperament, which divides the Octave into twelve equal degrees, or Semitones. Thus, the Semitone is represented by 1, the Tone (2 Semitones) by 2, the Minor Third (3 Semitones) by 3, and so on; adding 1 for every Semitone, till 12 completes the Octave. Now these degrees, although they are equal Semitones, are not equal quantities; for, if measured by the part of the string that produces them, they decrease regularly as they ascend in the scale: nevertheless they are rightly called equal Semitones, because each of them bears the same proportion to the one that is immediately under it. So the numbers 1 to 12 represent the Scale of Semitones, as tuned on our pianofortes.

These numbers, so applied, are called Logarithms; 12 being called the Logarithm of the Octave, and so of the rest. By using decimal fractions, or high numbers, it is easy to adapt this method to all kinds of Musical Intervals. Thus, the two Semitones make up the Minor Tone; the two Tones, the Major Third; the two Thirds the Fifth; the Fifth and Fourth the Octave:—

		Log.
Chromatic Semitone . . .	24 : 25 . . .	·708.
Diatonic Semitone . . .	15 : 16 . . .	1·116.
Minor Tone	9 : 10 . . .	1·824.
Major Tone	8 : 9 . . .	2·040.
Major Third	4 : 5 . . .	3·864.
Minor Third	5 : 6 . . .	3·156.
Fifth	2 : 3 . . .	7·020.
Fourth	3 : 4 . . .	4·980.
Octave	1 : 2 . . .	12·000.

This Logarithm of the Equal Semitone, or twelfth part of the Octave, is so easily explained, and so convenient for comparison, that I have adopted it in the present little work, in preference to taking the Minor Tone as unity, which I did in former treatises. In comparing the different methods of Temperament, I have used only two places of decimals, which give the Intervals true to the hundredth part of the equal Semitone.

Any one who desires greater accuracy, may obtain it to the thousandth part, by using decimals to three places, as given in Art. 24.

These Logarithms render the calculation of Intervals exceedingly simple; and afford an excellent means of testing the pretensions of any new methods of Temperament which may be proposed.

Rockhaven, 29th December, 1864.

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INTRODUCTION

TO

MUSICAL ARITHMETIC.

CHAPTER I.

THE PITCH OF MUSICAL SOUNDS.

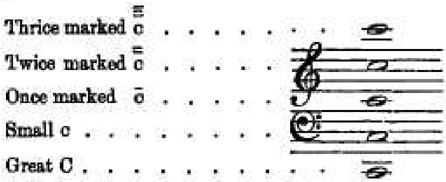
1. Musical sounds are produced by the regular vibration of elastic bodies, communicated to the air.

2. Slower vibrations produce graver sounds, or lower notes; and more rapid vibrations produce more acute sounds, or higher notes. Grave sounds below a certain pitch, and acute sounds above a certain pitch, are inaudible; but the vanishing point differs in different ears.

3. The rate of vibration is measured by an instrument invented on purpose, consisting of a kind of clock-work. But it is easier and more convenient to measure the length of the sounding body, whether string or tube; which, in similar circumstances, is always proportioned, inversely, to the number of vibrations.

4. The pitch of a musical sound, is its position in the Scale of acuteness and gravity. As no natural standard exists whereby the pitch of any particular note can be determined, a note is chosen which approximates to the middle of the range of human voices; it is called C, or *Do*, and its pitch is arbitrarily fixed at or near 256 vibrations in a second; which number, being the eighth power of 2, is easily remembered. This note, which occupies the added line between the Treble and Bass staves, is called the Tenor Clef note. By the Germans it is named once marked c. A range of four Octaves,

having this note in the middle, comprehends the most useful part of the Scale :—

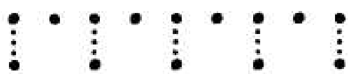


The Octave below Great C is called Double C, and marked C C.

5. The difference of pitch between two musical sounds is called an Interval. The measure of an Interval, is the proportion of the rate or velocity of the vibrations in the two sounds. Thus,

6. In the Interval called an Octave, each vibration of the lower note, is accompanied by two vibrations of the higher note; and the Interval is correctly expressed by 1 to 2, or 1 : 2, or $\frac{1}{2}$.

Every vibration of the lower note, coincides with every second vibration of the upper note; and the effect is almost the same as unison, or two notes of the same pitch sounding together:



7. In the Interval of the Fifth, every two vibrations of the lower note are accompanied by three of the upper note; and the Interval is expressed by 2 : 3, or $\frac{2}{3}$:

8. In the Interval of the Major Third, 4 : 5, the fourth vibrations of the lower note coincide with the fifth vibrations of the upper note :