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THE CAUSES OF THE RISE IN ORCHESTRAL PITCH

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APRIL 4, 1881.

C. E. STEPHENS, Esq.,

IN THE CHAIR.

*THE CAUSES OF THE RISE IN ORCHESTRAL
PITCH.*

By Dr. W. H. STONE, M.A., F.R.C.P.

It was my pleasant duty to deliver a discourse at the Royal Institution, on Friday week last, on the general subject of musical pitch, and its mode of determination. Our excellent Secretary, who was there, was kind enough to say that he thought a practical application of the scientific principles then laid down might be interesting to this Society, and I propose to do what the short period allowed for lectures at the Royal Institution did not allow me to do, namely, to carry one degree further into the artistic department the principles then enunciated. It is no use, as was remarked to me by more than one distinguished musician present, telling us all this, unless you can give some rules by which to prevent discords and discrepancies. Now I shall endeavour to take up the tail end of that lecture, and fasten on it a still longer tail of a practical character. I have put up, however, the large diagram which served as a *resumé* in my former lecture, showing the methods of determining musical pitch. For many centuries there was no definite pitch; then the pitch settled down, and for a considerable period remained—during the time of Beethoven and Mozart, and many of our great writers—tolerably steady. With the increase of the orchestra—with the multiplication of the means of producing sound—there came a very rapid rise in pitch, and this rise has been so rapid that since the time of Handel, as has been shown by Mr. Ellis in his learned and valuable papers, it has gone up at least a semitone; nor is there any finality observable in this matter; it might seem as if the pitch would go on rising with the same expeditiousness from causes which are still in operation and which caused the present rise. We cannot go into that part of the subject. We have at last determined a standard. Of the various methods on the diagram, some of the latter seem so satisfactory

that we may say that we have a pitch. We have a standard just as the French have their *mètre*; as the second is the measure of time; as there are now standards of electric measurement; so I think at last in some of the instruments here named, Scheibler's tonometer, Appunn's reed *tonmesser*, and Koenig's tuning-fork clock, we may be said to have a unit of measure like the British yard or the *mètre*.

Now, having this, what is the difficulty in applying it, and how can we best carry it out in practice? That is the text of my discourse. I have put on the table two of these instruments, because I shall have to refer to them further. A specimen of Koenig's tuning-fork clock has not yet reached this country, but Appunn's *tonmesser* and Scheibler's tonometer have.

In the first place, why all this trouble? What is the reason that the pitch should go up any more than that it should go down. It has been remarked to me in talking over the title of the lecture in a friendly way just now, Why is it that it goes up, and does not go down? And that is the first question I feel bound to answer. I have set up a small diagram there, in which I have named a number of causes—not that I mean it to be exhaustive—which, speaking as a player of some years standing (for I have been playing now in the Sacred Harmonic Society for about sixteen years), I consider as the most prominent causes of the rise of pitch. I have been told that no explanation is required, for if you go to many performances and listen accurately enough you will hear half-a-dozen pitches going together. That is perfectly true, but still some reason is needed to account for the fact that they shake down into agreement with those not erroneously flat, but those who are erroneously too sharp. The first and foremost cause is that which has been often named by Mr. Bosanquet and other mathematicians, viz., that true fifths are in excess of octaves. Remember your principal voice in the orchestra is the violin, and the violin is tuned to true fifths—to perfect fifths. The noises, of a somewhat dancing-master-like character, reminding us of school, are the tuning of these strings to true fifths without beats. The moment they are perfectly in tune they do not beat. Directly you add these together the octave is exceeded, and, it seems to me, the first step has been taken in the rise of pitch, a step which lies physically deep in nature, and which is not due to our own weaknesses. It is one of the many difficulties which arise from the incommensurability of the octave and the fifth, which is similar to the strange incommensurability between the diameter and the circumference of a circle. The amount has been fixed ever since the days of Pythagoras, from whom the quantity in excess has been named the Pythagorean comma; it is equal to $\cdot 23460$ of a semitone, say between the fifth and fourth of a semitone; if you take twelve fifths, they are greater than seven octaves

by that quantity. Another way in which it may be taken more simply is that six major tones exceed an octave by the same quantity. I will pass that over without further comment. The very fact that the violins, excepting always the double-basses, which at present are tuned in fourths—and even these are liable to the same error in a less degree—are accurate and correct in tuning, causes them to exceed the octave, and thus they are already tending to get sharp.

Then comes the cause which is usually assigned; as an instrumental player myself, I come to this with a certain amount of feeling. There is no doubt that wind instruments do sharpen extremely with heat, and there is also no doubt that there is a very great difficulty in getting wind-instrument players going into a cold orchestra to properly warm their instruments before beginning. Therefore, even although they are a little flat at the beginning, they get sharp afterwards, and often will not confess it. But this does not apply to all wind instruments. All who have tuning slides can get out of the difficulty, and do so even whilst playing. You often see the horns, and even the trumpets, whilst playing pull at their tuning slides. Other instruments, however, are not so easily susceptible of tuning; the principal enemies are the flutes, oboes, clarinets, and bassoons. In fact it is the woodwind which is liable to this second difficulty—that of rising with heat. Now, as regards the heat, I think every musical man in the room will agree with me that the flute is by nature—by some inherent weakness—liable to be sharp. You very seldom hear the flute down to pitch. In fact, many of the greatest players deliberately state that they never will play down to pitch, and for this reason: the flute is not a powerful instrument, and as the late Mr. Pratten once said to me very frankly, “I have not the power of a clarinet, I have not the power of the oboe, but I must compete with them in some way or other.” Having often sat beside that extraordinarily able player, I have noticed that when he had a prominent passage, when he was not covered by chords from other instruments, and when delicate dissonances were not liable to be overwhelming, he played as sharp as you like; but the instant he played in concert he came down again to harmony. The flutes can do this. The mere turning of the embouchure in and out will vary the tone quite a quarter of a note. I have an amateur friend who says he can play half a note sharp or flat.

Dr. BRIDGE.—Can he play in tune?

Dr. STONE.—I never heard him do so yet. We may dismiss the flute then. It is in their power to vary the tone. I do not think the flutes need trouble us. Then we come to the oboe, and this is a more difficult question. The oboe has from ancient times obtained the prescriptive right to tune the orchestra, and the reason of this no doubt is that in Handel's

time there was no other wind instrument. Sometimes he had two oboes, and sometimes twenty-six; the bassoon was only added later. The oboe is dependent to a great extent on the strength of lip of a performer. I dare say that many musical men here will bear me out in this, that an oboe-player will often begin sharp, and after a little while, although the instrument is sharpened by the heat of the air increasing, the muscular power of the lip fails, and on the whole the oboe has flattened. It is a most delicate and difficult instrument. It is one I confess myself beaten by. It requires a whole lifetime to keep it in order, and if out of tune it is beyond all bearing; that is due to the fact that the lip has to be most carefully maintained, otherwise the instrument is liable to go far away from the pitch to a degree not due to the physical causes I am speaking of. The clarinet, the third which I have named, is so important that I have drawn attention to it elsewhere, but I shall do so for a moment again. The rise in pitch of the clarinet with heat is enormous. It is so large that it has not been fully appreciated. Between the extreme cold of a day in winter and a hot concert-room it varies just a semitone. Now, we often hear musicians talk about a piano being half a note sharp, or a quarter of a note sharp, and generally speaking that means very much less, because the melodic appreciation of change of pitch is generally exaggerated; but with regard to the clarinet the rise of pitch is absolutely, as tried by rules I have properly worked out, what I have stated. Owing to the difference between a cold frosty night and a hot concert-room, a clarinet in B flat may become an A clarinet. I have heard it, and I could show it to you. Lastly, the bassoon, being an eight-foot tube, is not so difficult to manage. Of course, if the instruments are extremely cold they cannot be got up to pitch, but with any reasonable care on the part of the player you may bring all these larger instruments which do not suffer so much from small variations in their length of tube into harmony. Practically, the great difficulty rests with the clarinet. I frankly admit that one great cause of the rise in pitch is the rise of wind instruments generally with heat, and especially prominent among these is the clarinet. The horns and trumpets of course make the notes by ear, and the trombones can all be dealt with. It is only this small section of the band, the wood-wind, which is making all this difficulty so far as heat is concerned.

The third point, which I have not been able to explain at length, although I have put it down, is the difficulty of hearing slow beats. I will not trouble you again with the whole question of beats, but accurate tuning can only be done by beats. The melodic appreciation of pitch is very vague and very feeble. Beats, of course, are the differences of the vibration numbers of the notes beating, and Scheibler and Appunn have

shown how from the relative beats of these two notes absolute pitch can be obtained. But that is not my particular object to-day. I wish to point out that unison tuning is not so accurate as tuning to a definite number of beats, and orchestral tuning is essentially unison tuning. This was found out by Scheibler, and Mr. Ellis has narrated it very well. Scheibler ceased attempting to make his tuning-forks in unison, because the slow beats were inappreciable, and deliberately used tuning-forks four beats out and tuned to the difference: they could be easily counted by a clock. But that you cannot do in the orchestra. You must attempt unison. Now, one beat in a second is not appreciable in the noise of a concert-room, and from the tendency of human nature to be prominent, to stand out above its fellows, that little difference of unison is generally taken by the player on the side of prominence, and he tunes that small quantity sharp. Here again is a natural cause of rise in pitch.

Then comes the physiological point, which I have put down as number four—the predominance of sharp notes. If two notes are sounded in the same room, and one is a shade sharper than the other, even the most musical amongst you—even Mr. Stephens, I believe—would be tempted to choose the sharper note. It is a curious fact that the sharper note attracts attention more quickly and more distinctly than the flatter note; hence the tendency of conductors in an orchestra to say, "You are too flat." I believe a great deal might be done by saying to the other players, "You are too sharp"; but that I will come to presently. The difficulty of hearing slow beats is this: If a standard be taken which beats a certain number of times a second, it will be very easy to say whether that number be fulfilled or not. For instance, here I have a watch which beats four times a second. I have only to take four beats of the second hand and compare them with the sound of these tuning-forks; it is very easy to make the comparison. But suppose I have a slow repeated beat, one in a second or in a second and a half, it is very difficult to know exactly how often it occurs. Yet that little difference in the particular instrument above the rest is quite sufficient to give it enormous predominance, and sufficient to determine a gradual pulling up of the band to that sharper note. So each man goes on overtopping his neighbour and, the process being continuous, tends to raise the pitch.

Now beyond this there is something more to be said. It may seem rather a paradox, but I think I can prove it physiologically, that different ears make different estimates of unison. Unison should be an absolute fact, just as the boiling or freezing point; and we know how those two physical facts are influenced by a number of circumstances. I believe the acuteness of the ear varies, and that what one man would call unison another

would not call unison. No doubt real unison exists all the while, but according to the thinness and accuracy of a particular tympanum as compared with another, different persons do not possess quite the same appreciation of unison. Here we have another cause still of sharpening, which perhaps may require a little proof. The first proof that ears are liable to be mistaken in unisonous notes was given some years ago by Mr. Hipkins. If two pianofortes in Broadwood's rooms are exactly tuned by beats, which is the only accurate method of tuning, and one has a soft hammer and a full quality tone, and the other a hard hammer and rather an acute quality of tone, the best musicians will come into the room and declare that the soft tone is the flatter of the two, although they are by the only mathematical method of measurement absolutely in unison. To show you how insensitive ears may be to differences of pitch, I will mention what will be in the recollection of several of you. Many of you were doubtless present when the *Toy Symphony* of Romberg was played at the Promenade Concerts, and repeated over and over again as part of an interesting concert of comical music, such, for instance, as Mozart's *Musical Joke*—which, though a joke, is a magnificent composition. It appeared from the tonometer that all through the performance of the *Toy Symphony* the toys were at the French pitch, whilst the orchestra were at the English pitch, and nobody found it out—that is to say, there was nearly a semitone difference. I mentioned it afterwards to a friend, whom I advised to take a tuning-fork, and tell me if the nightingale and cuckoo were not at French pitch. They were; there was a difference of nearly a semitone, and yet that large band calmly went through the *Toy Symphony* without the least idea that they were in dissonance nearly half a tone. It was a pity the thing was not done in tune, because there is a singularly beautiful effect produced out of one of the toy instruments in the slow movement. It only speaks a single note, but that note happens to come in very beautifully, like the one note of the singer in the "*Son and Stranger*," which is made to do such wonders. That effect is lost by this pretty instrument being half a tone too flat, and yet nobody seems to have discovered it.

So far I may say I have dealt with the destructive part of my argument, and now the point is, What can we do? What should we not do? Of course when there is any question of pitch our ancient friend the tuning-fork comes to the front, but each man has his own tuning-fork, just as he has his own dog or his own cat; and these tuning-forks are perfect, and have no error, and never can by any possibility be wrong. But, even putting aside prejudice, the tuning-fork is too feeble for tuning purposes in an orchestra. Indeed, the tuning-fork is hardly dealt with fairly. Helmholtz has noticed how very pure and

free from harmonics is the tone at the best, but as we generally use it its tone is damped to an astonishing degree. I have mounted a tuning-fork here to show the difference which can be made between a tuning-fork properly used and one unfairly dealt with. If I put it in the ordinary way on the table and strike it, it has a very feeble note indeed. If I let it vibrate properly by holding it differently, you hear a very coercive note. Put it on the table or on the floor, and it is immediately dumbed. We do not do our tuning-fork justice by not allowing the resonance box connected with it to vibrate freely. There is only one point in the tuning-fork, the point of least motion, which is almost stationary, just below the prongs, which should be mounted, and the box should be allowed to be quite free. I think an orchestra could be fairly tuned from a tuning-fork so dealt with; but at the best the sound of a tuning-fork is feeble, it contains very feeble harmonics, and is not therefore very liable to beat. Again, it requires special training to deal with it. Many good tuners cannot take a note from a tuning-fork. I was the other day at Hill's factory to tune an organ, and the voicer, whom everybody knows to be excellent, can make the note of two organ pipes speak accurately together, but he could not hear the tuning-fork—he declared the tuning-fork was in unison when it was not. I am saying no harm of him, because every one knows his ability, but not being accustomed to a tuning-fork he said it was in tune, when I, having had a little more practice with tuning forks, could hear two beats a second going. It was simply from want of practice. Therefore a tuning-fork, however valuable in a quiet study for the physicist, is not well-suited for the noise of an orchestra, and the unpractised ears which will have to listen to it. What can we replace it by? Here I may say that every other source of sound except the tuning-fork and the free-reed may be put aside as too variable and uncertain. The variations in tuning-forks have been investigated, and I agree with Mr. Ellis, that no other source of sound is, to anything like the degree of those two, stable. According to his investigations the tuning-fork will vary about one in 16,000 vibrations for 1° F. That is nothing. A reed will vary one in about 10,000 vibrations, and that still remains very far inferior to anything that is needed in the orchestra. Therefore, we have two to choose from, the tuning-fork and the reed; and I should decidedly say, on account of the coercive nature of the reed, on account of the harmonics it is accompanied by, and the predominance of beats, let us by all means have the reed.

But how is this reed to be properly applied? Of course here in Scheibler's *tonmesser* we have a record of any pitch we require. Any pitch can be taken throughout the range of the octave. But, unfortunately, if conductors were allowed to

manipulate so many tempting little handles, I am afraid they would be liable to yield in one direction, and not to keep to one pitch; therefore I am inclined to think the better plan would be to cut down these sixty-five reeds to one, or at most two, and that reed to be mounted in an invariable way, so that it could not be interfered with. These things already exist. Here is another form in a tube, and here is one called the Æolian pitch-pipe, which can be varied by means of a slide shifting the length of the reed. But the moment you have the power of altering, it seems to me we lose our standard. If the haberdasher could say, "How long a yard would you like, ma'am?" I am afraid very few ladies would go to that shop; and I fear that, with a variable reed, we should be apt to get too sharp in the same way as now. Such a standard is very easy to construct; indeed, I am now in the act of constructing a series of reed tonometers which shall be accurately true. The temperature should be kept within moderate limits, and the influence of varying pressure of wind should be as much as possible warded off. In the meanwhile here is one which I think will strike you as being sufficiently coercive for an orchestra. It is easy to show you that the beats with such an instrument are very audible. I will sound A on the clarinet, making it purposely a little flat, and I think you can see that players in an orchestra could not stand beats like that. Even as the instrument warms the beats alter. If the conductor used such a beat the most obstinate of instrumental players could not fight against it. As I vary my blowing the beating becomes so intense and intolerable it would be impossible to escape from it. If this is not absolutely the best, it is a very near coincidence with it, and may be called the second best test, and by it I think we shall be able to get out of the difficulty. Now, let us try with the tuning fork. It is more or less in tune with the clarinet; it is not quite in tune; but it does not hurt your feelings; it is not so frightful as the want of coincidence between the reed and the clarinet. In a reed judiciously used we have a standard pitch which cannot be departed from, and which will even bring clarinet-players to reason.

There is one more thing which deserves notice before I come to my last suggestion, and that is that the instruments themselves are not in tune; and really I have never yet seen a clarinet sent out which is in tune. The flute is somewhat better, but oboes and bassoons are very bad. I have adopted a method of tuning myself in which the parts are inverted, which is, perhaps, an improvement on the usual mode. The usual rule is to take a good measure of pitch—a series of reeds, such as I have here, or tuning-forks—and tune the tempered octave of tones of the instrument to it. But the converse is possible, and is much more delicate. Instead of tuning the

instrument to the tuning-fork, play the instrument until by consonance the tuning-fork speaks. The effect is very curious. I mount this tuning-fork in the far part of the room, and take the clarinet or bassoon; as long as the clarinet is out of tune there is dead silence on the part of the tuning-fork, but the very moment the note is right the tuning-fork sings out loudly. It is quite possible to show that. Here is an A tuning-fork, and here a clarinet: on sounding this it is quite within orchestral limits of tune, but now I have flattened the instrument intentionally a little bit, and the tuning-fork does not sound at all. I warm it a little more, and the moment it is in tune with the fork the latter speaks at once. Now, that mode of tuning, setting up your tuning-fork and trusting to the consonance of the tuning-fork for the accuracy of pitch is, I think, a step further in the right direction, and enables you to tune a little more accurately than has hitherto been done. I have one suggestion, lastly, for making this practical change, and that is that some society or institution, such as the Musical Association, should take the lead in this matter. Somewhere or other there ought to be established a means of pitching or tuning instruments, like that which is established for weights and measures under the Warden of the Standards. We do not want, as somebody mentioned to me just now, the interference of a despotic government. It could all be done after the English fashion, quietly amongst ourselves. Let it be understood that there is some place at which a standard series of tuning-forks or reeds, which I prefer, is kept, and that instrumentalists can go without charge, or at some moderate charge, to have their instruments tested and tuned—as thermometers are tested at Kew, and as the Warden of the Standards tests standard pounds and yards, and surveyors' chains—and they will be obliged to go and have their instruments corrected for the sake of their reputation, and so we shall get out of the difficulty.

DISCUSSION.

The CHAIRMAN.—Ladies and gentlemen, I am sure you will all agree with me that we owe Dr. Stone many thanks for his great kindness in presenting such an interesting lecture to us. I see some gentlemen present who will no doubt favour us with a few remarks. With regard to myself, I must say the experiment shown us as to the difference between reeds and tuning-forks is very satisfactory, inasmuch as the tuning-fork, to my ear at least, manifestly sharpens in pitch as the sound dies away.

Dr. STONE.—It does a little, but very little.

Mr. ELLIS.—Not perceptibly.

The CHAIRMAN.—To me it is very plain.

Dr. STONE.—Of course it apparently rises, but that is partly owing to the higher harmonics coming out more plainly as the sound dies away.

The CHAIRMAN.—There is to me obviously a rise in the pitch as the sound dies away; and therefore, admitting what Dr. Stone says, that it is a slight one, it confirms what he says as to the preference being given to the reed. I can also confirm what he says about the little uncertainty in one's own feeling with regard to pitch, for I remember on one occasion, when I had suffered from a very severe cold, on my recovery I found to my great dismay that I heard a different pitch with my two ears, and it was a long time before that got right. You can imagine the distress I felt during that time. If that applied to an individual in the two ears, it is very clear that one individual may be so constituted as to hear a pitch quite differently to another. I think Dr. Stone's remarks tended to that extent—that it was quite possible that such an anomaly might exist, that two persons would hear a different pitch at the same time. With regard to the sharpening of certain instruments in the orchestra, we must take into account that there is a tendency on the part of stringed instruments to flatten, which one would suppose to some extent would counteract the influence of the wind instruments rising. Perhaps he will kindly deal with that subject in his reply. It is quite true that they can sharpen as they go on.

Dr. STONE.—They do keep retuning, but there is a perpetual tendency to fall.

The CHAIRMAN.—There are two classes of stops in the organ, one of which rises, and the other falls through heat; so that there is a counteracting tendency in that case. But Dr. Stone has chiefly dealt with the orchestra. I am sure there are some gentlemen present who will be able to say much more on this matter than I can.

Mr. A. J. ELLIS, F.R.S.—To take the last point first—with regard to the apparent sharpening of the tuning-fork, as the one dies away, I do not know whether you decidedly notice that you scarcely hear the fundamental tone—after a short time. The octave is then heard, and then the twelfth becomes the principal sound. I think that the thinning of the tone in consequence misleads the ear. That it does not sensibly alter in forty seconds I think I am pretty well justified in saying, because all my experiments on Scheibler's own forks were made for a period of at least forty seconds each, and the counting was absolutely correct. Now that could not have been the case if the sharpening had taken place. That is the reason why I think the ear is misled by the alteration in the quality of tone.

Dr. STONE.—The Chairman was rather speaking of the effect on the ear with respect to the tuning in the orchestra.

Mr. ELLIS.—As a matter of fact, I think it really does not sharpen. I observed on this matter on another occasion, when I showed two forks which were very nearly in pitch together, but were of different qualities, that the persons present were about equally divided as to which was the sharper. The difficulty was entirely due to being misled by the difference in quality of tone. The tuning-fork has not such a pure tone as Helmholtz at first imagined. I can always get out of any tuning-fork the octave by putting it before the proper resonance cavity, and on some tuning-forks I manage to get the twelfth as well; and Mr. Bosanquet has said that on large tuning-forks he has got as far as the seventh partial tone. Besides that, you have a number of inharmonic partial tones, which tend to confuse the ear much as the sound dies away. Therefore it is not at all convenient for use in the orchestra; but there is no instrument at all comparable with it for the purpose of settling pitch, or determining minute varieties of pitch. The tone of a reed itself is so compound and rough that it is very curious to observe the effect of the beats. The beat is an extremely complex one. I have had to count Appunn's instrument for hours together, for days together, and therefore I know it perfectly well; and in listening to it it is necessary, in order to be accurate, to wait until you hear the beat of the fundamental tone, and disregard the beats of the other partial tones. The beat of the lower tone is a bell-like beat; and when you take notes which beat in the fifth, it is really the twelfth of the lower note which beats with the octave of the upper note, and you can also hear that beat as a bell-like sound. In measuring these lower notes—and the tenor and bass instruments can go down to a double bass as low as eight vibrations in a second—I was able to count as low as twelve vibrations in a second with great certainty, entirely by taking the upper partial tones, sometimes as high as the twentieth or thirtieth which exist in these low reed tones. The consequence is, there is a real and very great difficulty in determining the octave which you are hearing. You constantly hear the higher octave instead of the lower one; and persons imagine, in sounding the low reeds, that they have heard much lower tones than they really have heard, because they hear the octave or twelfth above it. I agree with Dr. Stone entirely that the reed is the best thing for the orchestra to tune from. That tunes in unison, but I also am perfectly certain that it is quite impossible to tune a unison; you can only approximate to it.

Dr. STONE.—You do not suggest that an orchestra should tune to four beats.

Mr. ELLIS.—It must be tuned inaccurately to unison. Extreme accuracy is not a thing to be thought of in practical

performances, for you could not keep it for two seconds together, if you got it.

Dr. STONE.—Whereas the natural beats of a reed are sufficient to make anything out of unison perfectly unbearable.

Mr. ELLIS.—I quite agree; I was only speaking of the scientific part of it. With regard to slow beats, the slowest I have ever been able to count was once in twenty seconds. It was two tuning forks which were tuned to be in unison together. They had been tuned by four beats, but there was that one beat in twenty seconds. It was very difficult to count. You know that persons do not listen for twenty seconds generally; there were five seconds of absolute silence, then there were fifteen seconds of a note which you could not tell whether it varied up or down at all. It seemed to be a blank and a dash; a blank and a dash. It was certainly a very remarkable fact. I never cared to go through the labour of hearing them a second time; but I worked them out on two occasions in one day, and that was sufficient to establish the fact. Now regarding what Dr. Stone has said as to these four points, I admit every one of them; but I think that is not the whole of the reason why we have risen in pitch so much during the last fifty years. We must recollect that for 200 years before that time pitch hardly varied at all. Now that is quite a remarkable phenomenon, which has been brought out by the results of experiments and observation which I have made on old instruments, old forks and organs, and sometimes organ-pipes which I had constructed according to measure. The variation was trifling—a comma more or less—and a comma more or less might reasonably arise from any of these circumstances. But such a very great rise happening so suddenly as this rise of more than a semitone, that has already taken place since the time of Handel, I do not think can be attributed entirely to these circumstances. I believe those circumstances can do very much and very markedly as to the variation of pitch in the course of one evening, or the pitch in one band; but they are not the things which tell generally upon the musical world. At any rate we have a number of facts which I have brought forward in my history of musical pitch, which have shown certain particular reasons for a rise of pitch at particular times and places. The rise in pitch began in 1816 at Vienna, and it spread from Vienna very slowly through Germany. In 1813, when the Philharmonic Society was established, the pitch was the same as Handel's, for we have a copy of the fork, preserved at Broadwood's, with which Mr. Peppercorn tuned the piano first used at the Philharmonic, and kept on tuning it to 1820. That is Handel's pitch precisely, or as nearly as possible, tuned in an unequal temperament then. Broadwood's did not think of tuning in equal temperament until 1840. The rise at Vienna arose, as we

have historical evidence, from the presentation of new wind instruments to two household regiments at Vienna; and it being the custom for the bands of the theatre there to reinforce themselves by military instruments when occasion required, the managers found themselves in a very great fix, for out of the three home regiments at Vienna there was only one left that could play in tune with the orchestra; and then of course the orchestra rose; but the rise was not adopted generally in Germany.

Dr. STONE.—That is reason number three—instruments being too sharp.

Mr. ELLIS.—The second band was a little sharper than the first; both sets of instruments were made by Koch at Vienna; and this pitch gradually spread through Europe, but it was a long time before it got as far as Dresden. Then it rose up in France, and they were so frightened at the great height of the pitch in Paris that they got this new pitch made, though they were not nearly so high as we are at present in England. They have now got a little bit beyond the English in America. I recently had an account of American pitches, which was not in time for my book, by which I find this. I mentioned that Steinway uses a sharper fork, which I got here in London; but there seem to be two or three American forks for pianos which are still sharper, although they had the French pitch several years ago. The French pitch, you will observe, is the pitch which Smart introduced when he sharpened his own pitch, and that was the utmost sharpness which he would allow of. It was known as Smart's pitch in England for a long time before the *Diapason normal* was constructed, but it happens to be identically the same. Then in different orchestras there have been several curious things related with regard to the sharpening of individual instruments. Dr. Stone said that players liked to make themselves more prominent, and that the sharper tone is the one that strikes the ear most. It is more penetrating, and no doubt it is heard better. Orchestral players seem to have laid to heart the Homeric maxim—

Αἰὲν ἀριστεύειν καὶ ὑπέρτερον ἔμμεναι ἄλλων.

which may be put into the English jingle—

Always be best,
And top the rest.

There was a curious case in Paris of that kind. They had flattened the pitch to accommodate a singer whose voice was a little *usée*, and one of the orchestra could not endure it; so after a while he quietly sharpened his instrument, and the others rose up to it without anything being said. Therefore, while I think that all these things are quite true, and that

excess of the twelve fifths over the seven octaves may possibly be one cause of it, yet it cannot have much effect, because the violins can always accommodate themselves by stopping, especially if they carry out the rule which used to be laid down, never to use the open string except for the lowest note; so that they are always able to stop in tune. The rise of wind instruments with heat is very great. Of course wind instruments would include the organ, where the rise is something frightful. The organ was excluded from the paper; but where, as at the Crystal Palace or Exeter Hall, the band plays with the organ and the organ rises so enormously with heat, it is very trying to the instruments altogether. I recollect Bryceson telling me that he had been sent for during a rehearsal at St. James's Hall, when they said:—"We cannot play with the organ at all, it is so dreadfully flat." But he had merely to say:—"Wait until the evening, and it will be all right." Of course it was all right when they heated it up, as they did under the old arrangements. I believe it is better now with the sunlights; but Bryceson said they had often 130° F. in the organ gallery: that is only for the evening. I do not think that is sufficient to account on the whole for the very great rise that has actually taken place. The difficulty of hearing slow beats is, of course, an important thing; for if people could hear them well they would hardly ever listen to an orchestra at all. When I have shut my ears to the music, and listened only to the sound, if I may make that distinction, I have been surprised at the enormous quantity of roughness which you hear in an orchestra, owing, of course, to the want of unison amongst those notes which ought to be in unison, and to their upper partial tones. I quite agree with Dr. Stone as far as he has gone; but I do not think he goes far enough to account for the actual state of things. Dr. Stone said that he is working now to get the instruments, especially the wood instruments, originally made so as to be possible to play in tune. That is a very important thing, and I am very glad he is working that out, for it is an extremely difficult subject. He mentioned that he had known one flute-player who could play half a note sharp or flat, and that reminded me that Delezenne, who some years ago began a collection of flutes and other instruments for the purpose of determining the history of pitch, finally gave up flutes altogether, for he found that practised players could make a semitone difference by the method of blowing them, and therefore they were no record, within a semitone, of the pitch actually produced. Again, of course, there is the old pitch, which Dr. Stone did not allude to at all—the old difference between the church pitch and the chamber pitch.

Dr. STONE.—Was that orchestral?

Mr. ELLIS.—It was orchestral.

Dr. STONE.—There was no orchestra in those days.

Mr. ELLIS.—It was hardly an orchestra—it was a quartet ; but they played together, and the difference was always a tone or a minor third, or some definite interval, so that they could play together by means of transposition. Then so lately as a very few years ago, at Madrid, they had that difference between the cathedral organ and the orchestra of the opera of exactly a semitone, in order that they might be able to play together on *festas*. I am very glad to find how Dr. Stone is working out this subject, and I am delighted at this way of mounting the tuning-fork. I have not mounted such tuning-forks myself, but I have been very much in the habit of holding the tuning-fork on the resonance-box in my hand, with the mouth of the box near my ear. By that means you hear the sound wonderfully well, and lasting a very long time. Of course there is a very great deal in the resonance-box ; and I find, if I put its mouth too close to my ear, as one was apt to do, I could almost damp it, and the question was whether I did not flatten it a good deal ; but the amount of flattening, if any, is very small indeed—it does not come to a vibration a second, although it exists to a certain degree. My notion was to have a standard fork four beats below the pitch you want to give, and to have a reed verified before the performance by means of that, which is very easily done. That reminds me of another point—that the reed is very loud, and dominates over the fork altogether. Dr. Stone mentioned about the difficulty that Hill's tuner had in hearing a beat with his ear ; but that was because his ear was close to the organ-pipe, and not close to the fork. I have had to take the pitch of organs by little hand-forks over and over again, and the only way in which I found I could do it practically was to go thirty or forty feet off.

Dr. STONE.—Organ-tuners always go to the end of the room. But that is part of organ-tuning, which is a larger subject.

Mr. ELLIS.—With regard to the reed, when the fork was placed beside the reed it was too close. Your ear should be much nearer to the fork than to the reed instrument. I found, by putting the fork close to my ear, I could determine the pitch of most organs, standing thirty or forty feet off, and I have been able to hear the beats and count them with the greatest accuracy.

The Rev. THOMAS HELMORE.—I am tempted to venture a few words on this subject, with reference to voices. My friend Dr. Hullah thinks the study of music should be conducted, in the first place, through the voice : and I think, if all those good clarinet-players, and people who play in bands, were from early infancy trained to listen more attentively than they do, the precision of pitch would be much greater than it is at present. With regard to the tendency to sharpen, I may say that I have had a great deal of experience in

hearing uncultivated voices in village choirs, town choirs, and all sorts of choirs, and I find, generally speaking, unless my ear is very inaccurate, the tendency of men is to sing a little flat; it may be from fatigue, but they will sing year after year almost a quarter of a tone flat, and not know it, because their attention has not been called to it. On the other hand, I find female singers always sharpen, it may be from the vigour with which they sing, and probably from that same feeling which Mr. Ellis spoke of, of trying "to top the rest." As a sharp note makes the voice more distinct and more impressive, the tendency is to sing sharp. With regard to the desire which Dr. Stone mentioned of humanity to push itself forward and to be heard more than other people, I can only say this, that with regard to some of my singers, with very loud voices and very poor ears, when I have been attempting to train them in singing, they have taken a note, and it has been sharper than the one I have gone to. Then I have given them the note they were singing; and they have immediately gone a semitone higher. I think what we have to do in orchestras and everywhere else is to teach people that the ear is a very delicate thing, that it is in very great danger of being deceived, and that by paying more attention to this subject, both boys and girls, and men and women, would appreciate tone much better than they do at present.

Mr. BLAICKLEY.—There are one or two points I think I might allude to with appropriateness, being practically engaged in the manufacture of instruments. I think with regard to the sharpening, owing to the excess of true fifths over octaves, it undoubtedly must have a decided influence; but I think also that, within the limit of an octave, it is very easy to get a little in excess of the true pitch in this way. The violin, of course, is tuned in the key of D, and the flute corresponds. The flute and violin sound D and the A as a perfect fifth. The A clarinet is tuned to the A string of the violin, or the A of the flute. The C clarinet, if played, is tuned a minor third above the A, and that is already a comma too sharp, within the limits of an octave. Again, there is a tendency in all instrumental players, in ordering new instruments, to say to the manufacturer, "Be sure it is well up to pitch," and they will have it cut and cut again. You may take a little pains to persuade them, but it is no use. With the modern facilities of travelling, players travel about; they say, "That is all right for London pitch, but I may be in some other town, and I must have an instrument a little sharper, in case I am landed in a hobble when I get there." It is an exceedingly difficult thing for manufacturers to keep down the pitch to the standard, however much they may wish to do so; they are constantly asked to send out instruments sharper than the recognised pitch. I think that desire for convenience on the part of players, to

have their instruments sharper than the recognised pitch, has a good deal to do with it; because, by degrees, in the course of a generation, all instruments in use would be sharper, and they would start from that sharper point again.

Mr. ELLIS.—There is one thing I forgot to mention with regard to reeds. Although a reed keeps well in tune in itself, it is apt to give suddenly. When I was a boy I played a great deal on the English concertina, and I have continually found a note go entirely, without any particular reason; and on this instrument of Appunn's I have found the lowest note lose two-tenths of the vibration in a second within a few months. There is no accounting for it; we do not know from what cause it arises. Hence the necessity for tuning a reed by a tuning-fork which is lower.

The CHAIRMAN.—Allow me to supplement what I said about sharpening in the fork by observing that, in the harmonium, the reeds are very much flatter when blown fully than when they are very lightly blown. That may be for the same reason as the variation in the tone of the fork.

Dr. STONE.—No, I think not. The harmonium reed has no fixed point in which each vibration begins. When it is blown with a strong wind it vibrates right down to the root, and therefore the amplitude of vibration, and with it, the length of the vibrator increases. The tuning-fork is not liable to the same difficulty, and therefore it is a decidedly better standard of pitch.

The CHAIRMAN.—I will now ask Dr. Stone to reply.

Dr. STONE.—I have really nothing to reply to. I understand Mr. Ellis to say that whereas these causes account for variations of pitch within a limit of time, the historical alteration in pitch is due to other causes as well. At the same time it is very singular that it should have been a steady rise. If it is due to other causes it might have had a variation in the other direction. As regards what Mr. Blaikley has said, I quite agree with him that the fear which a player has of being found anywhere with an instrument so flat that he cannot get up to pitch, has a great influence; this difficulty might be met if conductors would not always fasten on the sharper note and try to pull the others up to it. If conductors would say, "You are too sharp," instead of saying "You are too flat," we should very soon have got rid of a great part of the difficulty. I intended to have said when Dr. Bridge was here, and I will say it although he has gone—that only last week I was playing to his excellent conducting; a piano was brought very much too sharp, but he immediately ran up to the oboe-player and said, "You must get sharper; you are not following the piano." The man said, "I am up to the full pitch; I cannot get any sharper." He said, "I cannot go on unless you follow the piano."

The CHAIRMAN.—It is now our very pleasing duty to pass a vote of thanks, in which I am sure you will agree with me most cordially, to Dr. Stone for his very able and interesting lecture ; and I therefore beg to propose it.

The vote of thanks was carried unanimously.