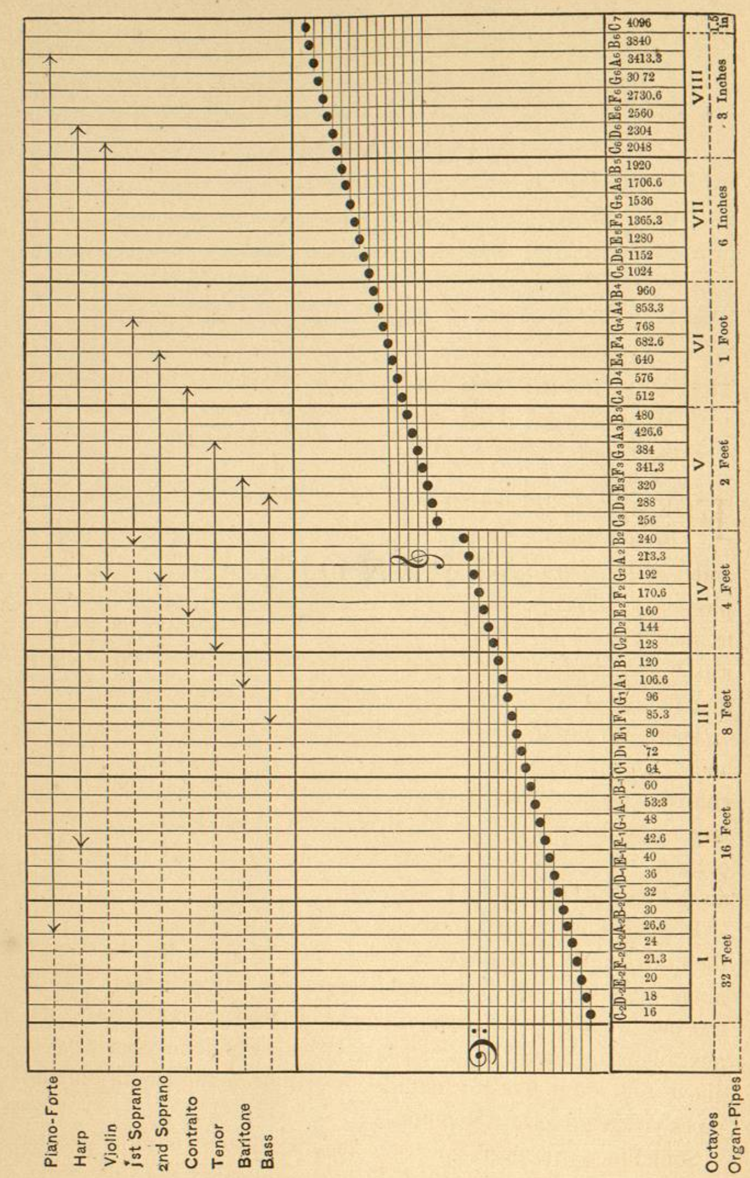


TABLE OF THE COMPASSES OF VOICES AND INSTRUMENTS.

APPENDIX.

I.

FREQUENCIES OF NOTES OF THE MUSICAL SCALE, AND COMPASSES OF THE HUMAN VOICE, AND OF SOME OF THE MORE COMMON MUSICAL INSTRUMENTS.

FOR purposes of reference and comparison there are exhibited in the diagram on page 438 the notes of the musical scale, and the frequencies of these notes according to the standard — physicists' pitch — used throughout this volume. Knowing the frequency-ratios of the different intervals, as detailed in Chapter X., it is an easy matter to calculate the vibration-number of any determinate note according to French or international pitch.

There are also given the various compasses of the human voice, and of a few of the musical instruments in most general use. The compass of the ordinary organ is only seven octaves; but in the larger instruments it is, as indicated in the diagram, fully eight octaves. In some exceptional cases the range may extend half an octave higher.

Inasmuch as the positions of notes are frequently referred to the corresponding organ-pipes, the lengths of pipes for the lowest notes — the C's — of the different octaves are here specified. Thus the lowest octave of the organ is often called the 32-foot octave; the next higher is known as the 16-foot octave; while the other octaves above this are in like manner designated from the lengths of the pipes yielding the lowest notes.

Sometimes, however, special names are given to some of the octaves. Thus the octave of C_{-2} is denominated the sub-contra, and that of C_{-1} the contra octave. The octave of C_1 is called the great, while that of C_2 is known as the tenor, or little octave. The octaves C_3 and C_4 are termed the middle and treble octaves respectively, and the two following — those of C_4 and C_5 — are, in the order named, spoken of as the octaves in alto and in altissimo. The octave of C_3 is likewise styled the one-stroked octave, while the octaves C_4, C_5, and C_6 are named respectively the two-stroked, three-stroked, and four-stroked octaves.

The pianoforte is classed as a seven-octave instrument, although its compass is sometimes less and sometimes greater. Similarly only the *average* compasses are given for the violin, harp, and the human voice. A reference to Chapter II. will show that the pitch, both for male and female voices, may in certain instances vary within a considerable range.

In connection with the foregoing I would call attention to the desirability of having some uniform system of indicating the notes of the different octaves of the musical scale. We saw in Chapter II. that there are several systems in vogue, those in Germany and England being quite different from the one that obtains in France. This lack of uniformity is often a source of much embarrassment, and even of grave error.

Now that an international standard of pitch has been adopted, it would be a great boon both to students and general readers if some uniform method of naming the notes could be established. A very slight modification of the French system would, it seems to me, answer admirably all practical purposes. Thus, if instead of calling the lowest C, corresponding to sixteen vibrations, C_{-2}, C'', $\underline{\underline{C}}$, or Ut_{-2}, as is now the custom, it were called C_1, and the C's following were designated C_2, C_3, C_4, etc., it would greatly simplify matters both for acousticians and musicians. It would then be an easy matter to locate any note, from that of the 32-foot organ-pipe to that of the most acute note perceptible by the human ear. The C of the sub-contra octave of the organ being C_1, the highest G of Appunn's forks — eleven and a half octaves above C_1 — would be known as G_{12}.

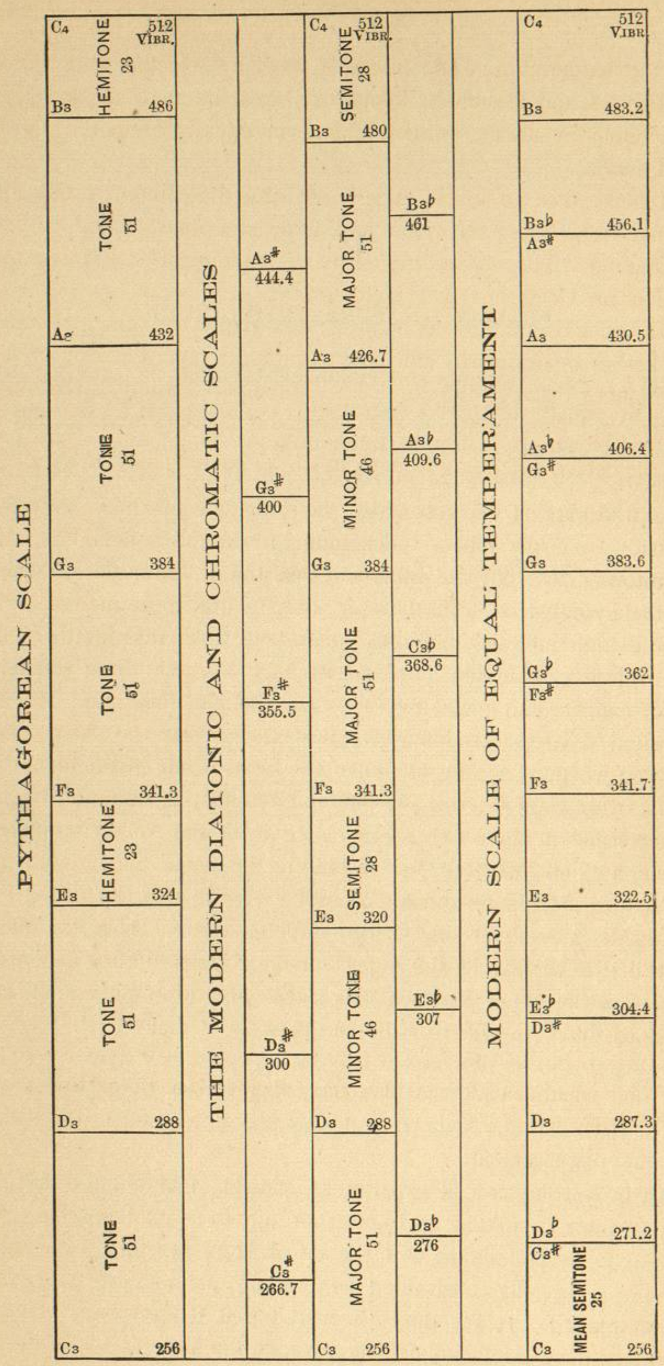
II.

PLAYING IN PURE INTONATION.

THAT good violinists and violoncellists, when unaccompanied by equally tempered instruments, execute pieces of music written for harmony, in pure intonation, is well known. This accounts for the remarkable purity and fulness of tone that characterize the playing of such artists as Remenyi, Joachim, Popper, Wilhelmj, and Ole Bull. In listening to such performers, one can always hear distinctly the *Tartini*, or beat-tones, that add such richness and volume to violin music. Virtuosi like those named give their theoretical value not only to octaves, fifths, and fourths, but also to thirds and sixths. Indeed, we may well doubt whether such artists could, when unaccompanied, play a major third out of tune, as required by the system of equal temperament. Remenyi tells me that when he is not accompanied by a keyed instrument, he instinctively plays in pure intonation, and that he *feels* the difference betweeen notes like D♯ and E♭, or G♯ and A♭, for instance, of which equal temperament can take no account.

Even in playing melodies, the best violinists play according to the just, and not according to the tempered, scale. This has been proved conclusively by the experiments of Delezenne and others. It is true that the experiments of Cornu and Mercadier seem to point to the Pythagorean scale as the scale of melody; but even granting this to be the case, it may be accepted as a demonstrated fact that whether violinists play according to the Pythagorean or the modern diatonic scale, they do *not* play according to the scale of equal temperament.

An interesting crucial experiment, showing that good violinists play in pure intonation, and not according to equal temperament, was made by Helmholtz, with the aid of Herr Joachim. For this purpose a specially constructed harmonium, giving pure intervals, was employed. It was thus discovered that the intervals played by the distinguished violinist were exactly the same as those given



by the harmonium. The intervals specially selected were thirds and sixths, and Helmholtz found that these intervals as played by Joachim were always perfect, and never equally tempered, thirds and sixths.

I have made a similar experiment with the eminent artist Remenyi, — he using the violin, and I an harmonium tuned in just intonation. The results arrived at were identical with those obtained by Delezenne and Helmholtz.

In order that the reader may see at a glance the principal scales spoken of in this work, and have a graphical representation of the differences between pure and equally tempered intervals, between sharps and flats, I append the accompanying diagram,[1] calculated for the octave extending from C_3 to C_4. The frequency of C_3, , is 256 vibrations per second, — the same as used throughout the book. By inspection of the diagram it will be noticed that the semitones have not the same value in any of the scales. Again, in the Pythagorean scale there are only two different intervals, the whole tone and the semitone, or hemitone; whereas in the modern diatonic scale there are, as we have learned, three different intervals, the major and minor tones, and the semitone. A very marked difference is likewise observed between the sharps and flats; the latter, contrary to what musicians teach, being higher in pitch than the former. The only interval that is common to the three scales is the octave. The intervals of the equally tempered scale are, as indicated, all of exactly the same magnitude, the deviations from pure intonation being evenly distributed among the different intervals of the octave. The relative values of the intervals of the three scales are given in logarithms. They may also, as is obvious, be obtained from the vibration-numbers of the various notes as given in the diagram.

[1] A combination of some diagrams, slightly modified, given in Pole's "Philosophy and Music."

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