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Publisher: Routledge
Informa Ltd Registered in England and Wales Registered
Number: 1072954 Registered office: Mortimer House, 37-41
Mortimer Street, London W1T 3JH, UK



Proceedings of the Musical Association

Publication details, including instructions for authors and subscription information:
<http://www.tandfonline.com/loi/rma18>

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Published online: 28 Jan 2009.

To cite this article: E. P. Lennox Atkins (1914) Ear-Training and the Standardisation of Equal Temperament, Proceedings of the Musical Association, 41:1, 91-111, DOI: [10.1093/jrma/41.1.91](https://doi.org/10.1093/jrma/41.1.91)

To link to this article: <http://dx.doi.org/10.1093/jrma/41.1.91>

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MARCH 16, 1915.

W. H. CUMMINGS, Esq., Mus.Doc.,

PRESIDENT,

IN THE CHAIR.

*EAR-TRAINING AND THE STANDARDISATION
OF EQUAL TEMPERAMENT.*

BY E. P. LENNOX ATKINS.

SYNOPSIS.

- I. The Ideal of Equal Temperament :
- II. Bach and Equal Temperament.
- III. The theory of harmony and modulation in modern music is based upon an assumption of Equal Temperament: at least, so far as regards keyboard instruments.
- IV. How far is this theory of Equal Temperament realised in the tuning of keyboard instruments to-day ?
- V. The attitude of musicians and amateurs to things as they are.
- VI. The ability and training of tuners.
- VII. The degrees of out-of-tunefulness of Equal Temperament.
- VIII. The beat test.
- IX. Should an expert on temperament be attached to every important academy or school of music ?
- X. The social position and certification of tuners.
- XI. An incorporated examining body should be established for the purpose of certificating tuners, and of giving them a high standing as professional men.

My purpose to-day is to bring before the members of the Musical Association, whose position in the musical world is I know so influential, some considerations regarding the manner in which the tonal base of the musical art—the pitch relation of sounds to one another—is, under existing circumstances, aurally presented; more especially through keyed instruments, such as the pianoforte or organ.

I venture to assert that the condition into which the tuning of such instruments has been permitted to drift demands the serious attention of the profession and the educational authorities of this country.

In my humble judgment there is no greater proof as to the necessity for inquiry and action than the almost incredible fact that so many persons possessing distinguished musical abilities are passively content to accept inaccuracy, and to deny that there is any reform to be accomplished. I am aware that by a beneficent law of the ear—or is it an acquired habit?—we are able to accept sound relations as being what they are meant to be, rather than what they are. Even on a school pianoforte at the end of a term a melody can be identified. To quote from Dr. Walford Davies (*Musical Times*, December, 1913, "Word play in music"):

"The mind has a certain transforming power to see or hear the perfective through the defective. This last fact is certainly strikingly illustrated in the case of the tempered scale of Western music."

But surely there should be some limitations of this kind of toleration of untruth? I believe that tonal errors of the kind I shall describe are vitiating the ears of hundreds of thousands of pianoforte students in this country alone.

I.—THE IDEAL OF EQUAL TEMPERAMENT.

What really is equal temperament? It is an attempt to realise within the compass of one octave twelve sounds only, each of a definite and fixed pitch; but all so tuned in their relation to each other, that all chords and intervals in the octave shall appeal to an ordinary ear as being equally true in all keys.

That is, these twelve sounds shall depart from the standard of just intonation by fixed degrees sufficiently small as to suggest no undue unpleasantness to the ear; and shall be a sufficing substitute for the smoother, the more melodious, or mathematically true, just intonation intervals.

It is, as an inevitable consequence, a systematic method, even at its best, *not* of tuning, but of *mis-tuning*. But this mis-tuning is of such a kind, and under certain circumstances

can be so carried out in practice, as to suggest the acoustically perfect intervals of just intonation.

"EQUAL TEMPERAMENT: AN UNREALISED THEORY."

An article in the *Musical Times* for February, 1913, headed, "Equal Temperament: An Unrealised Theory," brings forward the whole matter clearly:—

"We are all familiar with the visits of the pianoforte-tuner. During the process we hear him screwing and testing by sounding notes together, and when it is all over we are informed that the instrument is now tuned. But although musicians are familiar with the contradiction involved in the statement, *the great majority of the patient public who pay the piper*—if the expression can be employed in this connection—are *totally unaware that the so-called operation of tuning consists really in systematically putting the instrument slightly out of tune*. Of all the intervals that go to make up the tuner's scale, only one, the octave, is *purely in tune*. This necessity—we are almost tempted to say painful necessity—arises from the impossibility of twelve pitches in an octave providing accurate intonation for twelve independent diatonic scales.

"A diatonic scale is a clump of intervals. It is best considered in this aspect rather than as a stepwise melody. An interval is the relation which vibrations at one rate bear to those of a faster or slower rate

"RATIOS FOR TRUE INTONATION FROM A GIVEN KEY-NOTE."

C	D	E	F	G	A	B	C
doh	ray	me	fah	soh	lah	te	doh'
1	9	5	4	3	5	15	2
	8	4	3	2	3	8	

"These mathematically expressed relations represent perfect tune from a given key-note, but they do not provide correct inter-relations between some other degrees. To save complexity these inter-relations are for the present argument ignored.

"THREE SCALES COMPARED."

"The table next given reveals the fact that the pitches that will serve to stand for perfect intonation from one key-note will not serve for keys starting from the pitch of other degrees.

"A centre scale and a four-remove each side (four 'sharps' more and four 'sharps' less) are herewith compared; 120 vibrations are assumed to represent C. The horizontal rules

draw attention to differences in pitch as shown by the vibrational numbers.

E	doh'	300	F	fah'	320	F	lah	320
D#	te	281.25	E	me'	300			
			D	ray'	270	E♭	soh	288
C#	lah	250				D♭	fah	256
			C	doh'	240	C	me	240
B	soh	225	B	te	225	B♭	ray	216
A	fah	200	A	lah	200	A♭	doh	192
G#	me	187.5	G	soh	180	G	te,	180
F#	ray	168.75	F	fah	160	F	lah,	160
E	doh	150	E	me	150	E♭	soh,	144
			D	ray	135	D♭	fah,	128
			C	doh	120	C	me,	120
						B♭	ray,	108
						A♭	doh,	96

"This being so, we are faced by the question whether it is better to be in fairly good tune in a few keys and therefore to sacrifice seriously the intonation of all other keys, or to put up with all being somewhat out of true tune, or, as it is described, 'tempered.' The latter plan is that which has been theoretically adopted in most 'tuning' since the days when John Sebastian Bach wrote his immortal 'Forty-eight Preludes and Fugues' for the well-'tempered' clavier. The particular form of temperament which spreads the error over all keys and favours none, is called 'equal temperament.' In order to obtain this equality, all the perfect fifths have to be slightly flatter and all the major thirds slightly sharper than they would be in strictly perfect intonation, and other intervals are consequently more or less tempered.

"This then is the theory of attainment of the pianoforte tuner. We do not propose here to describe the exact procedure and rules in accordance with which the tuner works. It is sufficient to say that the process calls for the constant and accurate observation of the ear.

"The important point is that although equal temperament is the ostensible aim of tuning, there are strong reasons for grave doubt

as to whether this ideal is often reached. This failure of attainment is in many cases owing to the incompetence of tuners, and in other cases to an easy-going attitude towards the whole business, and a belief that an approach to equal temperament will do for most practical purposes. Even first-rate musicians are content to acquiesce in this compromise of a compromise, and this fact may appear to be an unanswerable argument for the general acceptance of the results of the line of least resistance into which tuning has drifted. This contention is supported by the well-known capacity of the ear to accept, within certain limits, a relation of pitches as what it theoretically should be, rather than as what it really is. It is fortunate that this tolerance of the ear enables us to enjoy the performance of a full orchestra during which the intervals are rarely if ever strictly in tune. But if those limits are overstepped we become painfully conscious of the error. In the case of the orchestra we generally meekly put up with a cacophonous din that no ear in the world can analyse, and we call it a magnificent climax, and in the case of the pianoforte we at once send for the tuner,—unless, indeed, we are in a young ladies' educational establishment where, the instrument being in use for many hours every day, the process has to wait for the holidays. Meantime——!

"Can anything be done to alleviate the mischief wrought to ears by bad tuning? What qualifications have the 15,000 tuners in this country for their expert task, and what authority has certified their competency?"

The standard of equal temperament, like that of our weights and measures, should be scientifically fixed. There should be some protection for the community, seeing that a vast sum (over a million at least) is paid annually for tuning.

The twelve equal temperament semitones of the octave must be a succession of twelve equal ratios or intervals in *geometrical* progression. Whatever pitch we select for middle C—whether 256, or 261, or any other number of vibrations—we multiply these twelve standard decimal ratios by this pitch, which gives the actual vibration values, note by note, of our equal temperament scale for any pitch.

I shall not weary you with further mathematical calculations: few practical tuners have any acquaintance with them, or employ them in the way they work. My aim is to translate calculations handed us by mathematicians, into everyday practical tuning or tempering.

The professional musician, conductor, performer, or accompanist, &c., generally assumes that the work of tuning is properly done, and there leaves the matter. But when we inquire thoroughly into what so-called "equal temperament" really consists in practice, we find some disheartening results. A gross state of

untunefulness is tolerated almost everywhere unheeded, and the practical meaning of equal temperament is ignored or misunderstood.

II.—BACH AND EQUAL TEMPERAMENT.

To no one more than Sebastian Bach do we owe the idea of the necessity for equal temperament. If he did not actually conceive, he at least endorsed, the daring notion of complete freedom and qualified excellence in all keys. The necessity for equality and the advantages accruing from it were displayed in that unrivalled monument of human genius, the "48 Preludes and Fugues for the well-tempered Clavier."

Bach's epoch-making innovation did not succeed all at once; it required time, practice, and experience to establish its merits.

The "mean-tone" temperament, which gave true thirds and sixths and good fifths in a few easy keys, long held the field, but was ultimately universally abandoned. When building up his equal temperament scale, "laying the bearings" as students call it, how did Bach proceed? What was his own particular method of tuning? What was the actual order in which he took the notes?

I have read in many books various references to Bach's method of tuning, and I have endeavoured in vain to ascertain the amount of knowledge as to the mathematical foundation of equal temperament available in his day. The impression which generally prevails is that he tuned by making three sharpened thirds yield a true octave. I think my investigations throw some light on this point, and the discovery came about in a most simple, natural way.

One afternoon I found myself in a certain pianoforte showroom, and my opinion was asked as to the tightness of the pins on a fine and expensive overstrung upright pianoforte just as a well-known tuner entered the premises, and I sought his confirmation of my diagnosis. I invited him, starting on the F as given below middle C, to proceed in his ordinary way for setting the "bearings."

The note F was given him as a starting point. He at once tempered the major third, F—A. Next he tackled the fifth, F—C. The octave F then received attention, and so the common chord was built up. The climax was as musical as it was correct in the theory of equal temperament. He stopped by obtaining a true octave, A to A, the tenth of course "proving" his third—a most beautiful test. Summarised the sounds were as follows:

F (tonic), A (mediant), C (dominant), F (octave tonic), A (tenth octave mediant). He said that a lifetime's experience

convinced him that this was at once the quickest and the most perfect way of "starting" the bearings. He then played them over and over again in this order :

F—A—C—F'—A'—C—F'—A'—so testing and proving the accuracy of his work.

I drew his attention to the fact that, whether he knew it or not, he was playing the introductory bar—"the tuning-up bar" as I have always considered it—of a most celebrated composition, namely, the opening strains of the immortal C major Prelude, though, of course, at a different pitch, in F and not in C. He denied that the form of his extemporisation was known to him as being by Bach.

III.—THE THEORY OF HARMONY AND MODULATION IN MODERN MUSIC IS BASED UPON AN ASSUMPTION OF EQUAL TEMPERAMENT ; AT LEAST, SO FAR AS REGARDS KEYBOARD INSTRUMENTS.

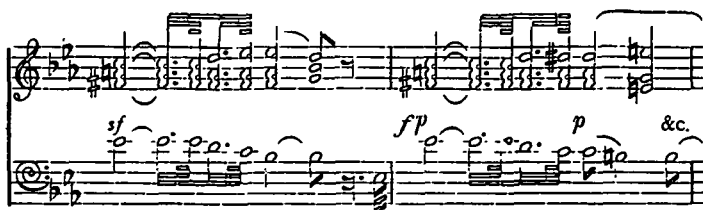
Just intonation enthusiasts contend that, notwithstanding a daily environment of music played on keyed instruments not tuned justly, the moment these instruments are out of hearing we instinctively hear and think in just intonation. Advocates of equal temperament say that inasmuch as the equal temperament scale is heard everywhere morning, noon, and night, it is not got rid of so easily, and they urge that, whatever composers say to the contrary, the mind, like the ear, gets educated to equal temperament. A most interesting article (from which I have already quoted) that appeared in the *Musical Times* for December, 1913, by Dr. Walford Davies, called "Word play in music," gave a very excellent and quite fair résumé of the *pros* and *cons* for both sides :—

"In that Bach advocated it [the equal temperament scale] zealously, and justified it gloriously in the 'Forty-eight,' he cannot be accused of lowering his ideal of perfection. On the contrary, he immensely extended it. But he lowered the standard of physical perfection, that was all. . . .

"As felicitous word-play sometimes throws magical light across conversation, so what may be termed 'chord-play' affords some of the most delightful and appropriate mental surprises in the course of great music. Many chords are capable of such treatment ; but those which most readily lend themselves are those which divide the octave into equal portions.

"In just intonation any equal division of the octave is manifestly impossible at every point ; it can neither be divided into two equal tritones, three equal major thirds, four equal minor thirds, six equal tones, nor twelve equal semitones.

"It is incontestable that purely diatonic and consonant music such as the 'Old Hundredth' or almost any 16th-century writing loses its chaste physical beauty by the equal temperament bargain. On the other hand, if euphony be at all times an object then discords as a whole stand to gain smoothness by the transaction, though the writer cannot resist the conviction that poignancy may often be better than compromise. However that may be, the fact of interest and importance which arises clearly at this point and lies beyond dispute is this: all the discords which variously divide the octave into equal portions and all the synonyms of varying signification enumerated above have only been made possible by the adoption of the tempered scale. In just intonation they simply cease to exist. Anyone who has listened to a diminished seventh when justly tuned will probably have been struck by the sense of discomfort produced by the teasing inequality of the intervals. And anyone who has been thrilled by Beethoven's masterly play upon chords at important moments such as in this well-worn instance :—



will realise that it is only achieved by the identity of sound between two chords with essentially different connotations."

IV.—HOW FAR IS THE THEORY OF EQUAL TEMPERAMENT REALISED IN THE TUNING OF KEYBOARD INSTRUMENTS TO-DAY?

This is a thorny question, which can be answered only by a patient examination, by qualified experts of pianofortes and organs as we find them everywhere; and by inquiry and examination of the tuners themselves. The matter is a subjective one. We can ascertain the sensitiveness of the tuner by examining the instrument which has passed through his hands. Its strings or pipes are to a very great extent the plastic material which can be moulded to reflect and identify his will to tune them in a certain manner.

It goes without saying there are good and bad tuners. It is not possible to demonstrate to those who have never studied equal temperament practically what constitutes a good or bad tuner. It is an unpleasant fact that few tuners really know much about the underlying theory of their practice. Scarcely any possess elementary knowledge of mathematics, and those who do are quite unable to apply their knowledge in a simple manner.

Most tuners observe a few empirical rules. Defects in results are not criticised by the musical owners of the instruments because they know nothing about the matter. The head of one of the greatest pianoforte firms in the world assured me that those of his customers who have had the best musical training are the very ones who declare that his finest tuners have ruined the pianoforte!

There can be no doubt that there is an enormous amount of tuning done in this country that cannot be described as fulfilling the requirements of Equal Temperament. The main obstacles to realisation are :

- (1.) Muscular Weakness on the part of the Tuner.—Even if he have the trained ear he may not have either the muscular strength or skill to handle a refractory tuning-pin. He finds the pins on a pianoforte of A's make easily turnable; on a pianoforte of B's make he finds them almost unturnable.
- (2.) Faulty Ear on the part of the Tuner.—This should be as hopeless as a similar disability is for a singer.
- (3.) Faulty construction of the instrument, cheap materials, hurried manufacture, output rushed, preliminary tunings in the factory possibly nil. Many of the cheap grands and uprights of one much-boomed Berlin make have had for years so many faulty bass strings that they are practically untunable.
- (4.) The unfavourable mechanical or material conditions of an instrument. Sometimes only a few weeks after purchase of a new pianoforte rust will attack here and there; in such case the string will set at defiance minute adjustment by the most skilled tuner.
- (5.) Time allotted for Tuning.—A trichord note can have its three strings in any one of twenty-seven different relations of pitch. Of these only one position is correct: how often is the tuner, even when he knows this fact, given time to secure the required adjustment?

- (6.) *The Quick Turnover of New Pianofortes.*—At present few makers think it worth while to store new pianofortes until they really begin to stand in tune. It would not pay them to do so. The extra cost and incidental expenses would amount roughly to about £10 per instrument. This is one reason why the Equal Temperament scale is so often non-existent in the home pianoforte two or three days even after a good tuner's visit. An output of 350 pianofortes per annum would require additional capital of £3,500.

A certificate from some outside and disinterested authority that an instrument has indeed gone through the required "probationary period" would remove many serious difficulties from the path of the competent and really conscientious tuner.

- (7.) *Varying Temperature of Rooms.*—The public need to be enlightened as to the dependence of equal temperament, and in fact any tuning of any kind, on uniformity of temperature. A self-registering thermometer should hang beside every pianoforte and organ for the tuner's information.

I have known cheap instruments, kept by some lucky chance throughout the year at a temperature of about 60 degrees, retain their temper for two or three years with hardly any readjustment being required.

[At this stage a pianoforte brought for the occasion was experimented upon. It was described as having been tuned in equal temperament only a week before, but its present condition was hopeless.]

V.—THE ATTITUDE OF MUSICIANS AND AMATEURS TO THINGS AS THEY ARE.

Musicians seem quite content with things as they are. Some prefer the *status quo*, but numbers are by no means satisfied. An eminent conductor with whom I got into touch made a serious complaint as to the ignorance of a well-known firm's representative. "It is not possible to trust any tuners in the provinces for important work," he assured me, "I dare not risk it; there is absolutely no proof that they are to be relied upon, and even

where they are competent the dealer's conditions for work make a good result problematical." A series of high-class concerts started off with a disaster owing to defective tuning, and it was ascertained that the tuner did not know one of the most elementary requirements for concerted works.

It has been part of my duty to interview numbers of tuners. They are practically unanimous in asserting that musicians frequently grumble and find fault with even the best tuning. The heads of firms inform me also that this is so. The principal of a popular school of music stated that a firm had sent him a most incompetent man, but the firm's own head tuner declared that the principal wanted the impossible and did not know the limitations of equal temperament, and he contended that this principal's ear had been wrongly trained. I could produce volumes of evidence on these lines—complete, absolute conflict of opinion between tuner and the musician for whom he tunes.

VI.—THE ABILITY AND TRAINING OF TUNERS.

When we come to consider the training of tuners, we encounter that dual difficulty facing all educational authorities, namely, the ability of the teacher and the willingness of the pupil to learn. A tuner may have ability, but has he been given the opportunity for instructing his public by his work? In voice-training a leading professor of singing often finds it necessary to give pupils several lessons a week, so as to impress his requirements on their minds. But the tuner is seldom allowed to see his "pupil," the pianoforte, more than two or three times a year, for the purpose of giving it, so to speak, a lesson impressing his will, his mind, on it.

The tuner should pass a reasonable arts test. I am assured that at present tuners generally deride acoustics. Few can express themselves simply and intelligently when asked by a householder to explain some acoustical detail, even of the most simple kind, in connection with equal temperament. Many incompetent tuners and beginners possibly improve their own ear by ruining ours. Before tuners are given *carte blanche* to tamper with our ear, surely some proof as to the state of their own ear should be demanded other than the mere verbal or written assurance of their employer, who often knows less about tuning than the employée. Some firms, though very few, have for years been troubled over the situation, and are sincerely anxious to improve matters. But little or nothing has yet been done.

Tuners should be afforded reasonable facilities for special ear-training, not only for their own good, but also for the good of the community. It is a quite common thing for a tuner with a more

or less faulty ear to hear only his own bad tuning. Quarter after quarter, year after year, he visits exactly the same houses—tunes or mistunes exactly the same pianofortes in exactly the same way. Where can such tuners experience correct tuning?

Why should we not be able to have available for reference at London University a grand or upright pianoforte or an organ or harmonium of the highest class correctly tempered on the equal temperament principle. If tuners could examine tuning under such conditions, with the aid of a tabulated statement giving the pitch of each note and the respective speeds generated by the various "beat-ratios," and at certain fixed periods hear an expert lecturer, the gain would be great.

REPAIRS AND TUNERS.

It is doubtful whether a qualified tuner should be allowed to carry out repairs other than those of the very slightest description. No music teacher could possibly give the pupil of his best if before, or during the lesson, he had to remove half a hundredweight of mechanism, and, going on his back under the pianoforte, spend most of the time at disposal remedying mechanical defects. Yet it is a common thing under present conditions for a tuner at his very first tuning to fatigue himself for the whole of the day over some irritating defect in the pedal, &c. (More as to this is said under a later heading.)

VII.—THE DEGREES OF OUT-OF-TUNEFULNESS OF EQUAL TEMPERAMENT.

Is the inherent out-of-tunefulness of the equal temperament scale serious or trifling? Most musicians and some music students are aware the fifths are very slightly flattened and the fourths slightly sharpened. The major thirds and sixths are also sharpened.

VIII.—THE BEAT TEST.

The aural comparison of two pitches sounded simultaneously produces a throb or beat that varies in the speed of its period in accordance with the vibrational relation of the two pitches. This beat can be used as an infallible test of the tunefulness or out-of-tunefulness of an interval. But if it is used crudely it is a snare.

We will take middle C as slightly under 256 vibrations for our pitch. The amount of untunefulness for other intervals shall

now be compared with the amount of "temper" we have to put into the fifth F—C, *i.e.*, the F below middle C and middle C itself. I avoid decimal points; the measure or amount of temper required is announced to the trained ear by the speed of the beat the tempering generates. This F—C fifth beats, say, at the rate of only half a beat per second (one beat in two seconds).

Now, half a beat per second is a beat so slow, so inoffensive, so difficult to identify very often, that the finest tuners place not the slightest value on it as a guide. But still we can conveniently gauge the untunefulness of other intervals by taking this speed of half a beat per second as a guide.

Measuring thus, we find the fourth on this F (F up to B flat) is about 50 per cent. more untuneful than the fifth F—C, half *versus* three-quarters of a beat per second.

The major third F—A has thirteen-and-a-half times the amount of untunefulness of the fifth F—C.

The major sixth F—D has fifteen-and-a-half times the amount of untunefulness of the fifth F—C.

The minor third F—A flat has eighteen-and-a-half times the amount of untunefulness of the fifth F—C.

Lastly, the minor sixth F—D flat has twenty-one-and-a-half times the amount of untunefulness of the fifth F—C.

These figures are for the middle of the keyboard. At the octave above they double; at the octave, below they are halved. In the low octave the beats are of a more "ear-impressing" kind, being more ponderous.

The ideal in equal temperament—if the tuner is competent—is, then, for this last interval (the minor sixth) to be twenty-one and-a-half-times as much out of tune as its fifth, and the fifth was of necessity out of tune to begin with.

Since everyone speaks of the pianoforte being "in tune" when the tuner has left the house, or that a certain interval is "in tune," then surely we have before us a typical example of what a universal muddle would have happened if half the world told a child a certain line was a "straight line," and the other half were just as convinced it was, or should be described as, a "curved" line. Students would realise all this with their ears if from their earliest days their attention was directed to these relative untunefulnesses.

THE "BEAT" IN TUNING.

From the foregoing it will be seen that it is by comparison of beat-rate that we must test good tuning. The plan of tempering by attending only to slow-beat ratios such as tempered fifths and fourths was an unfortunate error.

In testing our pianofortes or organs (to see if they are in tune), the student must be trained to note carefully the relative condition as to its speed of beat of any interval taken as a test. Is this or that interval beating at the identical speed to-day it was beating yesterday or the day before?

IX.—SHOULD AN EXPERT ON TEMPERAMENT BE ATTACHED TO EVERY IMPORTANT ACADEMY OR SCHOOL OF MUSIC?

The question has been addressed to me from many quarters, including principals of well-known music schools: "Is it suggested that all students in music—including those learning wood-wind and brass instruments, composition, &c.—should take a course of ear-training in equal temperament?"

To say that the answer is in the affirmative may seem to ask for too much. But the fact that students are learning this or that untempered instrument will not alter the other fact that from their cradle to their grave they will encounter keyed instruments in every direction. Canvass a whole street in the North, in the South, in the East, in the West, the instrument for home use is the pianoforte, which can only be put into "some form" of tunefulness by those who have mastered the science of its inherent untunefulness.

It is overwhelmingly demonstrated by experience that if music students do not master equal temperament in their student days, they seldom, if ever, master it later.

Does anyone suggest that Bach's ear suffered through his acquiring the practical art of equal temperament? I have never heard any such suggestion made.

X.—THE SOCIAL POSITION AND CERTIFICATION OF TUNERS.

To give in any detail even a brief summary of the various commercial demands made on the tuner is beyond the scope of the present paper. I fear we are all guilty in this respect—that we look to the material condition of the pianoforte first, and its acoustical condition last. What with pneumatic and electro-pneumatic pianofortes, the regulation of which we demand when the tuner visits us, it is becoming quite a common thing for tuners, on leaving their firm's premises, to have to carry a heavy bag of tools that no plumber's mate or navy would consent to be burdened with. Not many months ago I met one of our finest tuners starting from a well-known West-End firm carrying a bag of tools which I could hardly lift. Out of his forty or fifty-minutes' visit, with his general public knowing nothing

of tuning, three-quarters of the time allowed is spent in remedying, or pretending to remedy, some real or imaginary defect in the mechanism. Nominally, we pay for the use of a trained ear, yet we complain if a dozen other things are not included. Then as to the conditions in which tuners often have to work, I can personally vouch for the fact that thousands of pianofortes (on the hire-purchase system at 1s. 6d. or 2s. weekly) are being purchased by people of small means—charwomen, porters, labouring men, servants, waitresses, &c.—nearly always with the praiseworthy and touching desire to improve the musical education of children. Free tuning is often made an inducement to invest in a pianoforte. Tuners calling at the houses where this class of customer resides have to work in circumstances which are disheartening and most depressing. Doctors and clergymen, of course, have to go through the same unpleasantness when following their vocations. But they are accorded general social respect, they can earn degrees, obtain diplomas of recognized value, and so on. Should we not, then, invent some certificate or reward in kind to shine as a star in front of the young and deserving, the ambitious tuner? If an Academical or a University certificate or degree for professors of equal temperament were available, the social status of the tuning profession would be greatly raised.

As already stated, a young tuner with an excellent or most promising ear is sometimes physically incapable of turning the pin: an easy pin he can manage, perhaps; but one such as I produce, a "wrest" or tuning pin, is fixed so tightly in its plank that many tuners of indifferent experience would think it was not intended to be turned, or else conclude it had rusted in its plank and could no longer be turned without risk of snapping it. This consideration of physical fitness is most important: for if the beat generated on the tuner's ear is, say, 15 beats per second, immense strength and control of wrist are required to turn the tuning pin so as to generate a speed of, say, $15\frac{1}{4}$ beats per second. The adjustment of pin (or, of course, of organ-pipe) is infinitesimal. Qualified tuners should have a good general education, a good knowledge of music, a good knowledge of the theory of equal temperament, and a well-trained ear in equal temperament. But if the maker "pins his faith" and his pianoforte's reputation for standing-in-tune on the "extremely-tight-pin-theory" (and many do) of construction, such tuners may be physically incapable of giving us equal temperament in the home or elsewhere, notwithstanding their reliable ear. I have met many tuners who admit they cannot turn tight pins slightly. How can real equal temperament be possible if the pin is, for any reason whatsoever, not as nicely adjustable as a violin peg?

A candidate for a diploma should be able to emerge from his present shell of silence and read a paper or instruct a class as part of his examination ; and when visiting homes he should be able to explain plainly and succinctly interesting facts connected with equal temperament. A well-known authority on acoustics took the trouble to call in a well-known tuner in order to hear his method explained for obtaining equal temperament. "The fifth is the same as the fourth" was the only explanation obtainable: that cryptic remark summed up the whole of that "eminent" tuner's "theoretical" knowledge of his art.

The more educational necessities and the less trade considerations prevail the better it will be for everyone concerned in the welfare of the art of music. In a leading pianoforte trade journal a writer (of some weight) drew attention to the interesting fact that the only examination in existence for tuners commenced with the question, "How would you set about repairing a sticker hinge?" Seeing that sticker actions have been obsolete with high-class makers for some thirty years, and that not a single question was asked on the theoretical side of equal temperament, the surprise of this correspondent at the peculiar views as to what it is necessary tuners should know was justifiable.

As another instance of how not to do it, a recent examination in the metropolis furnishes an example: an important pianoforte trade journal simply reports that two candidates passed in tuning, but we were not even favoured with their names, or the qualifications of the examiners. Why this secrecy and anonymity?

Seeing that there are so many thousands of tuners, some highly educated, some already with university degrees in music, and remembering the way the ear of the community is absolutely at their mercy, I repeat that it would surely be a good thing to encourage their sense of responsibility by establishing a degree in connection with equal temperament acoustics. "We can turn out a fairly good all-round musician in three years," said a professor at a leading music school, "but it takes more than double that time to train the ear of an expert in equal temperament." Then why not recognize this fact? Large provincial centres have their own universities for their special needs. Surely, with the public paying, as I have said, probably a million or so for tuning fees, the matter is not a trivial one? A degree in equal temperament at a university would be a benefit to the nation, to the music profession, and of great value to the pianoforte maker. Standardisation in equal temperament would have a great influence on pianoforte manufacturers.

Had our schools of music taught practical equal temperament from the first, I do not believe the late German invasion of pianofortes would ever have taken place; or at least the attempt at invasion would have been nipped in the bud.

THE DESCRIPTION "TUNER."

Is it advisable to abolish the word "tuner" in connection with such a new examining body as we suggest?

"To temper is to mis-tune," writes Hermann Smith; and his work on "The making of sound in the organ and orchestra" is justly regarded by many authorities as a leading work, so his opinion ought to have some weight. Why, then, do we call the man who "mis-tunes" every interval (the octave excepted) a "tuner"? It is most misleading.

Again, no one wishes to take the living away from tuners in these times of the most strenuous competition: therefore it has been suggested that if the word "tuner" is abandoned, no opening for misapprehension would any longer exist. The diploma would refer only to equal temperament and its adjuncts (the arts test, the theory test, the ear tests, the physical tests, &c.).

There is the difficulty of finding an acceptable word to designate a tuner. Many tuners will not allow it to leak out how they earn their living: they are so dismayed with the social position of the tuning profession.

XI.—AN EXAMINING BOARD.

I come to the question of how an examining board should be constituted. In the first place, as the whole community is obliged to use equal temperament, or what passes for equal temperament, it seems to me reasonable that various sections of the community should in some manner be asked to share some responsibility in connection with the examinations.

Pianoforte makers, organ-builders, dealers, teachers, music students, parents, guardians, music critics, the Press, &c., &c., each and all in their own respective towns and cities might take an interest in the matter.

A firm drawing a large revenue from tuning fees should not be permitted to deride any and every form of examination for tuners, whilst taking care to declare in their circulars that their own system is the only one they will acknowledge, and that all tuners trained or examined elsewhere are a danger to the community and will ruin the pianoforte and so on.

One foreign firm claimed equal temperament as its sole and exclusive property. "No other tuners in this country are trained correctly except ours" was the statement made by this celebrated German maker, so he would not nominate an examiner "in case association with English examiners ruined the ear."

If the various boards of management at the great schools of music would only have the teaching instruments tempered by

students the best makers could hardly avoid taking some part in the examinations.

I am informed that under existing circumstances instruments in colleges are rarely attended to during the whole of a term, though of course they are often used for ten or twelve hours daily. A most regrettable state of affairs, and one which ought to be amended !

In conclusion, I should like to say that I am greatly indebted to Dr. McNaught for his assistance in the drawing up of this paper. Mr. Henry Thacker Burgess has also given me every assistance in the many points connected with the mathematical side of equal temperament about which I consulted him, and I am very sorry I have only been able to incorporate a few of his suggestions.

DISCUSSION.

THE CHAIRMAN: I should like to have an hour to reply to this Paper, so interesting is it, but I shall only occupy your time a very few minutes. First of all I would say how much we are indebted to Bach for his "Well-tempered-Clavier." Our Lecturer tells us that Bach tuned his instrument in a quarter of an hour, but considering that it had only two strings to a note, and a compass of five octaves, that could easily be done. I would remind you that Bach never played on the pianoforte, and did not like playing on the harpsichord; he preferred playing on the clavichord, an instrument which enabled him to move the string. For instance, when a note was a G sharp going to A, he could by pressing the key sharpen the pitch, and thereby secure very valuable variation on his instrument. I would remind you that even in my time, down to Dr. Wesley, a great many English people preferred the old system of tuning with unequal temperament. And I would remind you that Purcell, more than two hundred years ago, felt that a better tempered instrument was required, so he made Father Smith, the builder of the Temple organ, put two extra notes in each octave (D sharp and E flat, G sharp and A flat), by which additions he was able to play in extreme keys. I do not agree with the lecturer that all people could have their ears trained to be able to detect whether

an instrument was well tuned or no. I will tell you why. I was sitting at the Crystal Palace in the gallery opposite the orchestra one day, with Sir George Grove (Mr. Grove, then), and a lady with a fine voice sang a difficult and magnificent aria very excellently, but detestably out of tune. Grove said, "How fine it is!" I said, "Horrible! there was not a note in tune." "My dear fellow," said Grove, "pitch has nothing to do with it. It's all right. I like it." I pass rapidly to the next point. When I was Principal of the Guildhall School of Music, we had a great many pianofortes by different makers, and I insisted upon the makers sending a tuner at least once a week to look over and examine the pianofortes belonging to them.

Mr. GILBERT WEBB: I would ask why the system of 4ths and 5ths has been so universally adopted? What is the advantage of it? Is it quicker?

Mr. LENNOX ATKINS: It is quick for "rough" tuning; but no instance is known to me where the equal tempered scale has been obtained by using 5ths and 4ths only, though it yields what has been described—for lack of a better term—as a "bastard" scale, *i.e.*, neither just intonation nor equal temperament. The 5th under discussion (F up to middle C) gives a beat so slow, so innocuous, that the slightest impurity in the unison kills the beat *instantly*, and the best tuners place no weight on it. I admit the late Mr. A. J. Hipkins in his articles says tuning is done by 5ths and 4ths; but he proceeds to say the error is always greater in some 5ths than in others. His own tuners were examined, and not one got equal temper throughout the octave tuning this way, and the facts were published recently in the pianoforte trade journals. Later experience has proved that this system produces bewildering inequality in the tempering of the major and minor 3rds, 6ths, 10ths, and 17ths; these intervals generate beats not only far quicker in speed, but also far more powerful than do 5ths and 4ths; thus the finest tuners long ago discarded relying on 5ths and 4ths only. It is like judging a conductor's beat: who shall say the beat is correct for a bar in *grave* time if we only have in our mind one long sustained beat of perhaps four seconds as a guide, and neither pendulum nor metronome available? But if we have this bar split up (in our mind) into far quicker "beat-units," such as semiquavers (or even semidemisemiquavers), then we can instantaneously arrive at a more reliable verdict. Similarly, tuners make great progress at learning if they learn via 3rds and 6ths, testing as they go by 5ths and 4ths, which (if the 3rds and 6ths are correctly tempered) must automatically be correct. Before leaving the "bearings," however, the tuner should go through his work over again the reverse way: as a relief to the ear, first trying the slow 5ths and 4ths, and then the quicker and more ear-impressing major and

minor 3rds, 6ths, 10ths, and 17ths before passing the result as equal temperament. Employing both these methods alone enables us to ensure pure and beautiful unisons and octaves — mathematically correct. An instrument tempered correctly in this way is the nearest approach to just intonation the pianoforte or organ keyboard is at present capable of.

Dr. SOUTHGATE: Another word for "tuner" has suggested itself to me: a word that might be applicable would be "adjuster," i.e., one to set just and true.

Dr. MCNAUGHT: We have thought of that: we know what the word is in French. But we do not know whether it would be generally accepted.

Dr. SOUTHGATE: Our Lecturer referred to the speculation of the Greeks with regard to intervals. Most of their works are practically inaccessible or very difficult to understand. But there is a famous book in which those interested can read about vibrations, intervals, and their method of applying them—that is the work by Morin Mercennus. I think he was a Jesuit, who wrote about 1530. There are two editions of his book, one in Latin and one in French, both practically easy to read, and very valuable indeed are the illustrations given in this "*De Instrumentis Harmonicis*." The author appreciates the difficulty of getting intervals which would be perfectly in tune for every key, and suggests various built-up keyboards,—I think he calls them "*Abacus*." You will find illustrated there half-a-dozen of these, with the notes and keys divided; what is more important, in his endeavours to plan a perfect scale, he also presents a table showing the vibrations for each of the intervals. And of later years there has appeared a book by Colonel Perronet Thompson,—I think you may be aware of that publication,—on "*The Principles of Just Intonation*." It is a philosophical and highly mathematical work, but in it Thompson gives practical illustrations. He had an octave divided, I think, into twenty-eight sounds. You may imagine the enormous difficulty there was to find fingers to play these; but by means of little quadrants, hooks, buttons and studs which stood up it was possible to finger the multitudinous notes. I remember to have heard a blind girl—Miss Stafford Northcote—play Thompson's instrument at the Welch Chapel in Aldersgate Street, but that was many years ago. I recollect she played Mendelssohn's "*Wedding March*" on it; the chords sounded beautiful. As to whether the instrument was practicable for ordinary work or not, it displayed an attempt in adjusting scalar-true intonations. With regard to the statement that it takes some time to train the ear to appreciate these intervals—I think the Lecturer said three years,—that depends on the ear. I know cases. I have in mind at the present time one tiny boy who has a most wonderful

ear: he can tell you the exact number of vibrations. Some people are more keen than others.

Dr. McNAUGHT: And the beats?

Dr. SOUTHGATE: Yes, the beats also. I do not think that so difficult. Some persons take a long while, others a short while, to discriminate. If the desire of our Lecturer could be carried out, and we could have perfect intonation all the way through, I think we should enjoy music more. But at present many of us do not completely appreciate this.

Dr. McNAUGHT: I do not profess to have any expert knowledge of the tuning of keyed instruments. But I have some sort of an ear which has been formed mainly by choral music, and I feel conscious of the tonal shortcomings of keyed instruments. We have to recognise the absolute necessity of equal temperament, or as near an approach to it as science can attain. We have to be thankful that our ears are not too particular as to exactitude—by a merciful dispensation of Providence we are willing to accept inexactitudes as what they are intended to be rather than what they are. Otherwise we could not bear to listen to a full orchestra with its orgy of out-of-tunefulness. We hear then what we want to hear, although often it is a severe trial. But the question for us this evening is the matter of tuning on a scientific basis. None of us doubt the skill and capacity of the expert concert tuners attached to the great firms. But what of the rank and file who are entrusted with the hundreds of thousands of pianofortes in the homes and schools? If at this moment we could at one fell swoop test all the pianofortes in the country, what percentage of them would be likely to be found in tolerable tune? But it would be altogether unfair to the great body of tuners to blame them exclusively for the condition into which the out-of-tunefulness of pianofortes is permitted to drift. There is the physical condition, if I may so describe it, of cheap instruments which will defy the most conscientious tuning—five minutes after the tuner's departure there will be gives and takes that will neutralise all his efforts. Now much of all this we have to put up with as belonging to the inevitable. There is really no practicable remedy. But elsewhere in high places surely it is reasonable to insist that inasmuch as equal temperament is the theory upon which a musical student works, he ought to understand its mathematical and particularly its auricular basis. Further, the art of tuning should surely have a recognised scientific method, and its practitioners' qualifications should be certified by examination.

A vote of thanks to Mr. Atkins closed the meeting.
