No author

THE

TUNER'S GUIDE:

CONTAINING

A COMPLETE TREATISE

ON TUNING THE

PIANO-FORTE,

ORGAN, MELODEON, AND SERAPHINE;

TOGETHER WITH

A SPECIFICATION OF DEFECTS,

AND THEIR REMEDIES.

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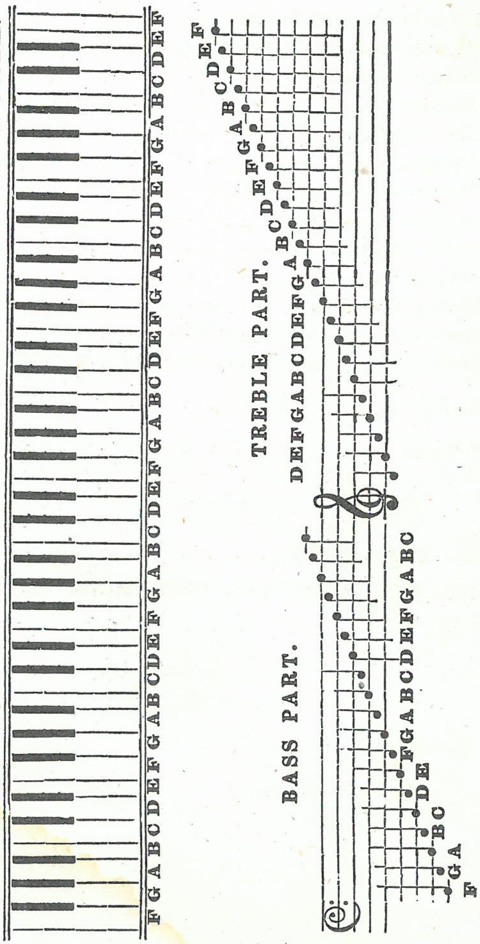


THE

TUNER'S GUIDE.

THE ART OF TUNING.

THE following practical introduction to the art of tuning the piano-forte 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 great difference between the sound of a piano-forte 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 piano-forte player, particularly in the country, where regular tuners are not always to be had, ought to be capable of tuning their own piano; and the time and trouble necessary to acquire the power of so doing do not bear any comparison with the convenience and advantages which result.

The present 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, explained and reduced to practice, is that of *Equal Temperament*, which is now universally adopted.

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 third. Unisons and octaves are always tuned *perfect*, as the ear will not tolerate any modification whatever in these intervals. The fifth, 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, or boudoir, piano-fortes 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 previous note; 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

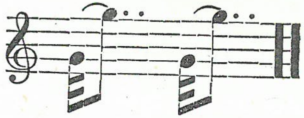
and turn the hammer a little towards the left, so as to relax the string, and thereby depress or flatten its pitch. If we

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 listen attentively, he will observe that, 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 we proceed, 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 morally impossible, even with the finest musical ear, to tune a piano-forte 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: —



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.

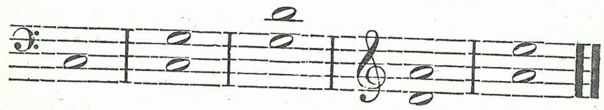
The student may now practise tuning the fifth, and the major and minor thirds. These concords, when *perfectly in tune*, have neither beat nor wave, but coalesce in one pure, agreeable, uninterrupted, *complex* sound. At first, he will, of course, tune them *perfect;* though we shall presently demonstrate 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, to avoid confusion we must stop the vibration of the other string or strings belonging to the note which we are adjusting. In 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 base, from which we started. Indeed, the third

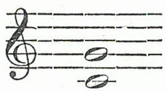
thus obtained is so sharp as to be utterly offensive to the ear, and therefore unfit for harmony, where this interval plays so conspicuous a part.

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 still 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

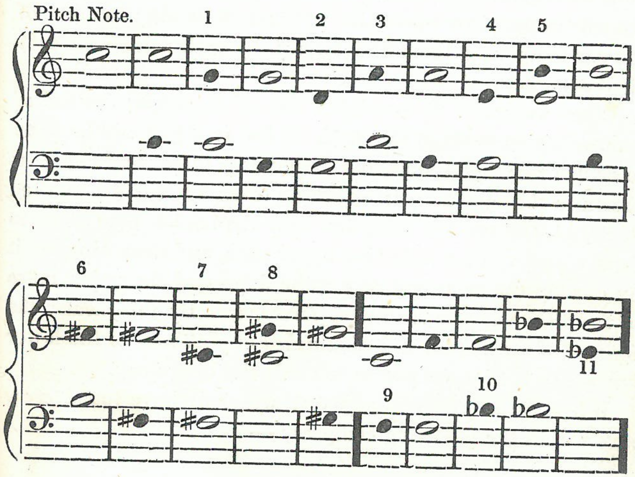


perfect; and then let him flatten the note G, so that, upon striking the notes G and C together, he hears *two slow and distinct waves,* terminating in one steady, continuous sound; and the fifth will be properly *tempered.* The same mechanical *test* will enable him to tune all the remaining fifths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

* In the article *Temperament,* we shall demonstrate these propositions upon mathematical principles.

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 pegs by almost incredibly minute degrees; he may therefore proceed to learn the following scheme:—

SCALE FOR TUNING ACCORDING TO THE SYSTEM OF EQUAL TEMPERAMENT.

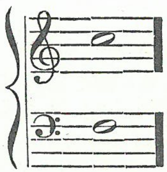


EXPLANATION.

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 store. 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 a 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 base 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 of 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

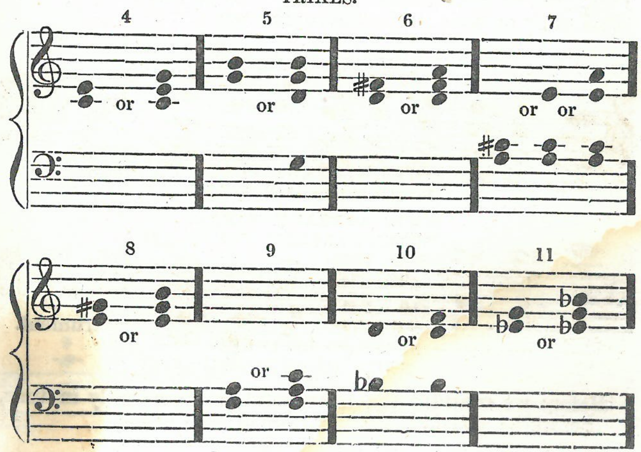
notes on the instrument are tuned to these notes by means of octaves above or below.

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:—

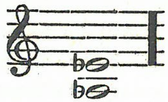
The correctness of the note E, forming the fifth No. 4, must be ascertained by comparing it with the C below it, thus:—

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:—

TRIALS.



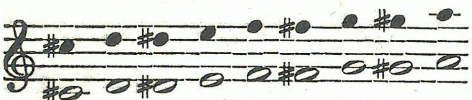
The last and severest test is the following fifth:—



as the two notes of which it is formed have each been obtained by a 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 in 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, there 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:—

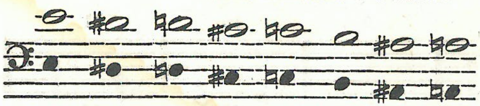
NOTES TO BE TUNED.



&c., to the top of the instrument.

NOTES ALREADY TUNED.

NOTES ALREADY TUNED.



&c., to the bottom of the instrument.

NOTES TO BE TUNED.

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 base note with its octave and double octave above: this is one of the surest ways of detecting any inaccuracy in our tuning.

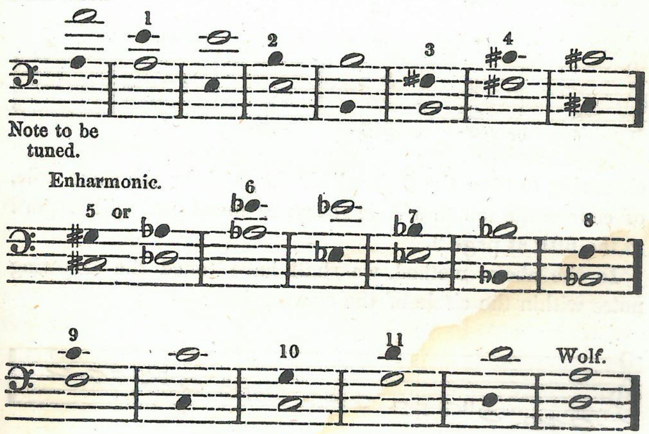
In tuning a cabinet or boudoir piano, it will be desirable to adjust first the whole series of notes upon *one* string, and then to tune all the second strings in unison to those of the first series.

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 base notes is apt to depress their pitch.

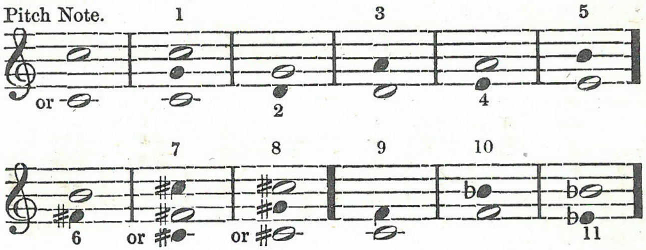
The Germans generally begin to lay their *bearings* from the note A, as better adapted to the pitch of the instruments which compose the orchestra.

We shall give the following scheme for this purpose:—



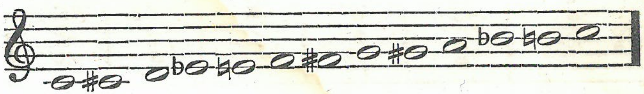
The system which we have explained is that of *equal temperament;* it is that generally adopted throughout Europe. Various systems of *unequal* temperament have been proposed, as those of Kirnberger, Earl Stanhope, &c., in which some of the major thirds or fifths are to be tuned perfect, others modified 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 piano-forte manufactories; which method is by fifths and fourths, omitting tuning the octaves until the groundwork is laid, as follows: —

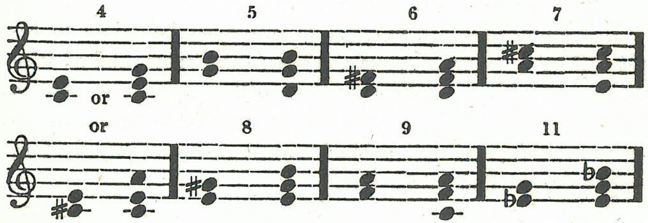


observing to tune the fifth a little flat, and, by the same rule, of course, the fourth a little sharp, as mentioned with regard to the fifth at page 9.

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 groundwork, 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 14.

The remaining notes of the piano-forte must then be tuned as mentioned at page 14.

GENERAL OBSERVATIONS.

Let the piano be tuned at least once in two months, keeping it always at concert pitch. If you allow it to go too long without tuning, it becomes flat, and occasions much trouble to get it to stay at concert pitch, especially in the country. There is no greater enemy to a piano-forte than damp. Close the instrument immediately after you practise; by leaving it open, dust fixes on the sound-board, and corrodes the movements; and if in a damp room, the strings must rust. Should the piano-forte stand near or opposite a window, guard, if possible, against its being opened, especially on a wet or damp day. When the sun is on the window, close the blinds. Avoid putting metallic or other articles on or in the piano-forte; such things frequently cause unpleasant vibrations, and sometimes injure the instrument. The more equal the temperament of the room, and the less the soft pedal is used, the better the piano will stand in tune.

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

Piano-fortes should be carefully guarded against extreme heat or cold, being liable by sudden changes of temperature to be put out of tune. Sometimes, during an intensely cold night, the base strings will so contract as to rise nearly a tone above the pitch. When thus affected, they should not be touched, as the return of the temperature will bring them into tune again.

It is advisable not to place them against outer walls, which, being more or less affected by the state of the atmosphere, naturally communicate such effects to adjacent objects.

The same circumstances produce opposite effects on different kinds of instruments. Flutes and other wind instruments are usually tuned a little too flat, because the warmth imparted to them by the breath and hands in playing upon them causes them to rise a little in pitch.

In tuning the violoncello, it is best to commence with the second string, as we do on the violin, by which means we are less liable to error; and if we take the pitch from the organ or piano-forte, the whole of the instruments in an orchestra are tuned with more ease and certainty from the chord of D minor than from any other note or chord. As the German flute plays mostly in altissimo, that instrument is more accurately adjusted to the orchestras by tuning to the highest D.

A
MATHEMATICAL DEMONSTRATION
OF THE
THEORY OF EQUAL 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, in 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, 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 the ratio of . .	2	to	1.
The Fifth	3	to	2.
The Fourth	4	to	3.
The Major Third	5	to	4.
The Minor Third	6	to	5.
The Major Second	9	to	8, or 10 to 9.
The Major Sixth	5	to	3.
The Minor Sixth	8	to	5.
The Major Seventh	15	to	8.
The Major Semitone	16	to	15.

Consequently, half the length of any string, when sounded, produces the octave above the note yielded by the entire length; two thirds of its length produces the *fifth* above; three fourths, the *fourth* above; four fifths, the *major third* above, &c.

And therefore, if we represent the length of the string necessary to sound the note C by unity, the lengths 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 three hundred and sixty inches; then the successive portions of the same string necessary to produce the notes of the ascending scale will be:—

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

If we now compare, one with another, the intervals formed by the notes of the above scale by means of their corresponding numbers, we shall find that they all preserve their original purity, except the minor third D F, which presents itself in the ratio of 320 to 270, that is, of 32 to 27, instead of 6 to 5; and the fifth D A, which presents itself in the ratio of 320 to 216, or 40 to 27, instead of 3 to 2, the natural ratio.*

A comparison of these ratios of the minor third and perfect fifth with the perfect ratios of those intervals will show that both are too small by the *syntonic comma*, a minute interval represented by the ratio of 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 base 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 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,—

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

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

2dly. 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.

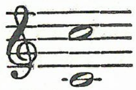
3dly. That each consonant interval, according to its degree of consonancy, shall lose as little of its original purity as possible; so that our ear may still acknowledge it as a perfect or imperfect consonance.

Several ways of adjusting such a system of temperament have been proposed, all of which may be classed either under the heads of *equal* or *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 a previous part of this work, may be demonstrated upon the following principles: —

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 A♭ C will be too flat to form a perfect octave by a small quantity, called in the

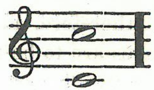
theory of harmonies a *diesis*, and expressed by the ratio of 128 to 125.

Demonstration. — Representing the length of the entire string by 1, as usual, then will C E be equal to four fifths of that length; similarly E G♯ $= \frac{4}{5} \times \frac{4}{5} = \frac{16}{25}$; and A♭ C, which is the same as G♯ C in a system in which the octave is divided into twelve semitones, $= \frac{16}{25} \times \frac{4}{5} = \frac{64}{125}$. Now, $\frac{1}{2}$, or $\frac{64}{128}$, which is the same thing, is the proper ratio of the octave C C, and the fraction $\frac{64}{125}$ is evidently greater than $\frac{64}{128}$; hence that portion of the string which the former fraction represents must be longer, and, consequently, its pitch flatter than $\frac{64}{128}$, which represents the octave. It is evident, therefore, *that all major thirds must be tuned somewhat sharper than perfect* in any system of equal temperament.

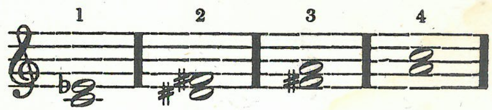
The ratio which expresses the value of the *diesis* is that of 128 to 125; if, therefore, the octaves are to remain perfect, each major third must be tuned sharper than perfect by one third part of the *diesis*.

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 A C will be too sharp in the ratio of 648 to 625.

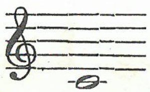
Demonstration. — Representing the length of the entire string by unity, as usual, then will C E$\flat$ be equal to five sixths of that length, and D$\sharp$ F$\sharp$ (the same as E$\flat$ G$\flat$) $= \frac{5}{6} \times \frac{5}{6} = \frac{25}{36}$; similarly, F$\sharp$ A $= \frac{25}{36} \times \frac{5}{6} = \frac{125}{216}$, and A C $= \frac{125}{216} \times \frac{5}{6} = \frac{625}{1296}$. Now, $\frac{1}{2}$, or, which is the same thing, $\frac{648}{1296}$, is evidently greater than $\frac{625}{1296}$; hence the length of the string represented by the latter fraction is too short, and therefore its pitch is sharper than is necessary to form a perfect octave. If, therefore, all octaves must remain perfect, it is evident that *all minor thirds must be tuned somewhat flatter than perfect* in any system of equal temperament.

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.

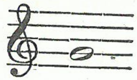
Proposition III.

Twelve perfect fifths employed within the space of an octave exceed the ratio of the octave, or that of 2 to 1, by the *ditonic comma,* a small interval, expressed by the ratio of 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 twelth part of the *ditonic comma.*

Demonstration. — If we represent the length of the string necessary to sound the note



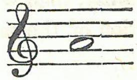
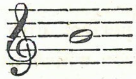
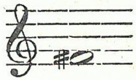
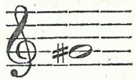
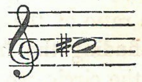
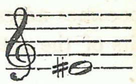
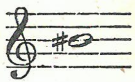
by unity, then will the fraction $\frac{2}{3}$ represent the length of that portion of the same string which will sound



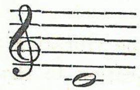
its perfect fifth above; and $\frac{2}{3} \times \frac{2}{3}$ or $\frac{4}{9}$, the length of that portion which will sound

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 thing as $\frac{4}{9} \times \frac{2}{1}$. 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.	$\frac{8}{9} \times \frac{2}{3} =$	$\frac{16}{27}$ gives	
IV.	$\frac{16}{27} \times \frac{4}{3} =$	$\frac{64}{81}$ gives	
V.	$\frac{64}{81} \times \frac{2}{3} =$	$\frac{128}{243}$ gives	
VI.	$\frac{128}{243} \times \frac{4}{3} =$	$\frac{512}{729}$ gives	
VII.	$\frac{512}{729} \times \frac{4}{3} =$	$\frac{2048}{2187}$ gives	
VIII.	$\frac{2048}{2187} \times \frac{2}{3} =$	$\frac{4096}{6561}$ gives	
IX.	$\frac{4096}{6561} \times \frac{4}{3} =$	$\frac{16384}{19683}$ gives	
X.	$\frac{16384}{19683} \times \frac{2}{3} =$	$\frac{32768}{59049}$ gives	
XI.	$\frac{32768}{59049} \times \frac{4}{3} =$	$\frac{131072}{177147}$ gives	
XII.	$\frac{131072}{177147} \times \frac{2}{3} =$	$\frac{262144}{531441}$ gives	

Now, the octave or $\frac{1}{2} = \frac{262144}{(262144)} \times \frac{1}{2} = \frac{262144}{524288}$; 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 of string, and therefore implies a flatter pitch than that indicated by the former fraction. Hence the B♯ or C produced by the circle of perfect fifths is sharper than 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♭, or 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 one twelfth of the *ditonic comma*, and, consequently, all fourths sharpened by the same quantity, and, again, all the thirds and sixths deviate only by one eighth of a comma from absolute purity, it follows that all the consonant intervals approach as near to perfection as possible.

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 made continuous by keeping up the motion. The pitch of the sound will be regulated by the number of vibrations; a stretched cord will give the same notes if the weights upon it be continued, and if the uniformity of its structure does not suffer from stretching. 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 its intensity. When the note obtained from two instruments is the same, and of

* Smith's Harmonies.

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 of both 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 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 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 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 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 seventh, 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 will reduce this to 27—45, or 3—5, a major sixth, an agreeable concord. Now this will be done, if, retaining the lower note 5 or 25, we change the upper from 45 to $45\frac{25}{27}$, that is to say, to a note whose vibrations are to its own as 25 to 27.

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 movable 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 a uniform wire be thirty inches, and be so stretched as to yield the sound of the first base 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, twenty inches, — then the sound produced by the two thirds will be a perfect fifth.

If the wire be reduced to three fourths 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.

No. 1. 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 ends of the monochord.		
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	60	
1st Base		
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	$19,^{288,512}$ +
D	107	$10,^{927,200}$ +
D flat	113	$84,^{199,576}$ +
C	120	

No. 2. 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 Base			
B	16		
B flat	12	50,	
A	8	$29,^{752,407}$ +	
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	$84,^{199,576}$ +	
C	40		

SOME ACCOUNT

OF

EARL STANHOPE'S MODE OF TEMPERAMENT.

If, in a musical instrument, (as the piano-forte, 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; and 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*.

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, C C, 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 in 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 base 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 base C. This method is preferred, because the beats are more perceptible to the ear.

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

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

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 C, F, downwards, a perfect fifth. Then tune the F next above, a perfect octave.

6. Tune F, B flat, upwards, a perfect fourth; or F, B flat, 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, proportioned* 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 A flat, E 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 A flat, D flat, downwards, a perfect fifth. Then tune D flat downwards, a perfect fifth; then tune 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 D flat, G flat, downwards, a perfect fifth. Having gone through the 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 E flat, B flat.

Each of these two fifths, says Earl Stanhope, differs from a perfect fifth only ONE in 2,657 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, approach 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 fifths 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 361 parts and a half nearly, or only about 8,298,850 parts in 3,000,000,000.

If the monochord be used to determine the pitch of D and A, then 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 to pitch 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 these 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.

TUNING TABLE,

Showing 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 Base 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.

VARIOUS EXERCISES

AND

EXAMPLES IN TUNING THE PIANO-FORTE.

(The following examples are to be regarded as scientific experiments, rather than a system or method for general use in tuning.)

Several systems of tuning have been successively employed since the invention of piano-fortes. The following method, No. 1, seems to give the most general satisfaction. The mode of tuning by occasional fourths may suit some tuners of long practice, but learners will never tune by fourths so soon as by fifths or thirds, because a fourth does not strike an unpractised ear so well as a third or fifth. The principal reason given for the system of fourths is, that the bearings are brought within a smaller compass than by the usual method. If that is the only principle on which it is defended, Nos. 2 or 3 are more likely to obtain a preference, as they are both within an octave, and are tuned by major thirds and perfect fifths.

If the exact number of beats in a wire could be ascertained, a mathematical division of the temperament would be no difficult operation; but as no two wires have an exact similitude of vibration, the precise temperament required in each piano must be subject to the ear of an experienced tuner. The following examples will materially assist the learner, particularly when the chords are well examined in their respective places.

No. 1.

Begin tuning with pitch C; from C descend to the octave. Then ascend to G, tuned flat, descend to G. Ascend to D, tuned flat, ascend to A, tuned flat; descend to A; ascend to E, tuned flat. Now try the chord of C, E, G. Then proceed to B above, which is tuned less flat than the preceding fifths. Try the chord of D, G, B. Descend to B, ascend to F sharp, tuned flat. Try the chord D, F sharp, A; descend to F sharp; ascend to C sharp, tuned flat. Try the chord A, C sharp, E. Ascend to G sharp, tuned perfect. Try the chord E, G sharp, B. Descend to G sharp. Now return from pitch C to F descending, tuned sharp. Try the chord F, A, C. Descend to B flat, tuned sharp. Try the chord B flat, D, F; ascend to B flat; descend to E flat. Try the chords of E flat; G, B flat, and A flat below C, E flat. If properly tuned, the E flat will be a good fifth to B flat above, and to A flat below.

The fifths, in beginning, are tuned less flat than they were formerly, as the modern temperament is more equal in fifths than according to the old method, which was that employed in most organs; according to which system, the keys most used are more harmonious, while the extreme keys, not so frequently played in, are intolerable. A good tuner can accommodate the temperament to the taste of those who play in particular keys, which they wish to be more perfect than the rest.

When the bearings are tuned, descend by octaves. Then tune the treble also by octaves. When the piano is very flat, tune the treble sharper than requisite, as it is sure to fall the first time it is drawn up. Most pianos fall from E, F, or G, below pitch C, to the upper part of the instrument.

No. 2.

Tune from F to F below; then to C, tuned flat; then A, tuned sharp. Try the chord F, A, C, F; then from F to B flat, tuned rather sharp; then D tuned sharp; then two trials of chords F, B flat, D, F, and F, A, C, F; then from A to E tuned flat; then from A to C sharp, tuned sharp; then try the chord A, C sharp, E; then C sharp, F sharp, tuned sharp; then two trials of chords F sharp, A sharp, C sharp, and F sharp, A, D; then from D to G tuned sharp; then to B tuned sharp; then try the chord of G, B, D; then from B to D

sharp, tuned sharp; then try the chord F sharp, B, D sharp; then from E flat to A flat tuned perfect. Then try the chords A flat, C, E flat, and A flat, D flat, F.

No. 3.

Tune from A to A below; then to E tuned flat; then from A to C sharp, tuned sharp; then from A to D, and from D to F sharp, tuned sharp; then try the chords A D, F sharp, A, and the preceding chord; then from C sharp to G sharp, tuned perfect; then from C sharp to E sharp, or F tuned sharp; then try the chord D flat, F, A flat; then from F to B flat, tuned rather sharp; then try the chord B flat, D, F; then return from F sharp, B tuned sharp; then to D sharp, tuned sharp; then from E flat to G, tuned sharp; then to C, tuned sharp; then try the chords C, E, G, and C, F, A.

ANOTHER SYSTEM

OF

LAYING THE BEARINGS.

EXPLANATION.

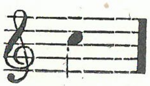
THE notes distinguished as crotchets, which are to be tuned grave, or rather more flat than perfect, have a mark placed over or under them, pointing downwards, thus ; /

The notes distinguished as crotchets, which are to be tuned acute, or rather more sharp than perfect, have a mark placed over or under them, pointing upwards, thus : \

The notes distinguished as minims are to be considered as the preceding crotchets, (having been properly tuned;) consequently, every subsequent crotchet, whether placed above or below a minim, is to be tuned to such minim, according to the explanation given.

The notes distinguished as semibreves are to remain as standard or proof notes. They will be perfect harmony, if the previous crotchets have been correctly tuned.

EXAMPLES.

Ex. 1. 

Tune C to concert pitch by the tuning fork; then tune its octave below.

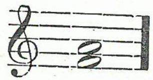
Ex. 2. 

Tune F a little acute, or more sharp than perfect to C.

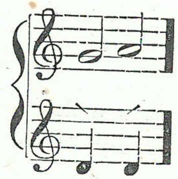
Tune G a little grave, or more flat than perfect to the same C.

Tune A a little acute, or more sharp than perfect, to the same C.

N. B. Having tuned F, G, A as equal to C as the ear can determine, then proceed to the third example,

Ex. 3. 

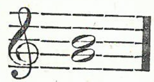
Which, on trial, should prove a perfect third.

Ex. 4. 

Tune D as equal as possible between G and A, by making D a little grave to G, and as little acute to A.

Ex. 5. 

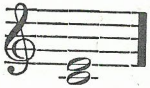
Tune B a little acute to D; then proceed to

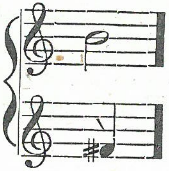
Ex. 6. 

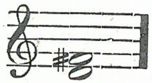
Which should prove a perfect third.

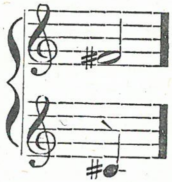
Ex. 7. 

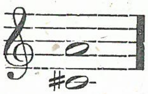
Tune E between A and B exactly on the same method as explained in Ex. 4; then proceed to

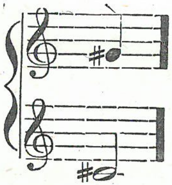
Ex. 8.  Which should prove a perfect third.

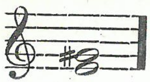
Ex. 9.  Tune F sharp a little grave to B; then proceed to

Ex. 10.  (as before) a perfect third.

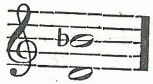
Ex. 11.  Tune C sharp a little grave to F sharp; then proceed to

Ex. 12.  Which should prove a perfect sixth.

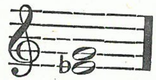
Ex. 13.  Tune G sharp a little grave to C sharp; then proceed to

Ex. 14.  A perfect third.

Ex. 15.  Tune B flat a little acute to F; then proceed to

Ex. 16.  A perfect sixth.

Ex. 17.  Tune E flat a little acute to B flat; then proceed to

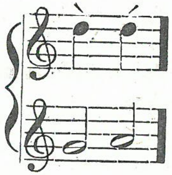
Ex. 18.  A perfect third.

The following are examples how to tune the octaves upwards:—

Ex. 19.  Tune C sharp a little grave to the under F sharp, and also a little acute to G sharp; then proceed to

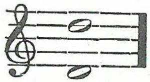
Ex. 20.  Which, on trial, should prove a perfect octave with C sharp below.

Ex. 21.



Tune D a little grave to the under G, and also a little acute to A; then proceed to

Ex. 22.

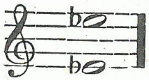


Which should prove an octave to D below.

Ex. 23.

Tune E flat a little acute to B flat; then proceed to

Ex. 24.

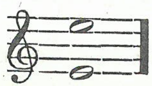


Which should prove an octave to E flat below.

Ex. 25.

Tune E natural a little grave to the under A, and also a little acute to B; then proceed to

Ex. 26.



Which should prove an octave to E below.

Ex. 27.

Tune F a little grave to the under B flat, and also a little acute to C; then proceed to

Ex. 28.

Which should prove an octave to F below.

Ex. 29.

Tune F sharp a little grave to the under B, and also a little acute to C sharp; then proceed to

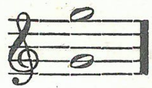
Ex. 30.

Which should prove an octave to F sharp below.

Ex. 31.

Tune G a little grave to the under C, and also a little acute to D; then proceed to

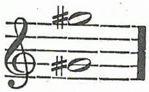
Ex. 32.



Which should prove an octave to G below.

Ex. 33. 

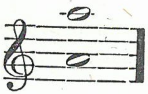
Tune G sharp a little grave to the under C sharp; then proceed to

Ex. 34. 

Which should prove an octave to G sharp below.

Ex. 35. 

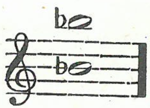
Tune A a little grave to the under D, and also a little acute to E; then proceed to

Ex. 36. 

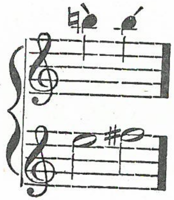
Which should prove an octave to A below.

Ex. 37. 

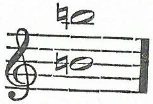
Tune B flat a little grave to the under E flat, and also a little acute to F; then proceed to

Ex. 38. 

Which should prove an octave to B flat below.

Ex. 39. 

Tune B natural a little grave to the under E, and also a little acute to F sharp; then proceed to

Ex. 40. 

Which should prove an octave to B natural below.

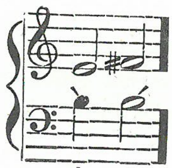
Ex. 41. 

Tune C a little grave to the under F, and also a little acute to G; then proceed to

Ex. 42. 

Which should prove an octave to C below.

The following are examples how to tune the octave downwards:—

Ex. 43. 

Tune B a little grave to E above, and also a little acute to F sharp above; then proceed to

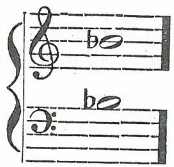
Ex. 44.

Which, on trial, should prove a perfect octave with B above.

Ex. 45.

Tune B flat a little grave to E flat above, and also a little acute to F; then proceed to

Ex. 46.

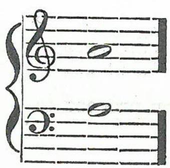


Which should prove an octave with B flat above.

Ex. 47.

Tune A a little grave to the upper D, and also a little acute to E; then proceed to

Ex. 48.



Which should prove an octave with A above.

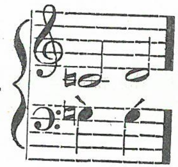
Ex. 49.

Tune G sharp a little grave to C sharp above; then proceed to

Ex. 50.

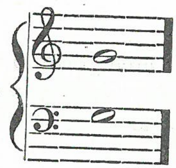
Which should prove an octave with G sharp above.

Ex. 51.



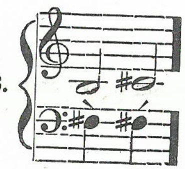
Tune G natural a little grave to C natural above, and also a little acute to D; then proceed to

Ex. 52.



Which should prove an octave to G above.

Ex. 53.



Tune F sharp a little grave to B above, and also a little acute to C sharp; then proceed to

Ex. 54.


Which should prove an octave to F sharp above.

Ex. 55.


Tune F natural a little grave to B flat above, and also a little acute to C; then proceed to

Ex. 56.


Which should prove an octave to F above.

Ex. 57.

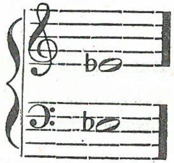

Tune E a little grave to the upper A, and also a little acute to B; then proceed to

Ex. 58.


Which should prove an octave to E above.

Ex. 59.


Tune E flat a little acute to B flat above; then proceed to

Ex. 60.


Which should prove an octave to E flat above.

Ex. 61.


Tune D a little grave to G above, and also a little acute to A; then proceed to

Ex. 62.


Which should prove an octave to D above.

Ex. 63.


Tune C sharp a little grave to F sharp above, and also a little acute to G sharp; then proceed to

Ex. 64.

Which should prove an octave to C sharp above.

Ex. 65.

Tune C natural a little grave to F natural above, and also a little acute to G; then proceed to

Ex. 66.

Which should prove an octave to C above.

CAUSES OF DEFECTS IN PIANOS,

WITH

THEIR REMEDIES.

KEYS STICKING.

When a pin is too tight in the mortise, file it.

When a hopper spring is too strong, weaken it.

When the hopper is rough in the part that touches the under hammer, sandpaper it and blacklead it.

When one key sticks to another, consider whether the pins are in a proper position; if so, plane a little off the key or keys: or if the key is considerably warped, bend it back with a warm iron; press it very gently, for fear of the mortise, where the key is weak.

When touching the front slip; which, in that case, must be reduced in thickness.

When a pin, needle, or any other detached substance, is between two keys.

When a key touches the cheeks of the key frame.

When it touches the cheeks of the case.

When it touches the pillars of the hammer rail.

When any glutinous substance is under it, or betwixt two keys.

When the leather on the under hammer is rough or too loose.

When the key is too light behind the balance rail.

To open the mortises or pin holes, a very fine key file must be used — a flat one for the square hole, and a round or rat-tail file for the round hole, under the key. They must be used very carefully. A key is frequently spoiled by injudicious management; for if the pin holes are too large, a rattling will certainly ensue. Most persons, ignorant of the whole apparatus of the key, immediately proceed to widen the holes, without examining whether the defect is not elsewhere. The key must be taken out with caution; draw the front block or blade of the hopper forward with your finger, to prevent its touching the under hammer, while with your other hand you gently lift up the key and pull it out. The same care is requisite in replacing it.

THE KEYS RATTLING, CLICKING, &c.

When the pin holes are too large, you must wedge the key on each side of the mortises; when all the keys rattle from that defect, it is sometimes better to introduce thicker pins.

By friction of one key against another. This is remedied as explained in the last page.

By friction of the key against the front slip. This defect is likewise provided for in the last page.

The friction caused by a key against one of the pillars that support the hammer rail. Remedy it as on the other side.

When the cloth or baize under the key is not sufficiently soft; or when

Some hard, detached substance lies between the key and the cloth or baize.

When the key touches the balance rail, file it underneath.

When the ivory or ebony is loose, reglue it.

When the lead is loose, hammer it till firm.

When the key is unsound, glue it.

When the front block or bracket is loose, glue it.

When the key frame is not firmly attached to the bottom, first examine the screws; if they are tight, glue some brown paper betwixt the rail and bottom where the vacancy occurs. If the screws do not hold, introduce larger ones.

When a loose splinter is in the pin hole.

When a pin is rough, file it at or near the head.

When the metal of a pin has communicated itself to the hole, which has become too hard, file it.

When the further end of the key touches two damper levers.

When a key touches a cheek of the hammer rail.

When a key touches a cheek of the case.

When the key touches the name board, the latter should have cloth under it.

When the leather at the further end of the key is too hard, it rattles against the damper lever.

When the ivory or ebony touches that of the next key, file it as smoothly as possible.

When the further end of the ebony touches the front of the name board, saw or file it off as carefully as possible.

When a key touches any hard substance at the further end, near the damper lever.

When any hard, detached substance is on a key.

When a hopper or hopper guard is loose.

NOISE IN THE HOPPERS

Is caused by the friction of the spring against the groove.

By looseness of the spring.

By looseness of the hinge.

By looseness of the check.

By looseness of the tenon.

By looseness or unsoundness in the blocks.
By roughness of that part which touches the under hammer.
By touching the next hammer.
By a sudden blow against a hard under hammer.
By touching the next hopper.
When the cloth is too hard.
When the pin is loose.

NOISE IN THE UPPER HAMMERS

Is caused by looseness or unsoundness of the hinges.
By hardness of the leather under the block.
By some detached, hard substance betwixt, upon, or under the hammer.
By looseness or unsoundness of the head.
By friction of the head against the damper socket.
By unsoundness of the shank.
By the friction of loose glue against the hammer rail, near the hinge.
By looseness or unsoundness of the block.
By looseness of the leather under the block.
By the friction of one shank against another.
When the upper coat of the hammer is too hard, if there is sufficient substance, prick it with a marking awl; if there is no substance in the leather, it must be replaced.
When a hammer in the box action touches the long block or the belly.

A RATTLING OR NOISE IN THE UNDER HAMMERS

Mostly proceeds from the same causes as in the upper hammers.

To take off a hammer, the slip must be first unscrewed.
To detach and replace the under hammer rail requires great caution.

NOISE IN DAMPERS

Happens when the socket hole is not well lined, or through hardness of the cloth. To remedy this, prick the cloth with a marking awl, or unscrew the damper, and line the socket hole with other cloth, having taken out the old. Paste, gum, or thin glue will fasten it.

When the damper wire is loose in the head, plug up the hole, and bore a fresh one.

When the damper wire is too close to the string. To remedy this requires much care in bending the wire, or in loosening the cloth from the socket hole on that side of the damper wire that touches the string. It sometimes happens that the string must be removed from the damper wire, by bending the bridge pins. This last alternative must be avoided, if possible.

When the damper wire is loose in the button, or detached from it. If the wire will not hold, plug up the button hole and bore a new one, or introduce another damper wire.

When the whole or major part of the socket holes are misplaced, detach the socket and place it in a better position, by planing it or otherwise, as the case may require.

When the socket hole is broken, glue some cloth or leather round it.

When the damper head touches the shade.

When the damper head touches the top.

NOISE IN THE DAMPER LEVERS

When the hinge is loose or unsound.
When one lever touches another.
When the leather, if any, is too hard.
When the wood is unsound.
When the wood touches the slip.
When there is glue betwixt the hinge and edge of the slip.
When the last lever touches the key frame cheek.
When the lever touches any hard substance, detached or otherwise.

THE STRINGS OR WIRES JAR OR JINGLE

When the damper wire is too close to the string.
When the strings touch each other.
When a string touches a rest pin.
When a string is not firm on the bridges.
When any brass work on the case is loose.
When any hard, detached substance is on the belly.
When the belly bridge is loose.
When the belly is unglued.
When the barring is loose.
When a castor is loose.
When the piano is not firmly placed on the floor.
When any detached, hard substance touches the piano.
When a brass hinge is loose, connected with the top.
When a wire touches the name board.
When a wire touches the break of the treble bridge.
When any detached, hard substance touches a string.
When a wire is unsound. In this case loosen it, detach it from the hitch pin and bridge pins, and rub it with leather. If that does not succeed, replace it with a new one.

When a damper cloth is hard, detach a thread or two with a marking awl.
When the cloth betwixt the belly bridge and right end block does not sufficiently damp the vibration of the strings.
When a covered string is loose, sometimes by rubbing it you may rectify it; but it generally happens that a new string is the only remedy.
When a bridge pin is loose.
When there is not sufficient side bearing.
When one string is thinner than the other.
When both strings are too thin.
When a string is confined by the pins on the belly bridge.

DEFECTIVE DAMPING

Occurs when the damper is not sufficiently screwed into the lever.
When the damper cloth is too hard.
When two wires are not of the same height under the damper.
When two wires are of different thicknesses.
When the damper cloth does not bear equally on two strings.
When the damper cloth touches the next note.
When the pedal wire is too long.
When the damper wire sticks in the socket hole.

A HAMMER BLOCKS

When the hopper is too far under the hammer. Unscrew it till the hammer falls off at about a quarter of an inch from the strings.

When the hopper spring is too weak, bend it to give it strength.

When the hopper check is too high, reduce it.

When the leather of the under hammer is not firm.

When the top of the hopper is not smooth, particularly on the inner edge, sandpaper and blacklead it.

When any part of the hopper is loose.

When the hopper strikes but one side of the under hammer, it must be placed in a right position.

A HAMMER STICKS

Against the damper socket.

Against the next hammer head.

Against the long block. In these cases, pare off as much leather as you can afford; alter the position of the hammer, or press it with a warm iron, as it may require.

When any glutinous substance adheres to it.

Against a damper wire.

Against the belly.

A DAMPER STICKS.

A damper sticks in the socket hole. You must open it, or unscrew the damper wire, and rub it with leather.

When the lever does not descend.

When the pedal wire does not act properly.

When the pedal foot sticks.

A HOPPER STICKS

Against the under hammer. Examine the leather and hopper spring.

When the hopper spring does not operate in the groove.

When the key sticks.

When placed on one side of the under hammer.

When the top is rough, sandpaper and blacklead it.

When the spring is too strong.

When the pin touches the hole of the front block.

When any part of the hopper is loose.

DAMPER LEVERS STICK

Against each other.

Against any detached substance.

Against the key-frame cheek.

TO ALTER THE TOUCH.

When the touch is too shallow, glue some brown paper under the balance rail, till you obtain the depth requisite. If the hoppers are close to the under hammers, plane the bottom of the front rail. After you have succeeded in deepening the touch, reduce the hopper checks if too high.

When the touch is too deep, glue some paper under the front rail. If the hopper checks are too low, glue some more leather on them.

When any part of the keys is deeper or shallower in touch than the rest, you must operate as directed above, in that particular part alone.

When one key is deeper than the rest, reduce it on the balance rail.

When any key is shallower in touch than the rest, you must raise it on the balance rail, unless

When the hopper is too short; in this case, you must raise the hopper by gluing part of a card under it.

When the touch is too stiff, you must ease the hinges of the hammers and levers, if necessary, by removing the slip a little off the hinges, or by weakening them, if too stiff, with a marking awl.

When the hammer falls off too far from the strings, the touch is loose; remedy it by turning the hopper pin.

When the hopper is high, and the front of the key too low, plane off a little under the further end of the key.

DEFECTS IN THE PEDAL.

When the pedal wire, or stick, is too short to raise the dampers, lengthen it by fixing leather at the top.

When, by being too long, it raises the dampers too high, shorten it.

When the pedal foot is too close to the floor.

When the pedal foot is too tight.

When the pedal foot pin is too tight.

When too loose, it rattles.

DEFECTIVE REST PINS.

When too small for the hole.

When the rest pin starts or jumps. This occurs when the wire has been wound on the pin with damp fingers, or when the block is unseasoned. A little chalk in the hole will often remedy this defect, which is very unpleasant in tuning.

When the wire is too high or too low on the rest pin.

When a rest pin, being too close to another, will not admit a tuning hammer.

When a rest pin is too close to the next string.

HAMMERS TOUCHING THE WRONG STRINGS.

When a single hammer, or minor part of the hammers, touches the wrong string, you must remedy them in the following manner: —

If the hammer head is too large, cut it.

If the hammer head is not too large, you must unhinge it, and replace it in a proper position.

If the wrong string it touches is not in its proper direction, you must remove it.

When a majority of the hammers strike the strings in a wrong direction, you must remove the key frame accordingly.

CAUSES WHICH PREVENT PIANOS FROM KEEPING IN TUNE.

When the rest pin is loose in the hole.
When the wire is not tight round the rest pin.
When the twist of the wire is not tight.
When the wire is too thick.
When the wire is defective.
When the hitch pin does not hold.
When a tuner pushes the rest pin sideways.
When the rest pin is turned too frequently.
When the rest pin is stopped in flattening the tone.
When the rest pin block is defective.
When the bracing is defective.
When the back is too thin.
When the bottom is too thin.
When either of the blocks is defective.
When the belly bridge is loose.
When the belly is unglued.

When the bridge on the long block is loose.
When the bridge pins are not firm.
When the damper wires touch the strings.
When the hammers block.
When the piano is not firm on the floor.
When the hammers do not strike the strings in a proper direction.
When the wood used in the construction of the case is unseasoned.
When the piano is very flat, it will never stand well in tune the first time, if drawn up to concert pitch.
When a new string is put on, it never stands in tune the first day.

ON THE HORIZONTAL GRAND PIANO.

The peculiarities of the horizontal grand piano are the following: Its form resembles that of the harpsichord. The *case* is composed of *the bent side, the end, the back, the bottom, the rest pin block, bracing,* including the block from the bottom to the nether part of the belly, opposite the rest pin block. Several steel arches are screwed against both these blocks, to prevent them from yielding to the great pressure of the strings. Some makers have cast iron bracing. Another has steel and brass tubes, passing from the bent side to the rest pin block.

DEFECTS.

Keys as in square, except friction against the dampers.
Hammers as in cabinet.
Dampers rattle in mortises when not well closed.

Wires jingle from most of the causes in square piano.
Defective damping — when the damper sticks in the socket, or between the keys, or from some of the causes in the square piano.

Hammers block when the lever is too far under the butt. Turn the regulating screw to the right, and let the hammer fall at about a quarter of an inch from the strings, as in the square piano.

When the hammer falls too soon, turn the screw to the left.

The lever spring will sometimes rattle or clatter, as also the lever, when loose.

The touch is generally altered by blocks or brackets under the balance rail, screwed up or down, as required.

Little brass screws are fixed to the hammer butts, in order to regulate the centre wire. In old grand pianos, the centre wires were bushed with leather, instead of cloth; the latter is a great improvement. Great caution is requisite in drawing out the key frame; lay hold of the hammer rail, and when the keys are sufficiently advanced, remove your left hand to the front of the key frame.

ON THE UPRIGHT PIANO.

The form of the upright grand piano is nearly the same as that of the horizontal in a vertical position, except that it is squared from the best side, for ornament. Its action is principally like that of the horizontal, with some exceptions. The key frame, bearing the whole action except the dampers, is drawn out from behind, after letting down a flap that secures it. The dampers are behind the strings. The damper frame is fixed to the block by numerous little screws. The hammer is more apt to stick at its centre than that of the horizontal or cabinet, on account of its shank, which is much longer than either. When the instrument, having been in a damp or cold room, sticks at the centre of the hammer butt, take the action out, and let it remain some time before the fire. If the hammer still sticks at the centre, turn the butt-screw; if that does not succeed, remove the brass plate that covers the defective part, take out the centre wire, and rub it with leather and whitening; if after that it does not act freely, open the centre hole with a wire for that purpose. You must be very careful not to bend the centre wire in detaching or replacing it. To rectify a damper, it is often necessary to detach the damper frame. Sometimes the hammer butt, as in the cabinet and horizontal grand pianos, sticks in the notches, which must then be filed. The soft pedal in this piano, as in the horizontal grand, moves the whole action on one or two strings, by touching a little bracket that slides up and down a notch or groove in the right end key block.

There are other pianos, as oblique, unique, boudoir, short upright, grand square, unichord, &c., nearly similar in action to the preceding instruments. The unique and oblique have their wires in a slanting direction. The short upright has its action in front. The grand square is a grand action in a square case, with the sounding board nearly covering the case. The unichord has but one unison. They are all subject to most of the defects mentioned in the preceding pages.

ON TUNING THE ORGAN.

THE leading principles of tuning are the same for the organ as for the piano-forte — that is to say, every octave must be tuned absolutely perfect, and every fifth tuned somewhat flatter than perfect.

The stop called the *principal*, is first tuned; and as it serves as a guide and model for all the other stops, it must be adjusted with great care and accuracy, as its influence pervades the whole organ.

The scheme for tuning the principal is as follows:—

Pitch Note.*

In the above scheme, the first note in each bar is already tuned; the second is the note to be tuned. All the remaining notes of the principal stop are tuned in octaves above or below to those given in the scheme.

* In order to tune this C in organs, a pitch-pipe, or tuning-fork, is used.

When the principal is tuned, the other stops are to be tuned in accordance with it.

In tuning the pipes, the necessary alterations in their pitch are effected in various ways, according to their structure.

Stopped metal pipes have a cap on the top, by which they are tuned. The deeper the cap is pressed down within the pipe, the more acute becomes the pitch, and *vice versa.*

In pipes of modern construction, the caps are generally fixed, and they are tuned by means of ears placed on each side of the mouth.

Stopped wooden pipes have a plug or stopper. In tuning these, as in the metal pipes, the further the stopper is pressed down the pipe, the more acute becomes the pitch; the more it is pulled upwards, the deeper the pitch.

The pipes belonging to the *reed stops* are tuned by means of the *crook* or twisted wire.

If the crook is pressed downwards, the pitch becomes more acute; if moved upwards, the pitch becomes deeper.

Large, open flue pipes are made sharper by cutting away a small ring around their tops, and flatter by increasing their length.

Small, open metal pipes are tuned by an instrument for the purpose, called a *cone.* One end of the instrument is a solid cone, the other a hollow cone. By this instrument, the tops of the pipes may be contracted or expanded, according as we wish the pitch to be flatter or sharper. If we desire to flatten the pitch, we must contract the aperture at the top of the pipe, by forcing the hollow cone of the tuning instrument upon it, and thus press its edges together; if, on the contrary, we desire to make the pitch sharper, we must insert the solid conical end of the instrument into the pipe, and force the edges a little outwards.

Pipes that have ears, or shades, are tuned by means of those shades. To render the pitch more acute, we must bend the shades nearer towards the opening of the pipe; to flatten the pitch, on the contrary, we must bend the ears a little outwards.

In tuning any two pipes in the relation of unisons, octaves, fifths, or thirds, or other consonant intervals, if we observe the smallest *wave* or *beat* arise from the collision of the two sounds, the interval is not perfectly in tune; and we must not consider it as perfectly adjusted till the two notes produce one steady, single sound.

The ranks of pipes, in the compound stops, that stand in the relation of thirds or fifths to the foundation stops, must always be tuned to them by perfect intervals.

ON TUNING THE MELODEON, SERAPHINE, OR REED ORGAN.

THE melodeon should be placed firm and level upon the floor to prevent any springing of the case, which may cause the reeds to strike against the sockets and produce a rattling or jarring sound, although this may be caused sometimes by small particles of dust drawing through the bellows, and preventing the vibration of the reed. Should this be the case, or any reed remain silent when the key is pressed down, the trouble may easily be remedied by taking out the key board, and removing the dust with the point of a knife.

Should any note become flat after using, it may be tuned by scraping the reed thinner at the *point;* or, if too sharp, by scraping at the *heel* of the reed. Care should be taken, in blowing, to press steadily upon the pedal, in order to produce a smooth and uniform tone. Too much pressure bends, and frequently flats, the reed.

Should a reed be fitted too closely in the socket, or by damp weather be caused to press against the socket, it may be liberated with a thin, fine file upon the inside of the mortise of the socket, without altering the tone of the reed.

There are such a variety of reed instruments, that it will be impossible to furnish information which will apply to every case. The rules here laid down will reach every ordinary instance. The *principles* of tuning are of course the same with those for the piano-forte. It is a favorite practice with many manufacturers to tune the popular keys as perfect as possible, throwing the imperfections among the remote keys. But no first-class instruments are tuned in this barbarous way, except when an ignoramus accidentally gets hold of them. In repairing a reed instrument, much depends upon the ingenuity and good sense of the practitioner.