TWENTYFIFTH EDITION.—REVISED AND IMPROVED.

HAMILTON'S ART OF TUNING THE PIANOFORTE.

EDITED BY

JOSEPH WARREN.

ONE SHILLING.

LONDON:

ROBERT COCKS AND CO.,

Music Publishers to the Queen, and H.R.H. the Prince of Wales.

HAMILTON'S

PRACTICAL INTRODUCTION TO THE

ART OF TUNING

THE PIANOFORTE;

Written for the use of Persons desirous of Tuning their own Instruments

WITH A MATHEMATICAL DEMONSTRATION OF THE

THEORY OF EQUAL TEMPERAMENT;

OBSERVATIONS ON

SOUND, VIBRATING STRINGS, AND THE MONOCHORD;

SOME ACCOUNT OF

EARL STANHOPE'S PRINCIPLES OF TUNING INSTRUMENTS WITH FIXED TONES;

And a List of Authors who have written on Temperament:

TO WHICH ARE ADDED

OBSERVATIONS ON THE SEVERAL PARTS OF THE PIANOFORTE

(PARTICULARLY OF THE COTTAGE, SEMI-COTTAGE, AND PICCOLO),

Its Mechanism, &c. and the Method of remedying its Defects,

AS ALSO SOME HISTORICAL NOTICES,

INSTRUCTIONS FOR THE MAINTENANCE AND PRESERVATION OF THE PIANOFORTE,

&c. &c.

NEW EDITION, GREATLY ENLARGED AND IMPROVED, BY

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not acc.

PREFACE TO THE SIXTH EDITION.

The following Practical Introduction to the Art of Tuning the Pianoforte will be found of great utility to persons desirous of tuning their own instruments, or who reside in the country, far away from the residence of a regular tuner.

The Observations on Sound and on Vibrating Strings, and the Account of Earl Stanhope's Mode of Temperament, contained in Part III, and first added to the second edition of this work, will greatly aid those who wish to make themselves acquainted with subjects of so much interest in the art of tuning instruments with fixed tones.

The hints given in Part IV (of this sixth edition) on the several parts of the Cottage, Semi-cottage, and Piccolo Pianoforte, and how to remedy defects, &c. as also Instructions for the Maintenance and Preservation of Pianofortes in general, will be acknowledged by all to be exceedingly useful.

ADVERTISEMENT

TO THE

SEVENTH EDITION.

The distinguished favour with which Mr. Hamilton's Treatise on the Art of Tuning the Pianoforte was received by the Profession and the Public, induced in the Publishers the wish to include in its pages all that could be useful in connection with its declared object.

Since this work left Mr. Hamilton's hand, besides the portion relating to Earl's Stanhope's temperament, a distinct section has been added, illustrating the defects to which instruments are liable, and the readiest methods of obviating those defects.

Succinct notices have moreover been added of the steps by which the Pianoforte arrived at its present state of perfection; and copious suggestions are offered for

preserving instruments from the effects of the injuries to which they are liable.

This Seventh Edition has been subjected to a very careful revision. The present editor desires to add, that he has not neglected to avail himself of competent assistance in the mathematical part of the work especially, in which Mr. Hamilton's method is in some instances departed from. Throughout, such verbal corrections have been made as, it is to be presumed, the original author would have made if he had had the opportunity. In the portion of the work that refers to the details of construction, the editor has been assisted by makers of eminence. In fine, as now completed, Hamilton's Art of Tuning consists of a series of treatises, embracing almost everything connected with the structure, regulation, and tuning of instruments, necessary to be known by the amateur; and although, from the circumstances under which the detached portions have been brought together, the arrangement may be thought to be in some respects inconsecutive, still, as a whole, the work will now be found to be invaluable to the amateur and student for information or reference, and highly useful as a *vade mecum*, or hand-book, to the professional man and the tuner.

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HAMILTON'S ART OF TUNING,

ETC.

PART THE FIRST.

METHOD OF TUNING THE PIANOFORTE.

Introductory Remarks—Equal Temperament—Intervals made use of in Tuning—The Unison—The Octave—The Fifth and the Third—On Temperament—Series of perfect Fifths—To temper the Fifth—Scheme for the System of Equal Temperament, with Explanation—Diagram of Trials—The Wolf—The Bearings—Diagrams of Octaves—Tuning the Cottage, Semi-Cottage, and Piccolo Piano—German Method with Diagram—Systems of unequal Temperament, Kirnberger, Earl Stanhope, &c.—Method of laying the Bearings by Fifths and Fourths, with Diagram—Trials—General Observations.

THE great difference between the sound of a pianoforte when perfectly in tune, as compared with that of the same instrument when *out of tune*, is well known to every player; indeed, at times, this difference is so great, that one is almost induced to doubt the identity of the instrument.

Every professor, and indeed every pianoforte player, particularly in the country, where regular tuners are not always to be had, ought to be capable of tuning his own piano; and the time and trouble necessary to acquire the power of so doing, does not bear any comparison with the convenience and advantages which result.

The present little work is intended to convey, in the simplest and most intelligible manner, the knowledge, both theoretical and practical, necessary to enable any one to tune his own instrument. He is merely supposed to know enough of the nature of intervals, to understand the meaning of the terms unison, octave, perfect fifth, major third, &c.

The system here explained and reduced to practice is that of *Equal Temperament*, which is now universally adopted throughout Europe.

In the Second Part, will be found a mathematical demonstration of the leading principles of this system.

The intervals chiefly made use of in tuning are the unison, the octave, the fifth, and the major and minor thirds. Unisons and octaves are always tuned *perfect*, as the ear will not tolerate any modification whatever in these intervals. The fifths, and still more the major and minor thirds, admit of some slight degree

of modification in regard to pitch, without losing their consonant nature and becoming offensive to the ear.

THE UNISON.

Square and cabinet pianofortes have *two* strings to each note or key; grand pianos, whether horizontal or upright, have three. The pitch of one of these strings is always determined by its being tuned in the relation of an octave or fifth to some note previously tuned; the remaining string or strings belonging to the same note are tuned in *unison* to this first string. Hence, the unison, or identical sound, is the interval, if it may be so called, which most frequently occurs in tuning It is also the easiest interval for the student to begin with.

Supposing the instrument to be in tune, let the student place his tuning-hammer upon one of the *pegs* or *pins*, round which the strings are coiled; say, upon one of the strings belonging to the note


C

and turn the hammer a little towards the left, so as to relax the string, and thereby depress or flatten the pitch If we now strike the note C, the collision of the two dissimilar sounds will produce that harsh and jarring effect, which we are sensible of when we touch a note that is much out of tune. Let him then turn the hammer to the right, gently and by almost imperceptible degrees, and, if he listens attentively, as the pitch of the two strings approaches more and more nearly towards coincidence, he will at first hear a number of strong and rapid pulsations or *beats ;* which, as the coincidence becomes greater, will succeed each other more and more slowly, till they degenerate into mere gentle undulations or *waves ;* and these, as he proceeds, will at length disappear, and give place to one steady, pure, and continuous sound; when the two strings will be perfectly in *unison* to each other. This progression from a mere confused and jarring sound, to strong beats, first quicker and then slower; and from these again to smooth and gentle wavings; and, ultimately, to one pure and uninterrupted sound—must be thoroughly impressed upon the ear and mind of the student; as these gradations are the *mechanical means* upon which the art of tuning depends: and without a distinct perception of them, through their various degrees, it is impossible, even with the finest musical ear, to tune a pianoforte tolerably.

THE OCTAVE.

When the student is able to tune a perfect unison, he may proceed to the octave. Here the sounds, though no longer identical, have so strong a resemblance to each other, that when struck together and perfectly in tune, they seem to form but one simple sound; the lower one, as it were, swallowing up the higher. He will observe the same succession and gradation of beats, waves, and ultimate coincidence, as in tuning the unison.

When he has tuned an octave by striking the notes together, let him also try them in quick succession, thus:

at the same time holding the bottom note down: for the ear is apt to be satisfied with the octave, while it is yet too flat, particularly in tuning the upper notes of the instrument; and striking them, one after the other, in the above manner, affords a ready and certain means of detecting any error in this respect.

THE FIFTH AND THIRD.

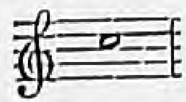
The student may now practise tuning the fifth, and the major and minor thirds. These concords, when *perfectly in tune*, have neither beat nor wave, but coalesce in one pure, agreeable, uninterrupted, *complex* sound. At first he will, of course, tune them *perfect;* though we shall presently demonstrate that, according to our present musical system, these intervals are never so tuned in practice. It is necessary, however, that he should be familiar with them in their perfect state, that he may be able to judge of the degree of deviation from this point which the ear will tolerate.

As we can tune only one string at a time, we must, to avoid confusion, stop the vibration of the other string, or strings, belonging to the note which we are adjusting. In the grand and cabinet pianos, this is done by means of the left-hand pedal, which shifts the key-board and the hammers belonging to the keys, so that they strike only one string to each note. In square instruments, however, this must be done by means of a *damper*, which is to be inserted between the string of which we mean to stop the vibration, and the string immediately adjacent to it belonging to the next note: a bit of card, soft paper, or leather, answers very well for this purpose.

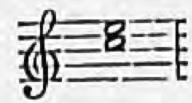
ON TEMPERAMENT.

Experience teaches us, and writers on the mathematical theory of sound demonstrate, that if we tune the following series of perfect fifths,

the E last obtained will be found too *sharp* to form a *true* major third to the note



the double octave to the C in the bass, from which we started. Indeed the third



thus obtained is so sharp as to be utterly offensive to the ear, and therefore unfit for harmony, where this interval plays so conspicuous a part.

To remedy this inconvenience, it becomes necessary to tune each of the fifths a very small degree *flatter* than perfect. The E obtained by this means will not be so sharp as that obtained before; though, if the fifth be properly altered—or *tempered*, as it is termed—it will be somewhat too *sharp;* as the fifths will not admit of being tuned so flat as to produce a *perfect* major third, without their consonancy being too much affected.

If we continue the above series of *perfect fifths* to B, F♯, C♯, G♯, &c. and compare the notes produced, respectively with the octaves or double octaves of the notes G, D, A, E, &c. before obtained, we shall find the same defect in all the other major thirds. Hence, it appears that if we tune by *perfect fifths*, all the major thirds will be so sharp as to be unbearable; and that if, by depressing the fifths, we tune our *major thirds perfect*, the fifths will be so flat as to be unfit for the various combinations of harmony.

We must, therefore, flatten each fifth of the complete circle, C, G, D, A, E, B, F♯, C♯, G♯ or A♭, E♭, B♭, F, C, *equally* and in a very small degree; this depression, while it will not materially impair the consonancy of the fifths, will produce a series of somewhat sharp, though still agreeable and harmonious major thirds*.

To assist the ear in determining the proper degree of depression, let the student tune the fifth

* In the article *Temperament*, in Part II of this work, we shall demonstrate these propositions upon mathematical prin

perfect; and then let him flatten the note G, so that, upon striking the notes G and C together, he hears *two slow, distinct waves*, terminating in one steady continuous sound; and the fifth will be properly *tempered*. The same mechanical *test* will enable him to tune all the remaining fifths of the circle.

By this time the student will have exercised his ear in tuning the principal intervals, and have acquired somewhat of that flexibility of wrist and command of the hammer which enable the hand to move the pins by almost incredibly minute degrees; he may, therefore, proceed to learn the following scheme:

SCHEME FOR TUNING ACCORDING TO THE SYSTEM OF EQUAL TEMPERAMENT.

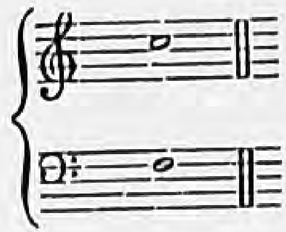
EXPLANATION OF THE SCHEME.

In the above scheme, the first note is tuned to the proper pitch by the help of a C *tuning-fork*, which, with the tuning-hammer, may be bought at any music-shop. In the next, and each subsequent bar, the black note is used to distinguish the note to be tuned; the white note in the same bar having been tuned already. These black notes always stand in the relation either of an octave or fifth to the white note in the same bar: and we have already explained that all octaves are to be tuned perfect, and all fifths somewhat flatter than perfect. The octaves, tuned after most of the fifths, are necessary to confine the circle of fifths to the notes in the middle part of the instrument: as the vibrations of the upper notes are too quick and indistinct, and those of the lower bass notes too often mixed with the sympathetic vibrations of other strings, their own harmonics, &c. (particularly when the dampers do not act properly, or when the instrument is old), to allow the ear tempering the fifths formed by such notes with sufficient accuracy.

When we arrive at the eighth fifth of the series, instead of proceeding onwards in the circle to D♯ or E♭, it will be *better* to return to C, and tune the remaining fifths *backwards*, as shown in the scheme.

In adjusting these latter fifths, marked 9, 10, 11, the student must first tune the bottom note so as to form a perfect fifth with the upper note, and then *sharpen* it by exactly the same quantity as he depressed the upper notes of the fifths which were tuned *forwards*. By this means the *interval* of the fifth is still *diminished* or *flattened*, as the lower extremity is brought nearer towards the upper one.

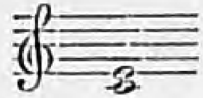
When the last fifth is adjusted, we shall have tuned *every note* within the following compass:—



This operation is called laying the *bearings*: it forms the most delicate and important step in tuning; as all the other notes on the instrument are tuned to these notes by means of octaves above or below.

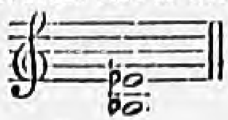
Generally speaking, it will be found necessary to go over the bearings a second time before we proceed to tune the rest of the instrument by octaves to them; trying the different chords, as we proceed, in the following manner:—

Tune, the correctness of the note E forming the fifth, No. 4, must be ascertained by comparing it with the C below it, thus:



and observing whether, when struck together, these notes produce a major third, somewhat *sharper* than perfect, but still consonant and agreeable. A similar test must be applied to all the subsequent fifths. These trials may be represented in notes, as follows; they afford, at each step, a check by which we may ascertain the correctness of our progress:

The last and severest test is the following fifth.—



as the two notes of which it is formed have been obtained by different series of fifths. Any imperfection which may have escaped us in tuning will manifest itself here; hence this fifth, from the frequent harshness and howlings of its beats, has been technically termed the *Wolf*. If, however, the directions which we have given have been carefully observed, this fifth will be little, if at all, inferior to the rest; and the chords, into which one or other of its notes enters, will not be less harmonious than the same chords on other notes of the system of sounds.

When the *bearings* are laid with sufficient accuracy, it only remains for us to tune the remaining notes on the instrument, in the relation of octaves to those already adjusted. This must be done in the following manner:—

Before we consider the instrument as thoroughly in tune, each upper note should be compared with its octave and double octave below; and similarly, each bass note with its octave and double octave above: this is one of the surest ways of detecting any inaccuracy in our tuning.

In tuning a cottage, or semi-cottage, or piccolo piano, it will be desirable to adjust first the whole series of notes upon *one* string, and then to tune all the *second* strings in unison to those of the *first* series.

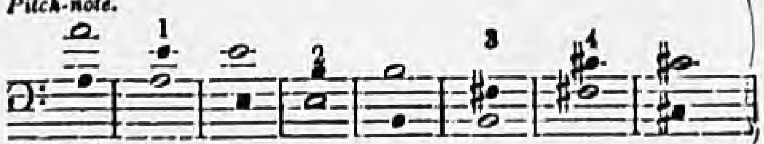
In a grand piano, after the second set of strings is tuned, we must tune the third set in unison to the first and second. In square pianos, the second string to each note must necessarily be tuned before we proceed to another note.

The upper notes must be gone over several times, as the tuning of the bass notes is apt to depress the pitch of the upper notes already tuned.

The Germans, who, both in public and private, are more accustomed than we to play, on the piano, music requiring instrumental accompaniments, generally begin to lay their *bearings* from the note A, as better adapted to the pitch of the instruments which compose the orchestra.

We shall give the following scheme for this purpose:

Pitch-note.



Notes to be tuned.

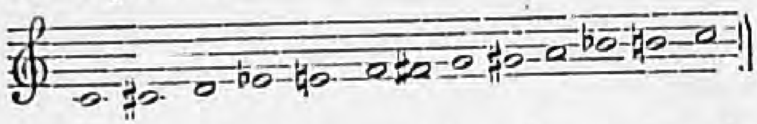
Enharmonic.

The system which we now have explained is that of *Equal Temperament:* it is that generally adopted throughout Europe. Various systems of *unequal* temperament have been proposed, as those of Kirnberger, Earl Stanhope, &c. in which some of the major thirds or fifths are tuned perfect, others modified in various degrees. These have all one capital defect, which is, that while some few keys are tuned more harmoniously than by the system of equal temperament, all the remaining keys are much less perfect; so that it becomes impossible to modulate into them without disgusting the ear.

Another method of laying the bearings has been used of late by some of the best tuners belonging to the most eminent of the pianoforte manufactories; which method is by fifths and fourths, omitting tuning the octaves until the ground-work is laid, as follows:—

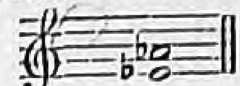
observing to tune the fifths a little flat, and, by the same rule, of course, the fourths a little sharp, as mentioned with regard to the fifths at page 8.

In the above method, we shall have tuned the following notes within the circle of the octave thus:—



and have avoided the possibility, when tuning the octaves between the fifths, as in other methods, of not getting the octaves true: besides which, the ground-work, or bearings, will be sooner laid down. The trials would be:—

The last test would be in the following fourth



and the result found as mentioned in page 13.

The remaining notes of the pianoforte must then be tuned as mentioned at pages 14 and 15.

GENERAL OBSERVATIONS.

Let the instrument be tuned at least once every month or six weeks, keeping it always up to concert pitch *. The damp must be carefully excluded from getting to the strings; and the belly or sound-board, and the action generally, must be kept free from dust, pins, &c. as the smallest substances either damp the tone or produce a jingling and disagreeable noise, the cause of which it is sometimes very difficult to detect.

If a string should break, great care must be taken to replace it by another of *exactly* the same thickness, and of wire of the same kind. A little practice will enable the student to put on a string neatly †. Pianoforte wire of all the different sizes may be bought in *rings* at most of the principal music shops.

New strings require to be drawn up several times, and well rubbed with a piece of soft leather, before they will stand in tune.

* See note on pitch, pp. 56, 57, *infra.*

† Vide Part IV (p. 62, *infra*) for the method of putting on a string.

HAMILTON'S ART OF TUNING,

ETC.

PART THE SECOND.

A MATHEMATICAL DEMONSTRATION OF THE THEORY OF EQUAL TEMPERAMENT.

Definition of Temperament—Ratios of the several Intervals—Minor Third—The Syntonic Comma—Requisites in every System of Temperament—PROPOSITION I—*The Diesis, and its Value*—PROPOSITION II—PROPOSITION III—*The Ditonic Comma, and its Value—Equal and Unequal Temperament compared—Temperament used at Rome as mentioned by Salinas—Zarlino—Guido Aretin invented a Temperament.*

IN the usual acceptation of the term, *Temperament* denotes a small, and to the ear almost imperceptible, deviation from the absolute purity of intervals; which is rendered necessary in practice by the various relations in which musical sounds may be employed both in harmony and melody.

In a more limited sense, *Temperament* denotes that arrangement of a system of musical sounds by which a minute quantity is abstracted from the original

purity or magnitude of some or most of the intervals which may be formed by them; in order that *all* the sounds of the system may be so connected, as that *each one* may not only form serviceable intervals with all the rest, but also that each one may be employed as the root of a major or minor scale, every note of which shall preserve the due relation of intervals with regard to each root.

In the natural generation of sounds, where each interval appears in its utmost purity, the sounds which enter into a major or minor key constructed on any given root or tonic, may be obtained by dividing the length of the string which gives the root or tonic, so that its entire length shall bear to the several parts or *segments* of it the following proportions or ratios :—

	Whole Length.		*Segments.*
The Octave is in the ratio of. .	2	to	1
— Fifth	3	—	2
— Fourth	4	—	3
— Major Third	5	—	4
— Minor Third	6	—	5
— Major Second	9	—	8, or 10 to 9
— Major Sixth	5	—	3
— Minor Sixth	8	—	5
— Major Seventh	15	—	8
— Major Semitone	16	—	15

Consequently, $\frac{1}{2}$ the length of any string, when sounded, produces the octave above the note yielded by the entire length; $\frac{2}{3}$ of its length produces the *fifth* above; $\frac{3}{4}$, the *fourth* above; $\frac{4}{5}$ the *major third* above; &c.

And, therefore, if we represent the length of the string necessary to sound the note C by unity, the length of the segments of the same string necessary to produce in succession the notes of the ascending major scale of C, will be represented as follows:—

C	D	E	F	G	A	B	C
1,	$\frac{8}{9}$,	$\frac{4}{5}$,	$\frac{3}{4}$,	$\frac{2}{3}$,	$\frac{3}{5}$,	$\frac{8}{15}$,	$\frac{1}{2}$.

To exemplify the use of the above fractions, let us suppose that the absolute length of a string necessary to sound the note C is 360 inches; then the successive portions of the same string necessary to produce the notes of the ascending scale will be, in inches, as follows, viz.

C,	D,	E,	F,	G,	A,	B,	C.
360,	320,	288,	270,	240,	216,	192,	180.

If we now compare one with another (by means of the ratios expressed by their corresponding numbers) the intervals formed by the notes of the above scale, we shall find that they all preserve their original purity, except the minor third, from D to F; and the fifth, from D to A. The first of these intervals, viz. the minor third from D to F, presents itself in the ratio of 320 to 270, instead of 324 to 270 (which latter is equal to the ratio of 6 to 5, the true ratio of the minor third). The third from D to F, therefore, is to the true minor third as 320 to 324; i. e. (dividing for the sake of greater simplicity, both terms by 4) as 80 to 81. Again, the fifth from D to A presents itself in the ratio of 320 to 216, or (dividing each term by 4) 80 to 54; instead of 3 to 2 (= 81 to 54—multiplying each term by 27), which is the ratio of the true fifth*.

The comparison, then, of these ratios of the minor third (from D to F), and the fifth (from D to A), with the perfect ratios of those intervals, thus shows that each is too small by the *syntonic comma*, a minute interval represented by the difference in the terms of the ratio 81 to 80.

Hence, if, in a melody in C major, we introduce the A as a perfect sixth to C, in the ratio of 5 to 3, and place under it as a bass the note D, then will the fifth, D A, be too flat by the syntonic comma. As experience teaches us that, in so perfect a consonance as

* If we continue the scale an octave higher, we shall find that the sixth F D, and the fourth A D, will labour under the same imperfection, &c.

the fifth, the ear cannot endure the excess or deficiency of a whole *comma* without being offended, it is easy to see that some *Temperament* must take place, even in using such a simple and limited number of sounds as the above series of eight notes.

The necessity of *Temperament* becomes still more apparent, when we propose to combine every sound used in music into a connected system, such that each individual sound shall not only form practical intervals with all the other sounds; but also that each sound may be employed as the root of its own major or minor key; and that all the notes necessary to form its scale shall stand in such a relation to each other as to satisfy the ear.

The chief requisites of any system of musical Temperament adapted to the purposes of modern music, are:—

1st. That all *octaves* must remain perfect, each being divided into *twelve semitones*:

2ndly. That each sound of the system may be employed as the root of a major or minor scale, without increasing the number of chords or sounds in the system:

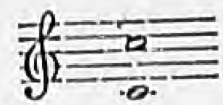
3rdly. That each consonant interval, according to its degree of consonancy, shall lose as little of its original purity as possible; so that our ear may still acknowledge it as a perfect or imperfect consonance.

Several ways of adjusting such a system of Temperament have been proposed, all of which may be classed either under the head of *equal* or of *unequal* temperament.

The rationale of the system of *equal* temperament, which is that now in general use throughout Europe, and of which we have explained the practice in the previous part of this work, may be demonstrated upon the principles established in the three following propositions:

PROPOSITION I.

If we divide the interval of an octave, as



into three major thirds, each in the perfect ratio of 5 to 4, as

then, the C obtained from the last third, Ab, C, will be too flat to form a perfect octave by a small quantity, d, in the Theory of Harmonics, a *diesis*, and ex-ssed by the ratio 128 to 125.

DEMONSTRATION.

The length of the string being given (represented in the following demonstrations by unity, or 1) which sounds C natural, then will the note E, the major third to that C, be sounded by $\frac{4}{5}$ of that entire length.

In like manner, G♯, the major third to E, will be sounded by $\frac{4}{5}$ of that segment of the string which sounds the note E: that is, G♯ will be sounded by $\frac{4}{5}$ of $\frac{4}{5}$ ($= \frac{4}{5} \times \frac{4}{5} = \frac{16}{25}$) of the entire length of the string which sounds C natural.

But again, the major third to G♯ (the same as A♭ in a system in which the octave is divided into twelve semitones) is C natural; which major third will be sounded as before by $\frac{4}{5}$ of that segment of the string which sounds G♯ or A♭; i. e. by $\frac{4}{5}$ of $\frac{16}{25}$ ($= \frac{4}{5} \times \frac{16}{25} = \frac{64}{125}$) of the entire length of the string.

But the note now obtained (C) is the octave to the note C given by the entire length of the string; and the true octave will always be sounded by the exact half of the length of string which sounds the fundamental note (i. e. the octave below).

Now the exact half of the string is represented by $\frac{64}{128}$ ($= \frac{1}{2}$), instead of $\frac{64}{125}$, as obtained by the succession of major thirds.

Hence it appears that the octave obtained by a succession of major thirds will differ from the true

octave in the ratio of 128 to 125—the true octave being the sharper*, because represented by the fraction with the greater denominator, the numerators being the same.

It is evident, therefore, that *all major thirds must be tuned somewhat sharper than perfect*, in any system of Equal Temperament†.

The ratio which expresses the value of the *diesis*, is that of 128 to 125. If, therefore, the octaves are to remain perfect, each major third must be tuned sharper than perfect by one third part of the *diesis*.

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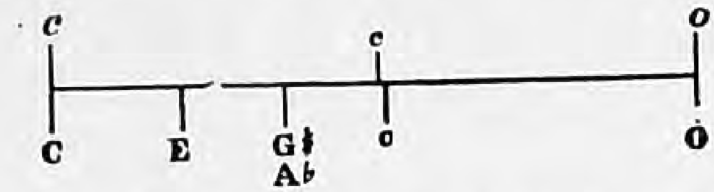
* To explain this familiarly, so many 128th parts are less than the same number of 125th parts: the string therefore represented by the former fraction is shorter than that repre sented by the latter; and consequently will give a more acute sound.

† The demonstration as given in the text is altered from that given by Mr. Hamilton, because the latter, although true in its result, was, from an undue zeal for conciseness, defective in form, and therefore likely to produce confusion in the minds of those who for the first time address themselves to the subject.

A similar remark is applicable to the Second Proposition. The Third Proposition, however, remains; as it was not liable to the same objection, being perfectly formal and regular.

The foregoing demonstration may be rendered more clear and intelligible by the subjoined diagram:



Let C O or *C O* represent the entire length of the string which sounds C natural.

Then *c O* (*taking the italic letters above the line*) will represent the exact half, which sounds the perfect octave.

E O = $\frac{4}{5}$ of C O, represents the segment of the whole string which sounds the major third to C natural (viz. E natural).

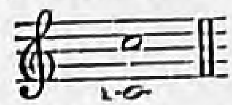
G♯ O = $\frac{4}{5}$ of E O (= $\frac{4}{5} \times \frac{4}{5}$ of C O) represents the segment which sounds a major third to E (viz. G♯ or A♭).

c O = $\frac{4}{5}$ of G♯ O represents the segment which sounds a major third to A♭ (viz. C natural, an octave above the former C).

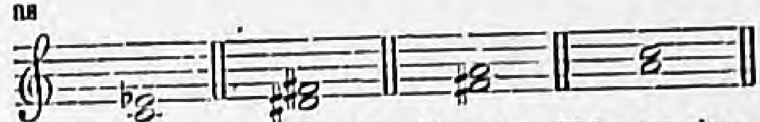
It is obvious, by inspection, that the C obtained by the succession of major thirds, represented by the length c O, will be sharper than the perfect C represented by *c O*—and in the ratio shown by the numbers in the foregoing demonstration.

Proposition II.

If we divide the interval of an octave, as



into four minor thirds, in their perfect ratio of 6 to 5, as



the C obtained from the last third AC will be too sharp in the ratio of 648 to 625.

Demonstration.

Let the whole length of the string (represented as before by unity, or 1) sound C natural,

Then will

E♭ (the same as D♯), be sounded by $\frac{5}{6}$ of that length; and

F♯ (the same as G♭) by $\frac{5}{6} \times \frac{5}{6} = \frac{25}{36}$

A .... by $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{125}{216}$

C .... by $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{625}{1296}$

each of these notes being at the interval of a minor third to the preceding note, and the ratio of the minor third being as 5 to 6.—(*See pages* 19, 20, *supra*.)

But the perfect octave will be represented by $\frac{648}{1296}$ $(= \frac{1}{2})$.

The perfect octave (represented by the fraction $\frac{648}{1296}$) is therefore flatter than the octave obtained by a succession of four minor thirds (and which is represented by the fraction $\frac{625}{1296}$), in the ratio of 648 to 625.

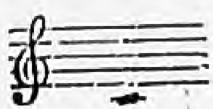
The ratio of 648 to 625 expresses the excess by which four minor thirds exceed the ratio of the octave; consequently, each minor third must be made flatter by one-fourth part of this ratio, than it would be produced by the original ratio of 6 to 5.

Proposition III.

Twelve perfect fifths employed within the space of an octave, exceed the ratio of an octave (or that of 2 to 1) by the *ditonic comma*, a small interval, expressed by the ratio 531441 to 524288; and therefore, if, in a system of equal temperament, all the octaves are to be tuned perfect, each fifth must be diminished by one-twelfth part of the *ditonic comma*.

Demonstration.

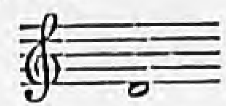
If we represent the length of the string necessary to sound the note



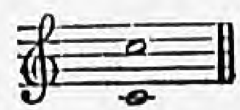
by unity (or 1), then will the fraction $\frac{2}{3}$ represent the length of that portion of the same string which will sound

its perfect fifth above; and $\frac{2}{3} \times \frac{2}{3}$ or $\frac{4}{9}$, the length of that portion which will sound

a perfect fifth above the G last found: but as this D is beyond the limits of the octave, we must double its length to find the value of



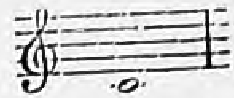
its octave below; which will therefore be $\frac{4}{9} \times \frac{2}{1} = \frac{8}{9}$. This latter value might have been found at once by multiplying $\frac{2}{3}$, the ratio of the fifth, by $\frac{4}{3}$, which is the same as $\frac{2}{3} \times \frac{2}{1}$. In finding the fractions which represent the remaining fifths of the circle, we shall, to save space, multiply by $\frac{4}{3}$, whenever it becomes necessary to reduce the following fifth within the limits of the octave.



Steps.					
III.	$\frac{8}{9}$	×	$\frac{2}{3}$	=	$\frac{16}{27}$ gives ..
IV.	$\frac{16}{27}$	×	$\frac{4}{3}$	=	$\frac{64}{81}$ ......
V.	$\frac{64}{81}$	×	$\frac{2}{3}$	=	$\frac{128}{243}$ ......
VI.	$\frac{128}{243}$	×	$\frac{4}{3}$	=	$\frac{512}{729}$ ......
VII.	$\frac{512}{729}$	×	$\frac{4}{3}$	=	$\frac{2048}{2187}$ ......
VIII.	$\frac{2048}{2187}$	×	$\frac{2}{3}$	=	$\frac{4096}{6561}$ ......
IX.	$\frac{4096}{6561}$	×	$\frac{4}{3}$	=	$\frac{16384}{19683}$ ......
X.	$\frac{16384}{19683}$	×	$\frac{2}{3}$	=	$\frac{32768}{59049}$ ......
XI.	$\frac{32768}{59049}$	×	$\frac{4}{3}$	=	$\frac{131072}{177147}$ ......
XII.	$\frac{131072}{177147}$	×	$\frac{2}{3}$	=	$\frac{262144}{531441}$ ......

Now the octave or ½ $(\frac{262144}{531441} \times \frac{1}{2}) = \frac{131072}{531441}$; and this fraction (as its denominator is less than that of the fraction representing B♯, while its numerator is

the same) evidently represents a greater length string, and therefore implies a flatter pitch than tha indicated by the former fraction. Hence the B♯ or C produced by the circle of perfect fifths is sharper tha is necessary to form a perfect octave to



in the ratio of 531441 to 524288, or a small quantity called the *ditonic comma*. And therefore, in any system of temperament, if all octaves are to be tuned perfect, and C♯ D♭, D♯ E♭, &c. are to be considered as synonymous sounds and to be represented by the same chords of the system, we must distribute the above excess, either by depressing each fifth one-twelfth part of the *ditonic comma*, which is the system of *Equal Temperament*; or, by tuning some of the fifths perfect, and distributing this excess among the remaining fifths of the circle; which, in whatever way it be done, produces a system of *Unequal Temperament*, such as those proposed by Earl Stanhope, Kirnberger, and others.

As, however, in this system of Equal Temperament, all octaves are tuned absolutely perfect; all the fifths depressed only by $\frac{1}{12}$ of the *ditonic comma*, and consequently all fourths sharpened by the same quantity; and again, all the thirds and sixths deviate only by ¼ of a comma from absolute purity—it follows that all the consonant intervals approach as nearly to perfection as possible.

Salinas tells us (vide Smith's Harmonics, page 37 that, when he was at Rome, he found the musicians used a temperament there, though they understood not the reason and true measure of it, till he first discovered, and Zarlino published it soon after—first in his Demonstrationi Harmoniche, Ragionamento quinte, proposta 1ma; and after that, in his Institutione Harmoniche, part 2, cap. 43. After his return into Spain, Salinas applied himself to the Latin and Greek languages, and caused all the ancient musicians to be read to him (for he was blind); and in 1577 he published his learned work upon Music of all Sorts (Francisci Salinæ, de Musicâ Libri Septem), where, treating of three different temperaments of a system, he prefers the diminution of the fifth by a quarter of a comma to the other two, which he says are peculiar to certain instruments.—De Musicâ, lib. iii, cap. 22. Deschales says that Guido Aretinus was the inventor of that temperament; but this opinion wants confirmation, especially as Deschales makes no mention of the claims of Zarlino and Salinas to that invention for it seems they had a dispute about it.

HAMILTON'S ART OF TUNING,

ETC.

PART THE THIRD.

MISCELLANEOUS.

§ 1. *On Sound and Vibrations*—§ 2. *The Monochord*—§ 3. *Monochord Tables: No. 1, No. 2*—§ 4. *Account of Earl Stanhope's Mode of Temperament*—§ 5. *Tuning Table*—§ 6. *List of Authors who have written on Temperament, &c.*

§ 1. OBSERVATIONS ON SOUND AND ON VIBRATING STRINGS.

SOUND is caused by the vibration of elastic bodies, which communicate the like vibration to the air and these again to our organs of hearing*; for instance, if a wire or cord be stretched between two fixed points, and be then pulled with the finger, it will be drawn from its position, and, for a certain number of times, will vibrate backwards and forwards. During the time of vibration a sound will be given out, and it may be

* Smith's Harmonics.

made continuous by keeping up the motion. The pitch of the sound will be regulated by the relative number of vibrations which occur in a given interval of time, say one second. A stretched cord will continue to give the same notes, if the weights upon it be continued, and the uniformity of its structure does not suffer from retching. In the case of vibrating strings, the same length and tension are not the only conditions required for the production of the same note; for the size and density have a considerable influence.

In estimating the character and peculiarities of musical sounds, three things are to be considered; the intensity, the quality, and the pitch.

The *intensity* of a sound is its comparative loudness, and depends upon the violence of the impulses from which it proceeds. From any musical instrument, a note may be obtained so loud as to be unpleasant to the ear, or so soft as to be scarcely audible; the only difference is in its intensity. When the note obtained from two instruments is the same and of the same intensity, there may still be a difference between the tones; the organ and the flute, for instance, may be made to repeat precisely the same sounds and with the same intensity, yet the ear would instantly detect a dissimilarity of character: this is called *quality*. Sounds produced from the same instrument may be of different qualities; and we can scarcely estimate how much a

musical performance depends on the quality of the sounds. In musical performances, the quality of sounds will depend partly upon the capabilities of the player and partly on the instruments.

The *pitch* is altogether independent both of intensity and quality, which may be different in the same sound. When we strike two or three adjoining strings on the harp or the violin, we detect a difference in the sounds, that cannot be attributed to either the greater loudness or sweetness of one than of another; the sounds are essentially different; they are not of the same *pitch*. When any two or more notes are of the same pitch, they are said to be in unison.

Sounds of different pitch, or different notes, are attributable to the greater or less rapidity of the vibrations. A certain number of vibrations in a second will always produce the same note, whatever may be the instrument used in obtaining the vibrations.

In the production of a certain musical note, the sounding body must be in a particular state—a state, in fact, suited to the production of a fixed number of vibrations in equal times. That a string should give out, when touched, a note of any definite pitch, it must have a fixed length, tension, and density; and if either of these be changed, the note is instantly altered.

All these elements are important; because the number of vibrations is regulated by them. Tuning an instrument, therefore, is nothing more than bringing the vibrating or sounding body into such a state, that a certain number of oscillations may be performed in a given time.

It is found that whenever the vibrations producing any two notes have a simple or low proportion, they are in concord. The lower the proportion, the more perfect the concord. Thus, when the vibrations are as 1 to 2, 1 to 3, 2 to 3, and so on, concords are produced. When, on the other hand, the vibrations have no numerical proportion, discord is the result.

The simplest concord is the unison; that is, when two notes are produced by the same number of vibrations. Next to this, the octave, where the vibrations are as one to two. When these are sounded together, it is almost impossible for those unacquainted with music to distinguish between them. A woman's voice is an octave higher than a man's; yet there are many persons who are not aware of the fact.

When the vibrations are as 1 to 4, we have the octave of the octave, or fifteenth, which is also a perfect concord; as are all the octaves, as 1 to 8, and 1 to 16. A twelfth is where the vibrations are as 1 to 3. If the octave of the note represented by 1 be used instead, we obtain a proportion of 2 to 3, which is called a fifth; a fourth is the proportion of 4 to 3.

If the vibrations, on the other hand, should be in

high proportions, discords are produced. Higher primes* than 5 enter into no harmonic ratios. Such combinations as 1—7, 5—7, or 6—7, are altogether discordant. The same may be said of the complicated combinations of the lower primes, 1, 2, 3, 5. The ear will not endure them. Let us take the ratio of 5—9, which is called a flat 7th, a combination decidedly discordant. If we multiply the terms of this ratio by 5, we get 25—45. A small change in one of the notes wil reduce this to 27—45, or 3—5, a major 6th, an agreeable concord. Now this will be done, if, retaining the lower note 5 or 25, we change the upper from 45 to 45 × $\frac{27}{25}$, that is to say, to a note whose vibrations are to its own as 25 to 27.

The following quotation, with the remarks appended, may be useful to the student,

"The number of vibrations in a given time (say one second), and not the size, length, or volume of the sounding body, determines the pitch of the sound or

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* A *prime* number is such as cannot be divided, without remainder, by any number greater than 1 (*e. g.*), 2, 3, 5, 7, 11, 13, &c. On the contrary, 4, 6, 9, 10, &c. may be divided by some other number greater than unity; 4, for example, may be divided by 2; 6, by 2, or by 3; and so on. Hence such a fraction or ratio as [illegible] may be reduced to lower terms, as [illegible]; and so of others.

note. The tone given by the fourth string (C) of the violoncello is as grave as that given by an 8-feet organ-pipe, because the number of vibrations is the same in either case. That same note, viz.

gives, according to Euler and Marpurg, from 118 to 125 vibrations per second, as the experiment is more or less accurately made. By others, it has been reckoned at 130; and Chladni adopts the number 128 from certain conveniences attending the use of that number."

Assuming, then, that 128 vibrations per second produce the note C natural, as above, there will be no difficulty in determining the number of vibrations which produce the remaining notes of the octave. For, in strings of different lengths, *cæteris paribus* (that is, thickness, tension, &c. being equal), the number of vibrations will be in the inverse ratio of the lengths of the strings. But the relative lengths of the strings producing the successive notes of an octave was (page 22 *supra* shown to be as).

(Lengths)

	1	$\frac{8}{9}$	$\frac{4}{5}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{3}{5}$	$\frac{8}{15}$	$\frac{1}{2}$
for the notes	C	D	E	F	G	A	B	C

It follows that the number of vibrations producing those notes will be (inverting the terms of the fractions) as

$$1 \quad \frac{9}{8} \quad \frac{5}{4} \quad \frac{4}{3} \quad \frac{3}{2} \quad \frac{5}{3} \quad \frac{15}{8} \quad 2;$$

which ratios or fractions, referred to 128 as unity or the whole, will give

(Vibrations per Second.)

	128	144	160	$170\frac{2}{3}$	192	$213\frac{1}{3}$	240	256
for	C	D	E	F	G	A	B	C

as the number of vibrations per second, which produce the successive notes of the octave.

§ 2. DESCRIPTION AND USE OF THE MONOCHORD.

The Monochord is an instrument admirably calculated to illustrate the laws which govern the production of sound in vibrating strings. Let a gut string or wire (which is the best) be stretched over a hollow wooden box with a moveable bridge, and with a projecting piece of wood at each end. Let the string be tuned to any note that the length of the string will most conveniently allow, which may be done by means of pegs at each end (violin pegs will do); by shifting the bridge, the length of the vibrating part of the string may be either increased or decreased at pleasure, and the effects may be estimated under different circumstances. The pitch of any note given out by a tense cord will vary according to the density, length, or degree of tension possessed by the vibrating body: for instance, if a string or wire of uniform thickness, stretched on a monochord, be reduced to one-half of its original length, one-half will yield the sound of the perfect octave. That is, if, for example, the length of an uniform wire be thirty inches, and it be so stretched as to yield the sound of the first bass C; then, in order for the same wire, with the same tension, to give the exact sound of the C above, which is termed middle C, the length of the wire must be reduced to fifteen inches.

If the wire be reduced to two-thirds of its original length, that is, to twenty inches; then the sound proуced by the two-thirds will be a perfect fifth.

If the wire be reduced to three-fourhs of its original length, namely, to twenty-two inches and a half, it will yield a perfect fourth.

And if the wire be reduced to four-fifths of its original length, those four-fifths will yield a perfect third. In like manner any pitch within the compass of the monochord may be obtained, by regulating the length of the wire to the exact degree that is requisite for that purpose.

NOTE.—The term monochord (from μόνος alone and χορδή a string) signifies an instrument with only one string. Such instruments have been used in different ages for the ordinary purposes of performance. On the monuments of ancient Egypt (three or four thousand years old) are found representations of a monochord, i. e. a one-stringed musical instrument; and to this day, in the same country and in Syria, the Arabs play, with some execution, upon a one stringed instrument of the same kind, called by them *Rebâb.*

The simple and ingenious machine described in the text under the title of monochord, is only intended for demonstrating the properties of vibrating strings, or for pitching a note in tuning instruments, or for other similar purposes.

§ 3. THE MONOCHORD CONTINUED—TABLES.

The two following tables fully illustrate Earl Stanhope's mode of constructing the monochord. The dimensions given in these tables proceed on the supposition that the whole string or wire which yields the sound of C, an octave below 'middle C,' is 30 inches in length. This whole length (30 inches) is supposed to be divided by scale into 120 divisions, each equal to one quarter of an inch; and the tables show the exact lengths of the segments which sound all the semitones of the octave.

No. I.

Showing the length of each wire from the middle C to the C next below, both inclusive; supposing that the wire which yields the sound of the last-mentioned C be 120 quarters of an inch long between the two bridges of the monochord.

Keys.	Quarters of an inch.	Hundredths of one quarter of an inch and decimal parts of 100th of one quarter of an inch.
Middle C	60	
1st Bass		
B	64	
B flat	67	50
A	71	70,247,592+
A flat	75	89,466,384+
G	80	
G flat	85	38,149,682+
F	90	
E	96	
E flat	101	10,288,512+
D	107	10,027,200+
D flat	113	84,199,576+
C	120	

No II.

Showing the manner of setting off the whole monochord scale from a single point, supposing that point to be the extremity of the length of the G wire.

Keys.	Quarters of an inch.	Hundredths of one quarter of an inch and decimal parts of one hundredth of one quarter of an inch.	
Middle C	20		To be set off backwards.
1st Bass			
B	16		
B flat	12	50	
A	8	29,752,107+	
A flat	4	10,533,615+	
G	0		
G flat	5	38,149,682+	To be set off forwards.
F	10		
E	16		
E flat	21	19,288,512+	
D	27	10,927,200+	
D flat	33	64,199,576+	
C	40		

§ 4. SOME ACCOUNT OF EARL STANHOPE'S MODE OF TEMPERAMENT.

If, in a musical instrument (as the pianoforte, for instance, which has exactly twelve fixed tones in each septave *), the octaves be tuned perfect, then the fifths cannot all be tuned perfect. And if the fifths be tuned perfect, then the octaves cannot be tuned perfect.

The human ear is so constructed, that we can bear to hear a greater deviation from perfection in the fifths than in the octaves; we can bear to hear a still greater deviation from perfection in the major thirds, than we can bear either in the octaves or fifths. Some tuners, to assist the fifths, tune the octaves a little imperfect. The objections to this method are obvious; for if we sharpen the octaves to assist the fifths, it injures the thirds; and if we flatten the octaves to assist the thirds, it injures the fifths.

However small the deviation from perfection may be in a single octave, it will become very sensible in two or three; and in the extent of six octaves such a deviation will become very offensive.

It is necessary, therefore, that all the octaves should be tuned *perfect*. This object can be obtained only in one way; and that is, by tuning one or more of the twelve fifths *flatter* than *perfect*.

* The utility of this word has led writers to overlook its exaggerated barbarism. Octave means THE EIGHTH NOTE: a word was wanting to express the group of seven notes or keys, which with the eighth note (i. e. the octave note) forms the diapason.

In order that all the octaves may be tuned *perfect*, it is likewise necessary that some one or more of the three successive major thirds, viz. C, E—E, G sharp (the same as A flat)—and A flat, C, must be tuned *sharper than perfect;* for otherwise, CC, which is produced by three successive major thirds, could not be (as it ought to be) a perfect octave; because three successive perfect thirds do not make up a perfect octave*. Therefore, in tuning any musical instrument which has exactly twelve fixed tones in each septave, the problem resolves itself into this—to ascertain which one or more of the successive major thirds ought to be tuned *sharper than perfect*, and in what proportion each is to be so tuned; and also which one or more of the twelve successive fifths ought to be tuned *flatter than perfect*, and in what proportion.

To arrive at this, begin by pitching the first bass C (which must be considered as the key-note) to a tuning fork or monochord; then make the C above, which is called the middle C, a perfect octave from the first bass C. This method is preferred, because the beats are more perceptible to the ear.

2. From the first bass C, make C, G a perfect fifth.

3. From the first bass C, make C, E, a perfect third. Then tune the two octave E's next above.

* See this demonstrated, Prop. I, pp. 23, 24, 25, *supra*.

4. From E, make E, B, a perfect fifth; and prove B, from G, as a perfect third.

5. From middle C, tune C, F, upwards, a perfect fourth; or tune F, C, downwards, a perfect fifth. Then tune the F next above, a perfect octave.

6. Tune F, B flat, upwards, a perfect fourth; or B flat, F, downwards, a perfect fifth.

7. Then pitch A flat exactly half-way between E and C next above.

If a monochord be used for this purpose, the length of the wire A flat must be made a *geometrical mean proportional* between the length of the wire E, and the length of the wire C next above.

8. The pitch of A flat, being determined, next pitch A flat, E flat, upwards, a perfect fifth; or tune E flat, A flat, downwards, a perfect fourth. E flat will then be exactly half-way between B and G next above.

9. Tune A flat, D flat, upwards, a perfect fourth; or tune D flat, A flat, downwards, a perfect fifth. Then tune G flat, D flat, downwards, a perfect fifth; then D flat, next above, a perfect octave.

10. The pitch of D flat being determined, tune D flat, G flat, upwards, a perfect fourth; or tune G flat, D flat, downwards, a perfect fifth.

We have now got seven fifths quite *perfect;* viz. 1—C, G; 2—E, B; 3—F, C; 4—B flat, F; 5—A flat, E flat; 6—D flat, A flat; 7—G flat, D flat;

and likewise got two-fifths very nearly perfect, but a little flat; viz. 1—B, F sharp (which is the same as G flat), and, 2—E flat, B flat.

Each of these two-fifths (says Earl Stanhope) differs from a perfect fifth only ONE in two thousand six hundred and fifty-seven parts and a half nearly; or about 1,128,831 parts in 3,000,000,000. It is a fact worthy of notice, that, in each of these two last-mentioned fifths, *two distinct beatings* are to be heard at the same time; the one very slow, and the other considerably quicker. And, as each of these two-fifths, as proved by the monochord, approaches nearly to perfection, it is evident that it is the *slower* beating which is the proper beating to be attended to in this case.

11 and 12. It is now requisite to pitch the D, and the A, between the G, perfect fifth, from C, and the E, second octave from that E which is a perfect third from C, in such a manner that the interval G, E, may be divided into three equally flat fifths, G, D; D, A; and A, E. None of these three fiths are of such a degree of flatness as to be offensive to the ear; for each of these three fifths differs from a perfect fifth only *one* in three hundred and sixty-one parts and a half nearly; or about 8,298,850 parts in 3,000,000,000.

If the monochord be used to determine the pitch of D and A, then in the length of the wire D, and that

of A, must be made two *geometrical mean proportionals* between the length of the wire G, and the length of the wire E. But if a monochord be not used for that purpose, and the tuner determine the pitch of D and A by the ear, it may be done with great accuracy by attending properly to the equality of the beatings of the three successive flat fifths, G, D; D, A; and A, E. If the interval G, E, be (as in Kirnberger's Method of Tuning) divided into one perfect fifth—such for instance, as the perfect fifth G, D—and two equally flat fifths, D, A, and A, E; then each of the two flat fifths, by becoming too flat, is offensive to the ear. And if the same interval, G, E, be divided into two perfect fifths and one flat fifth; then the flat fifth so produced is still more offensive.

§ 5. THE STANHOPE TEMPERAMENT CONTINUED —TUNING TABLE.

In the Table which follows, the principles already detailed *in extenso* are brought under the eye at one view. The student who desires to appreciate thoroughly the System of Temperament invented and recommended by Earl Stanhope) which has been a subject of much curious enquiry amongst musicians), will find his convenience materially promoted by this lucid illustration of the principles upon which that system is founded.

TUNING TABLE ADAPTED TO EARL STANHOPE'S TEMPERAMENT.

This Table shows at one view the manner and order of tuning the twelve keys, according to the Stanhope temperament. As soon as a key is tuned, it is expressed by a capital letter; the small letters represent those keys which are going to be tuned

Order of Tuning.	First Bass Septave.							The Middle Septave.							First Treble Septave.		
	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E
1	C	..	..	..	..	..	..	c									
2	C	..	..	..	g												
3	C	..	e	..	..	..	..	..	..	e	....		....		....		e
4	..	..	E	..	..	..	b										
5	..	..	..	f	..	..	..	C		..	f						
6	..	..	..	..	..		b flat	..	..	..	F						
7	..	..	E	..	..	a flat		C									
8	..		e flat	..	..	A flat		..	e flat								
9	d flat		..	..	..	A flat		d flat									
10	....	..		g flat				D flat									
11 & 12	....	..	..	G........				.. d ..			.... a				....		E

1 C—c, perfect octave.
2 C—g, perfect fifth.
3 C—e, perfect third; and e—e, e—e, two perfect octaves.
4 E—b, perfect fifth.
5 f—C, perfect fifth; and f—f, perfect octave.
6 b flat—F, perfect fifth.
7 E—a flat, a flat—C, two bi-equal thirds.
8 A flat—e flat, perfect fifth.
9 d flat—A flat, perfect fifth; and d flat—d flat, perfect octave.
10 g flat—D flat, perfect fifth.
11 & 12 G—d, d—a, a-E, three tri-equal fifths.

§ 6. A LIST OF AUTHORS WHO HAVE WRITTEN ON TEMPERAMENT, &c.

Bendeler (Joh. Philipp). *Acarium Melopoeticum.* Fol. Nuremberg.............. 1688
Werkmeister (Andreas). *Musikalische Temperatur.* 4to. Frankfort and Leipsic...... 1691
Hugenius (Christianus). *Cosmostheoros, sive de terris cœlestibus.* 4to............. 1698
G (C). *Temperamentum musicum universale* 1717
Sinn (Christoph. Albert). *Herzolich Braunschweigischer Geometer.* 4to............ 1717
Meckenheuser (Jacob Georg). *Die sogenannte allerneueste musikalische Temperatur.* 4to. 1727
Montvallon (de). *Nouveau Système de Musique* 1742
Sorge (Georg Andreas). *Anweisung zur Stimmung und Temperatur*................ 1744
Schröder (Christoph. Gottlieb). *Volständiger Plan der Pythagorischen gleichschwebenden Temperatur*........................ 1747
Sorg (Georg Andreas). *Gesprach zwischen einem Musico theoretico*............... 1748
——————*Gründliche Untersuchung*.. 1754
Fritz (Barthold). *Anweisung wie man Claviere* (2nd Edition, 1757, 3rd do. 1780). 1756
Sorge (G. A.) *Zuverlässige Anweisung Claviere* 1751

Riese (Joh. Heinrich). *Arithmetische und geometrische Vergleichung* 1759
Kirnberger (Joh. Phil). *Construction der gleichschwebenden Temperatur* 1760
Berlin (Joh. Daniel). *Anleitung zur Tonometrie.* 1767
Strêhle (Dan. P.) *Versuch eine gleichschwebende Temperatur* ....
Templehoff (G. F. von). *Gedanken über die Temperatur des Herrn Kirnberger* 1775
Tournatoire. *L'art musical rélatif à l'accord du Piano* ....
Marpurg (F. W.) *Versuch über die musikalische Temperatur* 1776
Lambert (Joh. Hein.) *Gedanken über die musikalische Temperatur* 1778
Jones (Sir William), *Physiological Disquisitions.* 1781
——— *On the Philosophy of Musical Sounds.* (Monthly Review) 1781
Cavallo (Tiberio). *Of those musical Instruments, in which the tones, keys, and frets are fixed,* &c. (in the Phil. Transactions)...... 1787
Wiese (C. L. G.) *Anweisung der mechanischen Behandlung* 1790
Marpurg (F. W.) *Neue Methode, allerlei Arten von Temperaturen dem Claviere* 1790
Wiese (C. L. G.) *Versuch eines formularisch und tabellarisch vorgebildeten,* &c. &c. 1791

Wiese (C. L. G.) *Formularisches Handbuch.* 1792
——— *Der populären Gemeinnützigkeit* 1793
Louvet (Alex.) *Instructions théoriques et pratiques sur l'accord de Pianoforte* 1798
Büttner (Joseph.) *Stimmbuch oder vielmehr.* 1801, 1804
Knecht (Justin Heinrich). *Ueber die Stimmung musikalischer Instrumente* (in Leip. Mus. Zeitung, vol. 5.) ....
Weller (Aug. Hein.) *Versuch einer Anleitung Claviere* 1803
Gall. *Clavierstimmbuch* 1805
Stanhope (Charles, Earl). *Principles of Tuning Instruments with fixed tones* 1806
Dall, Olio (G). *Memoria sopra la tastatura degli Organi e de' Cembali* 1806, 1807
Vogler (G. J.) *Gründliche Anleitung zum Clavierstimmen.* &c. 1807
Türk (Daniel Gottlob). *Anleitung zu Temperaturberechnungen,* &c. 1808
Salette (Joubert de la). *Lettre sur une nouvelle manière d'accorder les Forte-Piano* 1808
Blanchet (A. F. N.) *Méthode abrégé pour accorder le Pianoforte* ....
Steup (H. C.) *Méthode pour accorder le Pianoforte* ....

Asioli (Bonifazio). *Osservazioni zul temperamento* 1816
Harder (August.) *Unterricht das Pianoforte zu stimmen.*
Schneider. *Gründliche Anleitung zum Clavierstimmen.*
Wilke (Frederick). *Ueber Stimmung der Orgel* (in the Leip. Mus. Zeitung, vol. 24).
Lehmann (J. T.) *Gründliches, volständiges, und leichtfassliches Stimmsystem* 1827
Schiassi (F.) *Del Temperamento* 1832
Häuser (J. E.) *Das Stimmen des Forte-Piano.* 1834
Montal (C.) *Kurzgefasste Anweisung des Forte-Piano* 1835
Scheibler (Heinrich). *Anleitung die Orgel, &c.* 1836
——— *Mittheilung über das wesentliche, &c* 1836
Löhr (Dr. Joh. Jos.) *Ueber die Scheiblersche Erfindung uberhaupt und dessen Pianoforte.* 1836
Montal (C.) *L'Art d'accorder soi-même son piano* 1838
Kraushaar (Otto.) *Construction der gleichschwebenden Temperatur* 1838

To which may be added the following works on Acoustics, Harmonics, and Sound generally:
Smith (Robert). Harmonics, or the Philosophy of Musical Sounds .... 1749 and 1759

Maxwell (Francis Kelly). Essay upon Tune.. 1781
Keeble (John). Theory of Harmonics...... 1784
Young (Matthew). An Enquiry into the principle Phenomena of Sounds and Musical Strings 1784
Chladni (E. F. F.) Traité d'Acoustique.. .. 1809

These works, with many others, on Acoustics, Harmonics, Sound, and Musical Strings, may be found mentioned in Becker's Muskalischen Literatur, published at Leipsic, in 4to. 1836, pp. 211 to 245; and in his Supplement to the same (Leipsic, 1839), pages 57 to 60.

HAMILTON'S ART OF TUNING,

ETC.

PART THE FOURTH.

THE METHOD OF REMEDYING DEFECTS IN PIANOFORTES.

The several parts of the Pianoforte explained in detail —Defects to which they are liable—Methods of Cure and Prevention—On keeping Instruments in tune—Hints on Packing Pianofortes.

THE pianoforte having become an instrument indispensable to the drawing-room, it is thought that a few remarks on its several parts (mainly of the cottage, semi-cottage, or piccolo) may serve as a guide to those who may wish to regulate and put in order their own instrument. Some directions are also given how to repair any little defects that may occur, and to which all musical instruments are liable, either from accidental causes, or from the changes of Temperature.

These hints are not given for the purpose of superseding the professional regulator, repairer, and tuner: but more particularly for the use of those who may live far distant from a person whose business it is to attend to such matters.

The details which follow have been collected from the experience of makers and tuners, the editor having availed himself largely of the facilities afforded by the extensive pianoforte manufactory of the publishers of this work. The results of his enquiries, now offered to the public in a greatly improved form, will be found to embrace much matter not elsewhere to be met with; rendering this tract, it is presumed, superior, both in point of matter and arrangement, to any other work of the same kind, whether English or foreign.

The order in which the several parts of the pianoforte are treated of is as follows, the paragraphs being numbered, for facility of reference, as under, viz.—

1. Scale.
2. Bridge.
3. Wrest-plank.
4. Bearing.
5, 6. Key-frame, Key-bottom, Key-blocks.
7. Belly, or Sound Board.
8. Hoppers.
9. Action.
10. Levers, Stickers, &c.
11. Hammer-rails.
12. Dampers.
13. Wrest-pins, Hitch-pins, Hopper-pins, —Bridge-pins, Key-pins.
14. Strings or Wires.
15. Cases.
16. Damper-pedal.
17. To put on Strings.
18. Rattling of Dampers.
19. Rattling of Stickers.
20. Rattling of Hammers.
21. Sticking of Hammers.

(1.) All pianofortes have what is called THE SCALE, which is the speaking length of string between the belly-bridge and wrest-plank, which, if not of the correct length, will cause a continual breakage of the strings, and the instrument cannot be kept up to concert or standard pitch*. The editor has known

* It may be here remarked that, as Concert-pitch is an indefinite term, it is well to know that there are various pitches. That used in concert generally, is now called the Standard-pitch, which is in fact Hullah's pitch used in singing, and considered the best, as it is a medium between others, viz. the Opera-pitch, which is about two-thirds of half a tone sharper, and the Philharmonic-pitch which is a shade or two flatter. Standard-pitch is also the French-pitch. But the temperature of our climate ever changing, especially about spring and

pianofortes become perfectly worthless from the inaccuracy of their scale. *The scale must be true.*

autumn, always causes a change in the pitch of pianos, however well they may be tuned; the metal of the strings expands or contracts as the weather changes. In warm weather they expand, consequently get flatter, and in cold or frosty weather they contract and become sharper.

In a close, damp atmosphere, pianos are more likely to get out of tune, generally, than in any other.

When the strings break of themselves, it is on account of sudden changes in temperature from warm to cold. Then the metal contracts to a greater degree than in ordinary weather.

Wood also expands, contracts, or shrinks in a similar way.

The following report, respecting Concert-pitch, made in consequence of an *arrêt*, issued by direction of Napoleon I, was published in the official part of the *Moniteur*, for December, 1812.

"The Committee of Instruction at the School of Music, being apprized that the extreme height of Concert-pitch (*élévation du ton*), in use at the Concerts of the *Conservatoire*, strains the voices of the pupils, and endangers their being forced beyond their natural means, have judged that it is become indispensable to bring back the pitch of the orchestra to a degree more conducive to the preservation of the voice. The Committee have compared the pitch (*diapasons*) of the various Orchestras in Paris, and have fixed and adopted a medium between those of the Imperial Academy of Music, the *Opera Buffa*, the Chapel of His Majesty, and the *Conservatoire*.

"The Director has therefore ordered that the pitch chosen by the Committee be used in future at the *Conservatoire*."

(2.) THE BRIDGE on the wrest-plank is glued to that part. The long bridge and the short bridge (the latter carrying the covered strings) are both glued to the sound-board, as well as screwed to that part by screws from the back passing through wooden nuts, before the sound-board is glued in the case.

(3.) THE WREST-PLANK is that part in which the tuning-pins are inserted. If this be not made of hard and well-seasoned wood, the pins, from the immense strain on them, will give. The same remark may be applied to that part (at the bottom of the piano) where the hitch-pins are inserted. Instances have been known where the hitch-pins (from the strain on them) have torn through the wood. This is another cause why pianos have not kept in tune.

(4.) By the BEARING is understood the direction the strings take from the hitch-pin to the wrest or tuning-pin. The SIDE-BEARING is the distance from the bridge to the wrest-plank; and that from the hitch-pin to the belly-bridge, wrest-plank and wrest-pin, is called the DOWN-BEARING, which, if not properly adjusted, will prevent the due amount of vibration.

(5.) The back-rail, the front-rail, and the cross-rail together constitute what is called the KEY-FRAME,

which must be fixed to the key-bottom (as it is technically termed), in some instances a third through each rail.

(6.) In some pianos the key-frame is fixed by blocks at the back of the KEY-BOTTOM, which hang in a rabbit of key-frame, so as to allow the key-frame to shift with the soft pedal, besides which two pins fix in the key-frame, and slide in a groove in the KEY-BLOCKS.

(7.) THE BELLY or SOUND-BOARD is made of deal or pine-wood. The most approved sorts are those brought from the forests of Switzerland. The American woods are also much esteemed. Bars are fixed underneath in the spaces that occur between the bracings. The white keys are faced with ivory; the black keys with ebony; the body of the key being formed of lime-tree wood. The blow given to the strings is communicated from the motion given to the hammer by the key raising the hopper which strikes the lever to which the sticker is attached.

(8.) THE HOPPERS are glued in mortices made in the keys*, at the part underneath the levers on which

* Mortices are made in the keys, into which the pins are inserted, one on the back-rail and another on the front-rail. Each key is loaded at the end, by which contrivance it is balanced.

the stickers are glued. The hoppers are composed of under-block, check-block, and front-fly. A tenant is formed on the under-block. A parchment hinge and metal spring pass through or into the under-block. A groove is made in the front-fly for the spring to work in. To prevent noise from the force of the spring on the front-fly, a hole is made in its centre, through which a brass pin passes. On this pin is screwed a button of leather, or wood covered with cloth. By turning the pin to the right, you bring the hammer closer to the strings; and *from* the strings, by turning it to the left.

(9.) We now come to the ACTION of the piano; from which the key-frame is entirely separated by removing the springs from off the top of the action-frame.

(10.) THE KEYS are glued to the hoppers in a mortice in the back end. The LEVERS are placed over the hoppers; which are supported by rails glued to them. Each lever is covered with doe-skin leather, to which STICKERS are glued. These stickers rise to the butt of the hammer-rail; and to these, leathern hinges are glued.

(11.) HAMMER-RAILS are made of mahogany, generally, under which plates of brass are used to cover

the centre-wires; and, as these wires pass through each hammer-butt in the centre, they are lined or bushed to prevent noise. Hammer-shanks are made of cedar-wood, and are glued to the hammer-head (of mahogany) at the one end, and into the hammer-butt at the other. Several coats of cloth, felt, or leather, are placed over the heads.

(12.) DAMPERS are glued to a rail, from which the hammer-action is entirely detached. The damper-wire is screwed into a small block or bracket. In some pianos, two centre cloth or leather buttons are attached to the dampers at one end, and to the stickers at the other, by wires, to prevent rattling.

(13.) Five kinds of PINS are used, which are technically termed tuning or wrest-pins, hitch, hopper, bridge, and key-pins.

(14.) The WIRES, or STRINGS, are of copper, brass, and steel; the sizes are from Nos. 12 to 24, the bass being covered with copper wire. Steel wire is now generally used throughout most pianos.

(15.) The CASES of pianos are formed of a bottom (on which is sometimes a metallic plate); a wrest-plank, in which the tuning-pins are inserted; the bent side (on which is a plate); back, bracing, top, and front-top door (containing a silk curtain, or fret or carved work in modern pianos); various shaped falls, key-blocks, cheeks, name-board, bottom door, pedals (two), viz. the right or loud (damper) pedal, the left or soft pedal, and the ends.

(16.) The action is moved on to one string by the left or DAMPER PEDAL; and the dampers are lifted up by the RIGHT PEDAL. In some pianos the action moves the key-frame as well; the object of which is to prevent the wringing of the sticker-hinge where it is glued on to the hammer-butt; which accident is caused by putting the action of the stickers out of the perpendicular: some makers only make the hammer-rail to shift. Should the hammer be in a wrong position, so as not to strike the two strings (or, when on the shift, the one string), the hammer-shank must be cast by a warmed iron, but without burning it, until it gains its right place.

(17.) The manner in which a STRING IS PUT ON is as follows. First, take the length, allowing six inches more than the distance from hitch-pin to wrest-pin; then, with the eye-twister, make the eye, which must then be placed on the hitch-pin; then put the point of the wire into the hole in wrest-pin, and place the wrest-

pin in the tuning-hammer; then twist round the pin, till the wire is sufficiently wound to come opposite the hole in the wrest plank; then drive the wrest-pin, and before drawing the string up to pitch, place the string on the bridge-pin, and see that the coils round the wrest-pin are close together; then tune up to the pitch required (as before observed, p. 17). A new string must be well rubbed with a piece of soft leather before it will stand in tune.

(18.) The RATTLING OF DAMPERS occurs when the hinge is unglued; or when the vellum is not firmly glued in the hinge; or when the hammer strikes the damper-wire in its passage to the string. This frequently happens when the hammer-rail shifts only, and not the whole of the action. The damper-wire must be bent in the opposite direction, but not so much as to get in the way of the hammer next at the side; the dampers also rattle when the buttons are not screwed close to the damper-arm; and when the damper-wire is not firmly inserted in the sticker.

(19.) The RATTLING OF STICKERS is caused by their being unglued from the under-lever, when not firmly glued; or through bad, elastic leather not keeping the sticker tight up to the butt of the hammer-rail.

(20.) The HAMMER RATTLES occasionally at the centre, from the hole being too large and badly clothed or bushed; or through the centre wire not being held firm by the forks of the hammer-rail, in which case tighten the screws that pass through the two plates that hold the centre. Should there be any looseness in the head, take it off and re-glue it. When the shank is loose in the hammer-butt, apply the same remedy.

(21.) The HAMMER sometimes STICKS when the centre wire is too tight in the clothed hole in the butt, or when the butt is confined in the forks, or when the hammer-head catches between the damper-wires.

(22.) The RATTLING of the KEYS occurs from the following causes:

1. From the looseness of the head, which must be hammered, or wedged, to make it firm.
2. From the baize, cloth, &c. becoming hard.
3. When the metal of the pin has communicated itself to the hole in the key, file the hole till you take off the metallic attachment from the pin; after which with a knife make an incision as long as the hole in the key, then wedge it. This plan refers to all keys that become noisy through much wear.

(23.) The STICKING OF KEYS is caused by the

pin sticking in the mortice, which must be filed; but be sure it does not occur through the sticking of the hammer butt, which it is necessary to try before filing the mortice.

(24.) Another cause is the hopper becoming rough, by which a grating noise is caused against the lever; to relieve which, it must be black-leaded with a bit of calf's-skin leather put on the surface of a piece of wood.

(25.) The key-pins sometimes get out of position, which will cause the sticking of keys to one another; in this case right the pins again.

(26.) By reducing the thickness of the KEY-SLIP you prevent its touching; or it may be kept from the key by a bit of card, inserted between the slip and the front of the key-frame.

(27.) Use a small file TO OPEN THE MORTICE-HOLE; but the file must be either round or flat, according to the hole in the key, and not larger.

(28.) To remedy NOISE IN HOPPERS, put a small grain of black-lead under the spring.

(29.) DAMPING DEFECTS are caused by the dampers being hung too far from the hammers, or when not properly covering the strings, by the hardness of the felt or cloth, or when the action-frame is not in its place.

(30.) To remedy what is technically termed "BLOCKING OF HAMMERS," unscrew the hammer one-fourth of an inch in its fall from the strings.

(31.) The blocking of hammers is sometimes caused by the hopper-checks being too high, or by the top of the hopper not being smooth. To relieve the latter defect, use sand paper, then black-lead.

(32.) Should the TOUCH be SHALLOW, take off the keys and raise the balance-rail of key-frame; and then to gain the depth required, glue underneath some paper.

(33.) Should the LENGTH of the HOPPERS be TOO GREAT, so as to prevent the hammer from lying level on the hammer-rest, raise the action-frame at each end, by glueing a small bit of card on the block that the action-frame rests on.

(34.) If the HOPPERS should be SHORT right through the instrument, lower the action.

(35.) If ONE HOPPER is SHORTER than the rest, you must raise the hopper out of the mortice in the key, and re-glue it, putting at the same time a part of a card under the shoulder of the hopper.

(36.) Should the TOUCH be TOO DEEP, you must glue paper under the key-frame rail.

(37.) By raising the front-rail baize, and putting some large centre-punch papers on the key-pins, you may RELIEVE the TOUCH OF ANY KEY, or keys, when it becomes shallower or deeper than the rest.

(38.) By glueing some thickish leather on the hopper-checks, you may RELIEVE the LOWNESS of the CHECK-BLOCK.

(39.) PIANOFORTES DO NOT KEEP IN TUNE from the following causes:

1. From the looseness of the wrest-pin in the hole; to remedy which, if the wrest-plank be sound, put a larger wrest-pin in.

2. When the hitch-pin does not hold in the bent side or bottom block. If the bent side or bottom block is sound, replace either with a stouter or longer hitch-pin.

3. When a new string is put on (which never stands well in tune at first), it must be tuned up several times to make it stand to the pitch required.

(40.) The remarks on the defects of the pianoforte, and the means of remedy, will equally apply to the square, semi-grand, or grand pianofortes, as well as cabinet; although cabinet pianofortes are out of fashion, and not made except to order.

(41.) In respect to the square piano, there is only one pedal (the damper pedal); but in the semi-grand and grand pianos there are two (as in the piccolo or cottage). The left pedal moves the hammers either on to one or two strings, there being three strings in grand pianos.

(42.) As regards old squares, or upright grands, so much depends on the state in which they may happen to be, that frequently (except to tune them) they are much better left alone, and are very trouble-some to repair. It is much better to sell or exchange them for modern instruments than to encounter the risk and uncertainty of repairing them—they are more trouble than profit. Yet much may be done even in old square pianos by keeping them free from dust, and taking care that no moveable substance (that might cause an unpleasant jarring or vibration) lies on the sound-board. In removing dust, &c. use a small pair of bellows, and blow the dust out from back to front. Pins are very likely to get on to the sound-board of squares, and cause a very unpleasant noise.

HINTS ON PACKING UPRIGHT PIANOFORTES.

In conclusion, a few hints to amateurs, respecting the care necessary in packing pianofortes, may not be unacceptable. The packing-case must be strong and sound, and should be furnished with corner-irons. Be particular to see that the inside of the packing-case is free from nails penetrating through from without. Roll the piano into the packing-case; then put the packing-case upon its back, and screw into the interior of bottom of packing-case two blocks of wood of sufficient thickness, to raise the pianoforte off its castors. If this precaution be not taken, there is great risk of breaking the castors or ripping up the ends of the pianoforte. Then get out a strong cross-bar of a length equal to the width of the packing case, and passing it behind the legs beneath the key-bottom of the instrument, firmly screw the cross-bar with four screws into the four cross-rails of key-bottom. To keep the cross-bar firm, it is necessary to screw three blocks (viz. one on the top of cross-bar, one in front, and one in the bottom) firmly into the sides of the packing-case. Another block is also requisite, fixed between the interior top of packing-case and the top of instrument, to prevent its rising. Be very careful in screwing or nailing on the front of case, so as to prevent the access of wet or dust. When instruments are packed for exportation, the cases must be lined with zinc or tin and soldered down.

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PART THE FIFTH—APPENDIX.

THE following articles were originally framed as an Appendix to the account of the Pianoforte already given.

In the *First Chapter* are to be found a few particulars connected with the history of the first application of the key-board to stringed instruments.

In the *Second Chapter*, mention is made of the several steps of improvement which finally issued in the invention of the Pianoforte.

The *Third Chapter* supplies some valuable advice on the preservation of pianofortes; with some hints on the subject of choosing a piano.

CHAPTER I.

SOME NOTICES OF THE ORIGIN AND HISTORY OF STRINGED AND KEYED INSTRUMENTS.—DESCRIPTION OF THE CLAVICHORD.

The pianoforte is an instrument of the same nature as the harp, differing, in its position being originally horizontal instead of vertical; the sounding-board

being differently placed; and the strings being struck in a different way. The harp is also to be considered as "a guitar with many strings;" and this latter instrument the Italians call by the name *cetera*, which is evidently connected with the word *cithara* (Gr κιθάρα), the lyre of the ancients.

The facilities afforded by the use of a key-board were not long in being understood; and we find keyed instruments in use, among musicians and persons of musical taste, from an early period in the history of the modern science— that is, from about the year 1530.

In the history of the great names of a century or two ago, we find constant mention of the harpsichord. This instrument the Italians called *cembalo;* the Germans, *clavier;* and the French, *clavecin*. But the earliest and rudest form assumed by instruments with keys and strings was that of the Clavichord.

The Clavichord seems to have been invented even as early as the commencement of the fourteenth century (A.D. 1300). InGermany and Belgium, the makers of instruments appear to have imitated the earlier construction of the Italians. Boccaccio, in the Decameron, it will be recollected, has mentioned the *cembalo;* but some have supposed that the cymbal, an instrument of percussion, was meant. Boccaccio wrote about the middle of the fourteenth century.

The Clavichord was an instrument square in form, and (as may be supposed from the early period of its invention, and consequent simplicity of its construction) had but a single string to each note. The action of this primitive instrument was eminently simple. Each key was a lever, to the extremity of which was attached (at right angles to it and therefore in a vertical position) a sort of tongue, made of copper. Over this simple apparatus, the strings were stretched horizontally. When the key was pressed, the copper tongue, being raised, struck the string. The use of this instrument continued till the time of Mozart.

The Clavichord was, from its simple construction, adapted for very general use, and the body of the instrument was so contrived as that a performer might fold it together and put it under his arm.

CHAPTER II.

THE PROGRESS OF IMPROVEMENT IN INSTRUMENTS WITH KEY-BOARDS—NOTICES OF THE VIRGINAL, SPINNET, AND HARPSICHORD.—THE INVENTION OF THE PIANOFORTE, AND TO WHOM ASCRIBED.

The grand defect of the Clavichord consisted in the rigid nature of the action.—The pressure of the finger upon the key moved the copper tongue in a vertical direction, and thus an impulse was given to the string: but, unless the finger was instantly removed from the key, the tongue continued to press the string, and prevented its continued vibration.

The ingenuity of inventors was accordingly directed to the removal of this obstruction to the freedom of execution. The result of the investigations and experiments which were accordingly set on foot, was the contrivance of the *quill*, which is so familiar to all who have inspected the interior mechanism of a harpsichord. The quill was carried upon a flat slip of wood, called a *jack*; and, having struck the string, passed on, leaving the vibrations free. The jacks were acted upon by the keys, so as to be moved by them in a vertical direction, upwards and downwards. The quills were so fixed in the jacks as that when they had fretted the string, in the descent of the jacks they passed the string silently, and were ready again for the next impulse communicated to them from the finger by the motion of the key.

The first instrument to which this improvement was applied was the Virginal, an instrument which is an object of curiosity to all who have read the musical annals of the Elizabethan period. The Virginal was rectangular in form, similar to what is called the square pianoforte.

The next form which these instruments assumed was that of the Spinet. This last-mentioned instrument seems to have taken the name also of the 'Couched Harp.' In the Spinet, the box-like form of the rectangular case was made to give place to a shape, no doubt conceived to be more light and elegant in outline, and more economical in point of space—having some remote resemblance to a grand pianoforte of the present day, upon a small scale. These instruments are perhaps still familiar among the early recollections of many now living. But in the Spinet, as in the Virginal, and the original Clavichord, there was but one string to each note; and the compass was very limited—three octaves and a half.

The Harpsichord was the next step in the progress of improvement: this instrument was, in its exterior form, very like the grand pianoforte. The quill was still retained, carried by the vertical jack; but two strings were adopted for each note.

A joiner of Antwerp, Hans Ruckers, who had turned his attention to the manufacture of musical instruments, constructed, about the year 1700 (earlier or later), Harpischords with a third string tuned at an octave above the other two, which were in unison; and provided his instruments with a second key-board, in order to render the unisons and octave available together or separately; and, finally, extended the compass of the key-board to four octaves.

The great and essential defect of the Harpsichord,

inseparable from the mode in which its strings were fretted, was the entire absence of that brilliancy of tone to which we have since become accustomed in the more modern instrument which has superseded it. Much discussion has arisen upon the not very important question of who was the first to adapt the HAMMER, in the place of the jack and quill, to instruments with key-boards; which improvement forms the transition to the modern Pianoforte.

The invention of the Pianoforte is usually ascribed to Christian Amadæus (or Christophe Gottlieb) Schroeter, organist of the Cathedral of Nordhausen, who made known his discovery in 1717. It appears, however, according to M. Fétis, that, in the month of February, 1716, Marius, a French manufacturer of musical instruments, in Paris, exhibited, to the *Académie des Sciences*, a novel instrument of the harpsichord genus, in which the strings were struck by hammers. The honour of the invention is also claimed for a third competitor, viz. an Italian, a native of Padua, named Bartolomeo Cristofori (or Cristofali, as the German writers call him), who, in the year 1716, produced an instrument which he called *Cembalo a Martelletti*—that is a Harpsichord with hammers.

CHAPTER III.

INSTRUCTIONS FOR THE MAINTENANCE AND PRESERVATION OF THE PIANOFORTE.

THE pianoforte is an instrument of a very complicated construction.

It is composed of so many materials more or less sensible to the influence of the temperature, that its duration and maintenance in proper order depends, in a great measure, on the care with which it is fostered; a care, for the most part, greatly neglected.

This negligence is one of the principal causes of the derangements so frequently complained of, and invariably, though nearly always erroneously, attributed to the construction of the instrument.

To prove the urgent necessity of attending to the instructions we are about to give, we think it expedient to mention the multitudinous materials, of various substance, employed in the manufacture of a pianoforte, and which may be thus classified:—

WOODS.

INDIGENOUS.—Sycamore, pine, birch, ash, Swiss deal, plane-tree, lime-tree, oak, beech, deal, walnut, maple, holly, pollard-oak; *sometimes* poplar, elm.

EXOTIC.—Zebra, mahogany, lance-wood, pencil-cedar, satin-wood, coromandel, beef-wood, ebony, rose-wood; *sometimes* amboyna, violet.

METALS.

Wrought iron, cast iron, wrought steel, cast steel, copper, brass, silver, lead.

CLOTHS.

Witney, box-cloth, felt, baize, casimirs, swan-skin cloth, taffeta.

SKINS.

Sole, buffalo, sheep, doe, calf (of various thicknesses,)

MISCELLANEOUS.

Ivory, glue, varnish, hog's lard, oil, japan black, French polish.

An inspection of the above details will undoubtedly convince every mind of the indispensable necessity of minutely attending to these precautions, so that all the various parts of which the instrument is composed, but especially the mechanism, shall constantly perform their proper functions.

I. The room where the piano stands should be kept at a moderate temperature, *not below* 12 nor *above* 30 degrees of the Centigrade thermometer; i. e. between 10 and 24 degrees *Reaumur*, or 54 and 86 degrees *Fahrenheit*.

Below this temperatnre of 12, 10, or 54 degrees, the woods, metals, cloths, and skins become contracted, and produce a rattling noise or a multitude of disagreeable sounds not easily corrected.

Above this temperature of 30, 24, or 86 degrees, many of the materials swell and consequently impede the action of the instrument.

II. It is most important that the pianoforte—and indeed all sonorous instruments—should be carefully preserved from dampness. An instrument therefore must not be placed on a damp ground-floor; or between two windows; or between a door and a window, forming a current of air.

III. The piano must never be left open when it is not being used, and particularly when the apartment is being cleansed.

IV. An instrument must not be placed too near a stove chimney, or fireplace.

V. Before closing the piano, it is essential to wipe the key-board after having played on it.

VI. It is of great importance to open the entire piano at least once a month, in order to remove (with a pair of bellows and not with the breath) the dust which, inevitably penetrating into the interior, conglomerates on the sounding-board and mechanism, and consequently destroys the tone and impedes the play of the keys.

VII. It may be as well to remark that the lid of the piano should never be covered with books, music, and other objects, the weight of which not only damages the instrument, but frequently occasions unpleasant jarrings during performance.

VIII. To ensure the standing in tune of a piano, it should be tuned at least every two months during the first year of its acquisition, and at least every four months subsequently. It is important that the tuner should be perfectly *au fait* at his art, and that he should be desired to keep the instrument up to concert-pitch, and never allow it to descend below, as the tone in the latter case would be essentially injured.

IX. If the pianoforte be removed from one place to another, it ought to be tuned after the removal, exclusive of the tunings recommended in the pre-section, it ought likewise to be tuned whenever the heat is raised above the ordinary temperature of the apartment, as on the occasion of a soirée, &c.

X. The soft pedal ought to be skilfully used, otherwise the instrument will become harsh, and perhaps the strings be broken. It is advisable to play softly with this pedal; otherwise the instrument will be soon out of tune, by reason of the pedal shifting the action on one string, which, being struck with force, naturally becomes flatter; so that, when the pedal is released and the action resumes its natural position, the whole instrument will be found discordant, owing to the unisons not having been equally employed.

XI. Having obtained a good pianoforte, equal in its various octaves, great care must be taken to avoid playing exercises of five notes, or similar ones, which occupy only a small compass of the keyboard and almost invariably the same notes; for it is evident that, this portion being more exercised than the others, the piano will lose all its equality of tone.

XII. It is advisable to keep the piano constantly covered with a double skin case, which must be daily removed, in order to dust the exterior of the instrument. Add to this precaution that of keeping the key-board covered with a little cushion of wadded silk or a double flannel band, and the piano will much longer retain the beauty of the varnish and the whiteness of the ivory.

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A WORD ON THE CHOICE OF A PIANOFORTE.

In a period like the present, when the progress of invention, by simplifying details, and reducing to a minimum the cost of production, has accustomed the public to look for excellence combined with low prices, it has become more than ever necessary for purchasers to be sufficiently on their guard to be able to discriminate between that which is valuable and that which is worthless. To say that a faulty instrument is cheap at no price, will only be to assert what every one is prepared to admit; but, beyond this, there are circumstances also to be taken into account in connection with the pianoforte, which render what may be called chance bargains more than usually liable to suspicion. Independently of the injuries which an instrument may have suffered from ill-usage, it may have had original faults of construction. The incredible strides which have been made in very recent days towards perfecting this most admired and fascinating of instruments, together with the increase of compass now sought and attained, fully vindicate the preference given to modern instruments. The action of a piano, constructed by the very first of makers forty years ago, becomes, by contrast in these days, simply an object of ridicule amongst pianists, manufacturers, and connoisseurs. It would be trite, as it is needless, to suggest that those who have no confidence in their own judgment may avail themselves of the assistance of some more experienced friend. In the absence of such friendly adviser, the name and reputation of the maker will be found to be the safest guide for those who cannot securely rely upon their own ear and experience, to appreciate truly the qualities of tone and touch in an instrument.

It is unnecessary here to enumerate the several well-known makers whose instruments have obtained a high reputation; as it would be invidious to intimate a preference where so much of excellence prevails. Many pianists, however, have a predilection for the instruments of one or other maker, and will seldom be entirely satisfied except with the manufacture of their favourite. But it may be as well here duly to caution those who rely exclusively upon a name, that they should satisfy themselves, in each instance, that they are not the victims of the common deception of fraudulently substituting a counterfeit name plate—ascribing an inferior instrument to a maker of renown.

It is obviously a desirable thing for purchasers that they should be able to inspect the instruments they propose to purchase, while still in the manufacturers' warehouses; or receive them directly from the maker with the due warranty. Orders will always be found to be carefully and conscientiously executed by *respectable* houses; and upon the responsibility of such houses, instruments are sent to all parts of the world, and, with rare exceptions, are found to give perfect satisfaction. With these facilities and the moderate charges at which new instruments may now be obtained, it seems to be a false economy to risk the entire loss of the purchase money in the acquisition of an instrument of specious pretensions, but without any real value.

The Editor feels that he cannot better close a work occupied entirely with details connected with the construction and tuning of the piano, than by thus specifically recording his obligation to the practical mechanics and others (more particularly those employed in the manufactory of Messrs. ROBERT COCKS AND CO.) to whom he has been indebted for many ingenious and valuable suggestions embodied in the several Chapters of this work.

And moreover, since, in the course of the compilation of this work, the whole process of their manufacture has been constantly subjected to his minute and careful inspection, he feels he shall not be departing from the strict line of propriety, if he calls the attention of those interested in the matter, more particularly to the admirable Pianofortes manufactured by the eminent firm just referred to — by whom also this work is published as a constant guide and book of reference to all who possess a pianoforte.

In the construction of their instruments, talent of the first order in each branch is well known to be employed, and several improvements of first-rate value have been originated in their manufactories.

Among the improvements thus introduced in the action of their Pianofortes, is to be reckoned the ingenious contrivance of an adjusting cylinder and screw, by means of which the leather tip of the hopper, when depressed by wear, may be raised again to the requisite height, thus obviating the expensive and tedious process of renewing the leather on the hoppers.

They have recently patented a most important improvement in the back frame of the instrument, by which, through the medium of wrought-iron tension rods behind, to counteract the forward strain of the strings, the whole of that strain (estimated to be, in an instrument tuned to concert pitch, equal in amount to the draught of seven horses) is made to exert itself entirely in the direction of the longitudinal fibres of the frame, in which direction their power of resistance is greatest. By this arrangement, the instrument can never become 'broken backed,' as the technical phrase is; and that tendency in the frame-work to yield, is removed, which, of itself, prevents pianos from continuing for any length of time in tune.

With elegance of exterior, they have also succeeded in uniting great economy in price; and the Editor feels assured that instruments of equal quality can by no establishment be supplied on more favourable terms.

Finally, it may be permitted him to solicit the attention of his readers to several highly commendatory NOTICES which have at different times appeared in musical and other papers, and which will be found in the circular appended to this work, under the head 'Opinions of the Press.'

THE END.