PROCEEDINGS OF THE MUSICAL ASSOCIATION

Musical Association (Great Britain)

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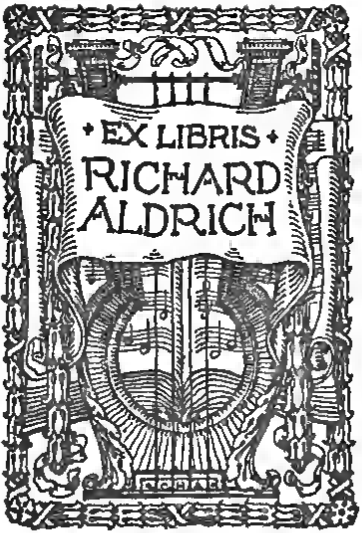

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PROCEEDINGS

OF THE

MUSICAL ASSOCIATION

FOR THE INVESTIGATION AND
DISCUSSION OF SUBJECTS CONNECTED WITH THE
ART AND SCIENCE OF MUSIC

FOUNDED MAY 29, 1874

SECOND SESSION, 1875-76

LONDON
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ERRATA

IN PROCEEDINGS OF FIRST SESSION, 1874–75.

Page 83, lines 41, 42, and 44, *for* Mr. Duncan *read* Prof. Donkin.
" " line 47, for *klang-tone* read *klang-tint*.
" 84, " 8, " *diatone* read *ditone*.
" " " 31, " origin of *read* Greek for.
" " " 33, " *tenos* read *phthongos*.
" " " 34, " interval *read* the note.
" 110, " 24, " 1818 *read* in the 18th century.
" " " 28, " Galhan *read* Galin.
" " " 36, " the book *read* a book.
" " " 37, " 1818 *read* 1864.
" " " 38, " Lund *read* Lunn.

CONTENTS.

RULES AND REGULATIONS

Passed at Two Special General Meetings of the Members, held at 27 Harley Street, W., on February 7 and April 3, 1876.

Objects and Constitution.

This Association is called the Musical Association, and is formed for the investigation and discussion of subjects connected with the Art, Science, and History of Music; and is intended to be similar in its organisation to existing Learned Societies.

It is not intended that the Association shall give concerts, or undertake any publications other than those of their own Proceedings, or the Papers read at their meetings.

Members.

The Association shall consist of practical and theoretical musicians, as well as those whose researches have been directed to the science of acoustics, the history of the art, or other kindred subjects.

Any person desirous of being admitted into the Association must be proposed by two members

Elections will take place by ballot of the members present at any of the ordinary meetings, and one adverse vote in four shall exclude

No newly-elected member shall be entitled to attend the meetings until the annual subscription be paid

Subscription.

The annual subscription to the Association is one guinea, which shall become due on the first of November in each year.

Should members desire to withdraw from the Association, they should give notice to the Hon. Sec on or before the 31st of October.

MEETINGS.

An ordinary meeting shall be held on the first Monday in every month, from November to June inclusive, at 5 P.M., when, after the dispatch of ordinary business, Papers will be read and discussed.

An annual general meeting of members only shall be held at 4 P.M. on the last Monday in October, to receive and deliberate on the Report of the Council, and to elect the Council and officers for the ensuing year.

Special general meetings may be summoned whenever the Council may consider it necessary, and they shall be at all times bound to do so on receiving a requisition in writing from five members, specifying the nature of the business to be transacted. At least one week's notice of such special meeting shall be given by circular to every member, and ten members present at any general meeting shall constitute a quorum.

Every member shall have the privilege of introducing one visitor at the ordinary meetings on writing the name in a book provided for that purpose, or sending a written order.

COMMUNICATIONS.

Papers proposed to be read at the meetings may treat of any subject connected with the Art, Science, or History of Music, Acoustics, and other kindred subjects.

Papers will be received from or through any member of the Association.

Experiments and performances may be introduced, when limited to the illustration of the Paper read.

All communications read will become thenceforth the property of the Association (unless there shall have been some previous arrangements to the contrary), and the Council may publish the same in any way and at any time they may think proper.

REPORTS.

A Report of the Proceedings of the Association, including the Papers read or abstracts of the same, and abstracts of the Discussions, shall be printed and distributed to the members as soon as possible after the end of each session.

This Report will be arranged and edited by the Honorary Secretary, under the direction of the Council.

COUNCIL AND OFFICERS.

The management of the affairs of the Association shall be vested in a Council, to be elected by ballot at the general meeting of the members on the last Monday in October.

The Council shall consist of a President, Vice-Presidents, and ten ordinary members of the Association.

The President, Vice-Presidents, Auditors, and five ordinary members of the Council shall retire every year, but shall be eligible for re-election.

At the annual general meeting in October, the Council shall present a balloting list, showing the names of the persons whom they propose for the offices of President, Vice-Presidents, and ordinary members of Council for the ensuing year. A copy of this list shall be given to each member present.

In voting, each member may erase any name or names from the balloting list, and may substitute the name or names of any other person or persons whom he considers eligible for each respective office; but the number of names on the list, after such erasure or substitution, must not exceed the number to be elected to the respective offices as above enumerated. Those lists which do not accord with these directions shall be rejected.

The Chairman of the meeting shall cause the balloting papers to be collected, and after they have been examined by himself and two scrutineers, to be appointed by the members, he shall report to the meeting the result of such examination, and shall then destroy the balloting papers. Auditors shall be appointed at the annual general meeting by the members, and the statement of accounts shall be sent by the Treasurer to the Auditors, and be remitted by them to the Secretary in time to enable the Council to judge of the prospects of the Association, and to prepare their report in accordance therewith.

The Council and officers shall meet as often as the business of the Association may require, and at every meeting three members of Council shall constitute a quorum.

ENACTMENT OR ALTERATION OF RULES AND REGULATIONS.

No rules and regulations can be enacted, altered, or rescinded, except at a special meeting of members summoned for the express purpose, the summons stating distinctly and fully the matter to be brought under consideration.

Musical Association

FOR THE INVESTIGATION AND DISCUSSION OF SUBJECTS CONNECTED WITH THE ART AND SCIENCE OF MUSIC.

FOUNDED MAY 29, 1874.

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REPORT

OF THE COMMITTEE,

Read by the Honorary Secretary, CHARLES K. SALAMAN, Esq., *at First Meeting of the Second Session, November* 1, 1875.

THE period has arrived when it becomes the duty of your Committee to present to you their first Annual Report, in connection with that of your Honorary Treasurer, whose statement will give you information as to the actual financial position of the Association. When it is remembered that the session just ended was the first of a newly-formed Association, novel in its objects as relating to musical art and science, and that it was devoid of those practically musical attractions hitherto considered to be inseparably associated with the idea of a Musical Society, your Committee venture to think that the success which has attended their efforts affords reasonable cause for congratulation. In the volume of Proceedings, lately issued, will be found the origin of the Association, its purposes, and its rules, together with a list of its members.

Notwithstanding the seemingly unfavourable circumstance that the Musical Association was founded as late as the 29th May 1874, that it was only on the 4th of August of the same year that it received its permanent title; that the arrangements for the first session then commenced, and that between that date and the first monthly meeting held in November, a long period had intervened, when most persons were absent from London, 150 original members had become enrolled when the operations of the Association began. During the session thirty-five members

were elected. The strength of the Association at the present moment is supposed to be 175 members. Your Committee have to deplore the death of three distinguished members: Mr. Richard Limpus (the late organist of St. Michael's, Cornhill, and Hon. Sec. of the College of Organists), Mr. J. Henry Griesbach, a respected musician of high repute, and a man of science; and lastly Sir Charles Wheatstone, F.R.S. Candidates for membership are seeking admission, and it is believed that as the objects of the Association become more widely known, application for membership will be greatly increased. Eight monthly meetings have been held at 27 Harley Street, on the first Monday of every month, from November 1874 to June 1875. Papers have been read and discussed at each meeting.

Your Committee desired to afford the members an opportunity to meet for conversation, and appointed the evening of Monday, June 28, with that view. Members were invited to contribute objects of interest with relation to music, such as rare music books, musical autographs and manuscripts, printed music, and ancient musical instruments. Some members responded to the invitation of the Committee, but not in sufficient numbers to justify them in again recommending a *Conversazione*.

To make the Musical Association a useful and a permanent institution, it is essential that the members shall take a special interest in it, and exert themselves to that end, by bringing it under the notice of musicians, both professional and non-professional, who might become useful members.

SESSIONAL ARRANGEMENTS

FOR 1875-76.

First Meeting—Monday, November 1, 1875.

Paper by CHARLES KENSINGTON SALAMAN, Esq., Hon. Mem. Acad. S. Cecilia, Rome, 'On Musical Criticism.'

Second Meeting—Monday, December 6, 1875

Paper by WILLIAM POLE, Esq., V.-P.R.S., Mus. Doc. Oxon., 'On the Graphic Method of Representing Musical Intervals. With Illustrations of the Construction of the Musical Scale.'

Third Meeting—Monday, January 3, 1876.

Paper by the Rev. Sir FREDERICK GORE OUSELEY, Bart., M.A., Mus. Doc. Oxon., Professor of the University of Oxford, President of the Association; 'Considerations on the History of Ecclesiastical Music of Western Europe.'

Fourth Meeting—Monday, February 7, 1876.

Paper by VICTOR DE PONTIGNY, Esq., 'On Kettledrums.'

Paper by Professor W. H. MONK, of King's College, 'On Some Points in the Received Method of Writing an Orchestral Score.'

Fifth Meeting—Monday, March 6, 1876.

Paper by Dr. W. H. STONE, F.R.C.P., M.A., 'On Standards of Musical Pitch.'

Sixth Meeting—Monday, April 3, 1876.

Paper by Lord RAYLEIGH, M.A., F.R.S., 'On our Perception of the Direction of a Source of Sound.'

Seventh Meeting—Monday, May 1, 1876.

Paper by Professor WILLIAM GRYLLS ADAMS, F.R.S., 'On the Musical Inventions and Discoveries of the late Sir Charles Wheatstone, F.R.S.'

Eighth Meeting—Monday, June 5, 1876.

Paper by Lennox Browne, Esq., F.R.C.S. Edin., Hon. Surgeon and Aural Surgeon to the Royal Society of Musicians, Surgeon to Her Majesty's Italian Opera, &c., 'On Medical Science in Relation to the Voice as a Musical Instrument.'

The Authors of the respective Papers are alone responsible for the opinions expressed in them, as well as for the correctness of the illustrations.

November 1, 1875.

Dr. WILLIAM POLE, Mus. Doc. Oxon., V.-P.R.S., in the Chair.

ON MUSICAL CRITICISM

By Charles Kensington Salaman, Esq., Hon. Mem. Acad. S. Cecilia, Rome.

Musical criticism is a subject which, I am of opinion, may be investigated and discussed with advantage by the members of the Musical Association. It is a field which may be thought delicate ground to tread upon. The atmosphere by which it is surrounded may be impregnated with explosive matter; but I am not dismayed from pursuing the inquiry I have proposed to myself. With the safety lamp of good faith and good temper, I believe that the ground may be traversed without any apprehension of danger.

Regarding music from an elevated point of view, I place before me a high standard of musical criticism. If it cannot be reached, the attempt to arrive at it may possibly lead to the improvement of some of its salient features.

Musical and literary criticism is subject to the same rules, and should be governed by the like principles. The boundary of the former is less limited, as it comprises the consideration of both musical composition and performance. The critic of music and the critic of literature owe similar duties to the public. The functions of the former are multifarious. To discharge them efficiently he should possess many and various qualifications, which are rarely met with in combination. The vocation of art and literary critic is one of importance and responsibility. When exercised with ability, justice, and earnestness, it is an honourable profession.

Musical criticism engaged the attention of many writers of antiquity known to the students of ancient musical history.

In Plutarch's* '*περι μουσικης*,' written about 1,800 years ago, I find the following specimen of ancient musical criticism:

* *On Music*, translated by J. H. Bromby (1822).

'By the ancients this art, with every other, was employed to the noblest purposes; but the moderns, ceasing to value those qualities in which its great excellence consists, have, in the room of what is manly, solemn, and divine, introduced into their theatres and public spectacles a feeble and frittered style. It is the which Plato, in the third book of his *Commonwealth*, condemns.' 'In the present day,' continues the ancient critic, 'so great is our degeneracy, that we have absolutely lost both the knowledge and the notion of that system by which youth were formerly trained up to honour and virtue. The only music now studied and listened to is that of the theatre.'

Aristoxenus, in his book entitled *Promiscuous Banquets*, quoted by Athenæus in 'οἱ Δειπνοσοφισταί,' more than 1,600 years ago, says:—'And so we also, since the theatres have become completely barbarised, and since music has been entirely ruined and vulgar, we being but a few, will recall to our minds, sitting by ourselves, what music *once* was.'*

Matthew Arnold considers that criticism is essentially the exercise of the quality of curiosity. He is of opinion that 'its business is simply to know the best that is known and thought in the world, and by, in its turn, making this known, to create a current of true and fresh ideas.' 'Its business,' he says, 'is to do this with inflexible honesty, with due ability; but its business is to do no more, and to leave alone all questions which will never fail to have due prominence given to them. Else criticism, besides being really false to its own nature, merely continues in the old rut which it has hitherto followed in this country, and will certainly miss the chance now given to it. For what is, at present, the bane of criticism in this country? It is that practical considerations cling to it and stifle it; it subserves interests not its own; our organs of criticism are organs of men and parties, having practical ends to serve, and with them those practical ends are the first thing, and the play of mind the second; so much play of mind as is compatible with the prosecution of those practical ends is all that is wanted.'†

The foregoing comments on literary criticism apply equally to musical criticism, of which I accept the late Dr. Crotch's definition: 'It is,' he says, 'the art of separating excellence from defect; of admiring as well as finding fault; of discriminating and comparing the several styles of music, of appreciating the relative value on principles which are generally true as applied to all the fine arts.'‡

Criticism is an art. Like other arts it must be acquired by long and patient study. The simple art of judging of what we see and hear is a natural operation of the mind, but an exact judgment must be formed upon recognised principles of criticism.

* *The Deipnosophists; or, Banquet of the Learned*, by Athenæus; translated by C. D. Yonge, book 14, chap. 31.

† *Essay on Criticism*, by Matthew Arnold.

‡ *Lectures by Dr. W. Crotch*, Prof. Mus. Univ. Oxon.

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'Refined taste,' according to Sir Joshua Reynolds, 'is the consequence of education and habit.'

The qualifications which the musical critic should possess are manifold. They include, *inter alia*, a comprehensive knowledge of every branch of musical art and its history, an extensive acquaintance with the music of all periods. He should be gifted with the æsthetic quality, and with the mental faculty of analysis, investigation, comparison, and discrimination. Addison requires in a good critic a clear and logical head. He instances Aristotle, who, he says, was 'not only the best critic, but one of the best logicians that ever appeared in the world'* Music and Logic, at first sight, may appear to have no affinity with each other. But as judgment will naturally follow critical examination, it must be evident that correct judgment can be arrived at only by those who have the capacity to think and reason justly. 'A true critic ought to dwell rather upon excellences than imperfections,' says Addison, 'and endeavour to discover the concealed beauties of a writer, and communicate to the world such things as are worth their observation.'

The musical critic should quickly perceive and appreciate novelty of thought: he should not condemn originality of idea because it may happen to be at variance with his preconceived notions and favourite theories. The Greek comic poet, Eupolis, who flourished about 435 years before the Christian era, says:—

> 'Music is a deep and subtle science,
> And always finding out some novelty
> For those who are capable of comprehending it.'

The critic should not forget that composers of Genius are the pioneers of art; their mission being to teach the world. It should be remembered, besides, that nearly every work of enduring fame was, at the first, welcomed with caution, suspicion, and distrust; that all innovators on established principles of art, from Timotheus to Wagner, have received an amount of censure which has risen almost to the dignity of abuse. The critic should bear in mind the unhappy fate of many illustrious inventors and discoverers. He should, like Lady Macbeth, 'feel the future in the instant' The critic should lead public opinion. If, in the exercise of his vocation, he display critical knowledge and honesty of purpose, public opinion will follow him; his criticisms will be respected and valued, and he will consummate one of his most essential obligations.

When he deems it to be his duty to point out error, and expose demerit, let him do it fearlessly and without hesitation. Let him use the critic's knife with effect; but while operating, let him cause as little pain as possible. Let him not dip his pen in gall. Let him avoid asperity of language, and abstain from personalities. The musical critic should freely and generously acknowledge merit; but he should be unsparing in his dispraise

* *The Spectator.*

of undue pretension; and he should unmask charlatanism, and every species of humbug. I would have my ideal critic, Bayard-like, *sans peur et sans reproche*.

'An indifferent poet may exert the art of criticism in a very high degree; and, if he cannot himself produce an original work, he may yet be of great service in regulating the happier genius of another.' If I substitute for the word Poet the term Musical Composer, I may adopt this opinion of the elder D'Israeli, who says, also, that 'the talent of judging may exist seperately from the power of execution.'* But the critic must be free from both predilection and prejudice, and must altogether eschew partisanship. He must be at liberty to express his critical opinions with entire freedom and independence. Now this condition of honest and independent musical criticism is precisely what even the most competent among musical critics, from force of circumstances, are not always able to fulfil. They are surrounded by influences so manifold that their power of action becomes crippled, their opinions become stifled, and their utterance impeded. Their comments are perceptibly not spontaneous, and the party to which they are attached is easily discernible. For be it known to all men that music has its parties—and very strong ones too—no less than politics. We have the musical Tory of the 'good old times;' we have the musical Conservative—pure and simple; we have the musical Liberal, the Conservative Liberal, and the Liberal Conservative; and, lastly, we have the musical advanced Liberal, who is the most ultra-liberal of all the musical politicians. To support his advanced musical opinions, he shows no liberality, no generosity, no mercy, neither to his predecessors, nor to his contemporaries, who presume to dissent from his musical creed.

The modern musical critic has to contend with persuasive external influences. There is the irresistible power of music publishers, proprietors, and editors of journals, managers of operas and concerts. There is also the insinuating sway of friendship. Indeed, the influences by which the modern musical critic is surrounded are so various and so numerous, that it would appear to be almost beyond the range of possibility that he should exercise his office without trenching upon some interest which it is not his interest to trench upon. I am alluding to able musical critics who, but for these influences, would, by the efficient practice of their profession, possibly fulfil all the conditions of musical criticism.

There are two classes of musical critics totally distinct, the competent and the incompetent. The uncultivated, incompetent critic exhibits his critical acumen by seeking for faults. He would appear to consider fault-finding as the beginning and end of criticism. The following fable in illustration:—An ancient critic, having collected all the faults of a famous Greek poet, presented them to Apollo. The god received them graciously, and, wishing to make him a suitable return for his labours, set

* *Curiosities of Literature*, by Isaac D'Israeli.

before him a sack of wheat, just thrashed out of the sheaf. He commanded the critic to pick out from the corn all the chaff, and to lay it aside. He entered upon his task with alacrity, and, having separated all the chaff from the wheat, was presented by Apollo with the chaff. The learned author of 'The Curiosities of Literature' writes of two pleaders: of one who knew more than he said, of another who said more than he knew. Here we have types of the competent and incompetent critic. The former, comprehending his art, and all its requirements and obligations, but, under influences, knowing more than he says: the latter, playing at musical criticism, so to speak, saying more than he knows, and thus attempting to veil his ignorance under a cloud of critical empiricism. Nothing is more easily learned than the use of conventional critical terms. Their wrong application deceives only the inexperienced. 'What,' says Dr. Crotch,* 'can we expect from the man whose sole qualification for being a critic is having an ear for music?' . . . 'This self-constituted critic may find his imagination fired by powerful effects, by pathetic expression; but the delicate refinements of taste escape him, and all that is scientific and learned is unregarded and despised.' Sir John Hawkins, writing a hundred years ago, says: 'The prevalence of a corrupt taste in music seems to be but the necessary result of that state of civil policy which enables, and that disposition which urges, men to assume the character of judges of what they do not understand.'

It is a recognised fact that there are those who assume the critic's office without any other qualification for it than a facility for writing, and some musical information, generally superficial and limited, gained by observation and by hearing music, and, possibly, by gathering the opinions of genuine musicians. These would-be critics possess no sound musical knowledge, and are led to judge of music and musicians by their individual tastes, which may by chance be good or bad. Their verdicts are not founded upon evidence, but they deliver them nevertheless with confidence. How often has a professional reputation been imperilled by an abuse of the critic's office! How often has a musical performance been commented upon by a critic who was not present at it! How often have proposed musical performances that were never held been minutely criticised! How often have elaborate criticisms been written upon the authority of a programme! If musical criticism is to be held in esteem, and the critic respected, these glaring irregularities must wholly cease.

There are, happily, in this country and on the Continent, most able musical critics; men of education and taste, accomplished musicians, elegant writers, with every qualification to enable them to discharge the responsible duties of their office with mutual benefit to music, to musicians, and to the public. It would be invidious to name them, but I have them 'in my mind's eye.'

* *Dr. Crotch's Lectures.*

If, in the more important matters of religion and politics, we find such a diversity of irreconcilable opinions, we cannot be surprised that, in matters of taste, the most opposite views of the musical art should prevail among critics. It may be asked, and not for the first time, 'Who shall decide when doctors disagree?' Let a doctor reply! 'The opinions of acknowledged critics,' writes Dr. Crotch,* 'accumulate in time, and are compacted into a mass that irresistibly bears down before it all the opposition of false taste and ignorance.' Until that golden age of criticism shall arrive we must fold our hands and look on with patience and resignation.

It will be conceded, I think, by none more than the critics themselves, that, as actually practised, musical criticism is more a counterfeit than a reality. I have heard it stated by an accomplished musical critic, that there is no such thing as musical criticism. In a certain sense there is doubtless some ground for the statement. Musical criticism is, however, not a myth; it is an acknowledged fact. This leads me to inquire, what is its practical use? Its chief aim should be to educate public taste in musical matters, 'to create a current of true and fresh ideas.' Another practical use is to draw public attention to the productions and performances of musicians. Without this attracting agency, many a meritorious musical work might be—

> 'Born to blush unseen,
> And waste its sweetness on the desert air.'

Regarding thus its practical use, I hold criticism to be the light and life of art and literature. Milton's sublime epic was comparatively unknown, and all but dead to the general public, until Addison's brilliant criticisms brought it once more into notice, and, as it were, quickened it into life. Many of the inimitable beauties of Shakespeare, but for his innumerable critics, might have remained longer unrecognised. Few persons have the experience, the confidence, the courage, the ability to form, unaided, independent opinions, and to express them. The general public, as a rule, had they even the power to judge, would not give themselves the trouble to think on matters relating to art. They are led by 'The Press;' they pin their faith upon what 'the papers say.' A very distinguished public man once said to me in jest, 'The fact is, I have no opinions until I have read my *Times*.' Great is the responsibility of those who mislead public opinion!

It may be alleged that no great musical works are now produced worthy to engage the pen of an accomplished critic. Works of a high class do now and then appear in this country and abroad, which, if they do not bear the Hall-mark of genius and the stamp of entire originality, are, nevertheless, compositions of considerable merit. These works receive, I presume, the attentive and conscientious considerations of musical critics. No pecuniary encouragement awaits the composer of music of a very

* *Dr. Crotch's Lectures.*

superior character. We are living in a utilitarian, not an artistic or poetic age. This is the 'golden age' of royalties and advertisements! A musical composition, to be recognised by a music publisher as a work of high merit, must possess the inestimable quality of immediate sale. This, from a publisher's point of view, is, no doubt, financially correct. His mission is to sell music, not to advance art. But what about the present and future of music? What about the music producer? Be it remembered that music was not bestowed upon us for mere amusement—not for petty objects—least of all for the sole benefit of music publishers and theatrical managers. It was a divine gift, for high moral purposes; for the delight, the solace, the civilisation of mankind. Every encouragement should be given to the development of these high objects. To point out this to the unreflecting, to dwell upon the fact, to keep it in view, to urge its unanimous recognition, might well be included among the manifold duties and obligations of the musical critic.

From the dignity of a profession, music appears to be fast descending to a trade. Is it not a duty incumbent upon the musical critic to arrest, as he undoubtedly might, this downward course? Notwithstanding the increased cultivation of music, the study of which, generally speaking, is more superficial than solid, the multiplicity of musical academies and colleges, training schools for music, choral classes, and the endless opportunities to hear fine musical performances on easy terms, and every kind of music, from the sentimental ballad of the Christy Minstrel, to the almost perfect orchestra of the Crystal Palace, there is no appreciable improvement in the public taste for 'high art' in music. I am aware that the designation 'public' is one of wide significance; that it embraces, if I may be allowed the expression, 'many publics.' I speak of the public as a whole. Undeniable testimony in confirmation of my assertion might be furnished by the ledgers of music publishers.

The earnest, accomplished musical critic should not confine his literary labours to the criticism of the music of the present time only, or even to that of a comparatively recent date. In these days of literary and musical research, inquiry, and investigation, it would be desirable, as both interesting and instructive, to stimulate curiosity to have a nearer acquaintance with the great Italian masters of the sixteenth, seventeenth, and eighteenth centuries. How few musicians know more than the names of Palestrina, Carissimi, Cesti, Leonardo Leo, Alessandro Scarlatti, Jomelli, Clari, Galuppi, and other learned composers of Italy, too numerous to mention? Rich mines of ancient Italian music remain almost unexplored. Musical critics of ability should enter the musical catacombs of Italy, and disentomb their buried treasures, and comment upon them; and show modern composers of all countries how they may refresh their musical faculties by an occasional draft from those pure sources. Then, of our own great musicians and their works—the illustrious Church

composers of the sixteenth, seventeenth, and eighteenth centuries —how little is known! Here, also, is a vast field for exploration, a glorious opening for musical research and criticism. I shall be reminded that many of these immortal productions have already been criticised by musicians of a by-gone period. I shall not stop to question the estimate which Burney and the critics of his day put upon the music and musicians with which and with whom they were acquainted. They judged by the light of their experience, which, compared with that which has been since acquired, was very limited. The compositions of the ancient masters of Italy and England will again bear critical examination by the light of modern musical science.

Let the critic of music emulate the critic of literature! See how he turns and returns to the writers of antiquity for themes for his critical pen! Will Homer and Horace ever cease to furnish employment to literary critics? Will Shakspeare? Will Dante? Will Schiller and Goethe? In like manner might musical critics be engaged! Then would the area of musical literature be enlarged; then would musical knowledge be diffused; then would the musical critic's vocation be honoured!

A few comments upon the criticism of musical performance will suffice. In this department of musical criticism we might well expect to find a more than ordinary diversity of opinion. Technical knowledge and long experience are necessary to those who would attempt to guide public opinion in its estimate of its executive merit. I have often marvelled at hearing what I have considered very inferior musical performances enthusiastically applauded, and warmly commended by musical critics. Indiscriminate applause and undeserved commendation tend to bring the critic's office into disrepute, and to render all applause and all commendation worthless. If musical criticism is to be of any practical utility, the critic must perform his task, albeit an unpleasant one, fearlessly. A delicate duty should be delicately performed; the critic owes it to the public. I shall, perhaps, be told that we are not living in Utopia, and that, as the world is constituted, a state of ideal perfection in musical criticism is not to be attained more than in the ordinary affairs of life.

In the *Monthly Musical Magazine*, commenced in 1818 and ended in 1828, are to be found some very excellent specimens of musical criticism. The *Harmonicon*, a once popular musical journal, whose existence terminated about forty years ago, contains also some critical articles of great interest and worth. The late George Hogarth and Henry Chorley were amongst the best modern musical critics. The former, an accomplished musical historian, as well as an acute critic, added to the stock of criticism by his well-expressed opinions, based upon sound musical knowledge and experience. The latter writer, eccentric in his views and in his mode of expressing them, was more generally correct than incorrect in his estimate of musical talent. Berlioz, in France, and the elder Fétis, in Belgium, have left rich legacies in musical criticism, although the accuracy of some of their musical

judgments is open to question The *Gesammelte Schriften über Musik und Musiker, von Robert Schumann*, published in two volumes, is a valuable contribution to musical criticism. That gifted composer and admirable writer evinced an appreciation of the late Sterndale Bennett's compositions, no less creditable to the German musician and critic than to the English musician he so generously and so ably judged.

This leads me to refer to the unpardonable ignorance displayed by the Germans on the subject of English Music and Musicians. They ignore the immortal compositions of our great Church composers; of our madrigal and glee writers; and they seek no acquaintance with the music which British composers have produced during the past half century. This is certainly discreditable to the German musician who assumes to have a comprehensive knowledge of music and its history The musicians of Germany are now occupied only with themselves By their writings and their performances they are striving to force into undue prominence the compositions of the modern German, or the so-called 'higher development,' school of music. German musicians of advanced opinions already regard as effete the glorious works of their most renowned masters. There are some musical advanced liberals who would even presume forsooth to lay their sacrilegious hands upon Beethoven's scores, with a view to their improvement.

Doubtless, the well-known epitaph upon Shakspeare's tomb, in the church at Stratford-upon-Avon, is yet in the memory of my auditors. It is this—

> 'Blest be the man who spares these stones,
> And curs'd be he who moves my bones.'

Might not the *spirit* of Shakspeare's epitaph, if not its words, be aptly applied in these meddlesome times to Beethoven's scores? Forty-five years ago Mendelssohn wrote: 'Certainly Germany is a strange land, producing great people, but not appreciating them' 'When a German like Beethoven writes an opera, then comes a German like Stuntz or Poissl, and strikes out a *ritournelle*, another German adds a trombone part to his symphonies, a third declares that Beethoven is overloaded: and thus is a great man sacrificed.'* We may, I think, congratulate ourselves that there is yet in existence a strong musical conservative opposition.

The taste for musical ugliness appears to be gaining ground rapidly amongst a certain section of modern German musicians. I judge so by the enthusiastic admiration I hear expressed for music whose discordant effects—*defects* would be a more apt expression—are simply hideous No amount of novelty, no new harmonic combinations, no ingenious instrumental contrivances, no increase of orchestral noise, can compensate for the absence of musical ideas, pure melody, musical elegance and grace, and

* *Mendelssohn's Letters*, 1st Series.

masterly symmetrical construction. Nothing is impossible! Musicians in general may, in the course of time, learn to discover beauty as well as sublimity in ugliness. Whether in music or in personal appearance, ugliness is, no doubt, an acquired taste, like the taste for tobacco, and similar nauseous appetites.

We have able musical critics, who advocate and uphold many of the wild musical doctrines and theories of modern German musicians of advanced opinions. We have others of at least equal ability who persistently oppose and utterly condemn them.

The controversies of art critics should not be discouraged, for benefit to art and artists may accrue therefrom, and in the end right principles generally prevail.

In bringing the subject of musical criticism to your notice, my aim has been to draw forth opinions. 'By discussion truth is elicited' I trust that the correctness of this ancient Oriental aphorism may be exemplified by actual experience.

DISCUSSION.

Mr Arthur Coleridge said he had been very much interested with Mr. Salaman's paper; but wished to say a few words in defence of the Germans, whom he thought Mr Salaman had been rather hard upon He did not say this without some little experience, having only recently returned from spending three weeks in Leipsic. He there found that great interest was now being taken by Germans in the English composers. Mr. Sullivan's works were carefully watched for and examined, and the meeting would be glad to hear that at Hamburgh some of the best English madrigals were being now reprinted, and practised by some of the leading societies.

Mr. Osborne had always thought it would be a very great advantage to this country if they could have as music publishers gentlemen who understood music, but he found that was not always the case. He thought the sun of music had really dawned in this country, when some years since a first-rate musician, no longer living, became a music publisher. He congratulated his friend, and told him he had no doubt in a short time he would be receiving a considerable number of oratorios, symphonies, and other first-class works. His friend replied that he did not propose being a publisher in order to ruin himself. On looking over his catalogue after two or three years, he found that there was very little in it to show any support given to those men who wrote such works as they all wished to see published. But what could a publisher do? He could not spend his money for the purpose of educating the public. He really thought it would be a very good thing for musical critics to open the books which

had been written upon the great men of days gone by, to bring their merits prominently forward, so that there might be an inducement for young composers to follow in their footsteps.

Major Crawford said it was quite correct, as Mr. Salaman had stated, that English music and musicians were by no means so well known on the Continent as they ought to be. To some extent, however, that was our own fault, because we ourselves had not taken care of our great men. If we wanted to know anything about a Continental composer, there were plenty of works to give us minute information. We could find all the particulars of his life from the cradle to the grave, and probably at the end of the biography a carefully digested catalogue of his works. But if we wished to know anything about an English composer, it was very difficult to get the information. With regard to the great Church composers, everyone referred to the pages of Sir John Hawkins, and almost all later biographies were condensed from him, with very probably several errors added. It would be well, therefore, to begin at home, and record the facts and incidents of our own composers' lives, and then the public would have the proper materials placed before it.

Dr. W. H. Stone was happy to say that, although at present there was no such work as the last speaker had referred to, there would be in a short time, as one was being brought out under the auspices of a Vice-President of the Society, Mr George Grove. It had been a very laborious work to organise, but it was now in progress, and a part was in the press. The difficulty of getting up such a work in an efficient and liberal way was very great. In the first place there was the difficulty of securing writers who would not be biassed, and then that of persuading them to write, which was still greater. With regard to the very able and sensible paper of Mr Salaman, it must be remembered that in musical criticism was included not only music, but criticism, the latter being at all times hard to get fairly and equally done. It was always open to the sneer, to some extent a true one, propounded by the present Premier in his recent novel, that critics were the men who had failed. If you did not want men who had failed, but successful men, it was all but impossible to find those who were at once competent and unbiassed. Indeed, there was not work enough, even on a large paper, to occupy the whole time of a musical critic; it must to a certain extent be delegated to handy men, so to say; in consequence, it was often done in a very perfunctory manner. There were excellent musicians, musical critics to leading papers; at the present time one at least was really a very learned musician, also editor of a musical paper, besides acting as musical critic to one of the largest and best daily journals. He was perfectly fair and unbiassed; no mercantile considerations could be said to interfere with what appeared either in the paper which he himself conducted or in the journal with which he was connected. On the other hand, critics could be named who, although sensible

literary men, knowing how to write a very pretty article, able to put words together, were quite unable to dissect musical notes. Such men were in the habit of going about to concerts and picking up information in the best way they could on musical matters. Any gentleman who had been so 'drawn,' to use a common expression, would perhaps be astonished the next morning to find in a daily paper, very nicely put together, the exact opinions which he had expressed the evening before; sometimes it was most interesting to read the articles thus concocted. On the other hand, in order to have good musical criticism, you must presuppose the gift of good writing, and musicians were not always endowed with this faculty. For these opposite reasons, many musical criticisms were as good as could be expected under the circumstances, any defects which were observed deserved one's pity rather than indignation. There were, however, other classes of critics, of whom he could not speak so kindly. First of all, there was what he should call the 'Musical Fluhhertigibbet,' who went dancing into a concert room and laying down the law in a most flippant tone. For instance, there was a paper which, to avoid naming, he might designate as the 'Dancing Barber,' the musical critic of which seemed to come prepared to settle everything and everybody in and out of the art with a flourish of his pen, he being at the same time perfectly ignorant of anything connected with it. He even criticised first-rate performers in the most uncalled for and unjust fashion. In such cases, the only proper thing to do was to throw the paper in the fire and give orders to your bookseller not to send it any more. Then there was another class of critics who did not deserve much greater sympathy, whom he might designate as the 'Hog in Armour' critics. This kind of gentleman wanted everything exactly as it was fifty years ago: everything was wrong except that to which he appended his own particular stamp. He seemed to write as if he were really out of temper at having to criticise such rubbish. He put himself in a false position altogether, and destroyed *a priori* the first idea of criticism, which should be impartiality. Quite recently a criticism of their own good-natured and well-intended Association had appeared something after this fashion, in which, from the first line to the last, it was perfectly obvious that the critic was out of temper with them. This kind of critic, shielded in the anonymous impenetrability of his hide, only showed the more plainly the swinishness of his nature. To all such criticism they should show no mercy, but should endeavour to prove that they had a spirit which could rise above all comments either flippant or ill-tempered. Where they had simply to chronicle mistakes made by persons who really could not avoid them, having perhaps been employed for a year or two as musical critics and then sent abroad to chronicle political movements in Paris, a little forbearance might be exercised, since it was obviously unreasonable to expect persons so situated always to produce

first-rate criticism. If a blow could be struck at dishonest, churnish, ill-natured, or culpably incompetent criticism, it would no doubt be a good thing for music and musicians generally.

Mr. Lennox Browne would like to draw attention to something which might be done in the way of remedying unfair, biassed, and venal criticism. He had hoped that Mr. Salaman would have endeavoured to suggest some remedy by which the criticism of paintings, theatres, and everything else might be made more unbiassed. He thought one reason why criticism was so defective was that they were living now in so much smaller a world than was formerly the case, because everybody seemed to know Jones on the *Times*, Smith on the *Standard*, and Robinson on the *Telegraph*. It appeared to him that it would be preferable if the proprietors of journals took a more independent tone by paying for the seats of their critics. If critics were allowed to shield themselves behind their anonymity, he believed their criticisms would be more impartial.

Mr. Charles Mackeson said he had heard so much which was to a great extent adverse to the critics, that, as he enjoyed the pleasure of the friendship of no small number of them, he might be allowed a few words—not in defence, for he did not think they needed it—but in explanation of some of the anomalies which had been spoken of. He took it that Mr. Salaman spoke from the standpoint of a professional musician, and, as such, critics would be very glad to hear what such an authority had to say. But at the same time critics might retort—at any rate those who had the conduct of musical journals entrusted to them—that the professional musician was perhaps a little to blame for the somewhat low standard of the musical journalism of this country. He knew from personal experience the trouble there was to get professional musicians to take up and support musical papers. Probably their retort would be that of Mr. Salaman's, that there were not on the staff of such journals men of the highest ability, and therefore musicians could not be expected to support these papers. It seemed to him, however, that this was a very poor excuse, and that the true way to raise the standard of musical journalism in England would be for professional musicians to give these papers the benefit of their opinions and of their knowledge, and if the critics engaged upon them needed setting right, to take the earliest possible opportunity of doing so. He regretted to have noticed the somewhat personal tone of Dr. Stone's remarks, because, if individual cases were to be given, it would have been as well to point out a few of the good specimens of musical criticism. He did read some rubbish, no doubt, but at the same time he read a good deal of musical criticism which was fully up to the standard of the literary criticism of the present day. In some quarters he had been met by sound criticism of a very high order, and he could not help thinking that it was simply from lack of demand that there was not more. If high-class musical criticism, including analyses of different movements of

symphonies and sonatas, were to be given in the columns of the daily newspapers, how many readers would care for it? Before such a thing could be expected, it would be necessary to provide for increased musical culture amongst the people, and if he might offer a suggestion, it would be that musical professors who had hold of the present rising generation should impart to them some of their own taste for the higher things of the art, and thus he believed they would create a demand for that which he was quite sure newspaper proprietors would be perfectly ready to supply. While he agreed with much that Mr. Salaman had said, he was not displeased that the present generation did not point back to Burney and other old writers, as if they over-topped everything in the present day. He confessed he had more pleasure in reading some modern articles than in turning to those musty old authors. No doubt the present generation lacked their erudition and historical knowledge, but at the same time they had a real practical acquaintance with music, and that bright style of writing without which there never would be any readers. All these things were increasing, and if the musical culture of the people were advanced, would go on increasing still more. One of the great difficulties which conductors of newspapers had, was that which a late editor of the *Saturday Review* pointed out. He said that he tried to get an able staff of critics on almost every conceivable subject, and he succeeded in almost every one except music. There, however, though he could get very intelligent musicians, and some of the highest professors and composers were critics as well, he always found a difficulty in obtaining the highest musical knowledge combined with the gift of literary ability—not that they could not write, but they were not practised journalists. The combination desired was a man who had been trained professionally as a musician, and who was also trained professionally as a journalist. When such a man was found, no doubt he would be appreciated. He thought he knew one or two gentlemen who would, before long, be able to take such a position, and possibly the Musical Association itself might be able to develop something like a musical journal, conducted on such principles as men of this stamp would approve.

Mr. Salaman, in reply to Mr. Coleridge, said that the remarks he had ventured to make on the indifference observed by German musicians with respect to English music, and their unacquaintance with the works of our past great composers, were based upon a very long experience, acquired not alone in this country but in Germany. He was pleased to learn from Mr. Coleridge that the Germans are at length beginning to take an interest in the subject, and that they are desirous of extending their knowledge of English music. Mr. Salaman would remind Mr. Mackeson that he had borne testimony to the undoubted fact that there are in this country, as well as on the Continent, many thoroughly able musical critics—musicians of education and taste—who, being at the same time elegant writers, perform their

honourable vocation with efficiency, impartiality, and justice. On the other hand, it cannot be denied that there are gentlemen who presume to exercise the profession of musical critic, without possessing the necessary qualifications to fit them for the delicate and responsible duty. In selecting for his discourse the theme of musical criticism, Mr Salaman's object was to endeavour to elicit opinions which might tend to its improvement.

December 6, 1875

R. H. M. BOSANQUET, Esq., M.A., F.R.A.S., F.C.S., Fellow of St. John's Coll., Oxon., in the Chair.

ON THE GRAPHIC METHOD OF REPRESENTING MUSICAL INTERVALS. WITH ILLUSTRATIONS OF THE CONSTRUCTION OF THE MUSICAL SCALE.

By William Pole, Esq., V.-P.R.S., Mus. Doc. Oxon.

The object of this paper is to explain a method of representing Musical Intervals, which is very useful in the higher class of musical investigations, from the easy and definite manner in which it enables relations, usually considered complex and obscure, to be presented to the mind.

If we think a little, we shall find that we have a natural tendency to compare the positions of musical notes with positions in space. It is not clear that there is any real physical or physiological connection between the two things, but it is certain that the idea of such a connection has, somehow or other, become implanted in our minds.

For example, we call a note with very rapid vibrations a *high* note, and one with slow vibrations a *low* note; clearly referring them to comparative positions in space. I do not know whether it has ever occurred to you, that these expressions, high and low, are purely arbitrary and conventional; there is no natural justification for them, but they have existed almost ever since music took a definite form, and they clearly illustrate the analogy I am speaking of.

Now further, if a rapid-vibration note is called high, and a slow-vibration one is called low, it follows that the *musical idea of distance*, or what we call the musical *interval*, between the two notes may be considered as having an analogy, in our minds, with the *interval in space* between the high position and the low one. And we can easily imagine that if the musical distance between the two notes is greater, it may be represented by a greater interval of space, and *vice versâ*.

In other words, it is possible, and consistent with ideas already existing in our minds, that representations of musical intervals should be made for the *eye*, so as to convey ideas of

comparative magnitude precisely analogous to the impression which these intervals make on the *ear*.

This I call the GRAPHIC method of representing intervals; and my object now is to show how this mode of representation may be reduced to rule and system, and put in a practical shape for use.

I shall have, by-and-by, to give you an illustration of the system in the graphic representation of the musical Scale, and I may at once remind you that the idea of such a representation is embodied in the very word itself; for our term *Scale* is derived from the Latin *Scala*, which means a ladder or staircase; and this, of course, implies that the intervals of *space* between the various steps of a ladder have been considered, from very remote antiquity, as corresponding with the *musical* intervals between the various notes of the scale.

Mr. Hullah has long ago given a practical form to this idea, by using the symbol of a ladder in some of his elementary books, to represent the diatonic major scale; and there is a point in his diagram which specially bears on my present subject, namely, that he has made the intervals between the third and fourth, and between the seventh and eighth steps of his ladder, only half the length of the other degrees, thereby expressing, in a graphic mode, the distinction in magnitude between the whole tones and the semitones. This is really the germ of what I am now going to show you. All I profess to do is to establish the mode of representation on more definite principles, and give it more capability and more accuracy.

Suppose we were to attempt to lay down two distances on paper, representing two intervals of different magnitudes. On the principle of *equal temperament*, this would be very easy; for as every interval is assumed to consist of a certain number of semitones, we should only have to take a certain unit of length, say one inch, to represent a semitone, and we should have—

An octave . . .	12	inches long.
A fifth . . .	7	" "
A fourth . . .	5	" "
A major third . . .	4	" "
A minor third . . .	3	" "
A whole tone . . .	2	" "

and so on.

But now suppose we want to go more accurately into the harmonic relations, by representing the magnitudes of *true* intervals, or intervals perfectly in tune—how should we set about this? Or, indeed, since it is not at all necessary to the philosophical definition of an interval that it should be in tune, or should be of any particular magnitude whatever, let us ask the more comprehensive question, What guide or rule have we for the graphic representation of an interval generally?

The problem then is, Given any two musical sounds, by what rule shall we find a distance in space representing the interval between them?

The first thing is to define accurately, in some scientific way, the *positions of the notes*; and the simplest way of doing this is, by their vibration-numbers.

Suppose, for example, that the upper note is one to 200, and the lower one to 100 vibrations per second, the musical interval being, as we know, an octave. Then, the difference between these being 100, it would be very natural to say, 'Let us take any space represented by 100 inches, or 100 equal parts of any sort, and this shall represent the octave interval between those two sounds.'

But the simplest mode of procedure is not always the right one; and that is the case here, as can easily be shown. Let us try, on the same plan, the interval between two other notes, of 200 and 400 vibrations respectively, which, as you know, will also be an interval of an octave. Here the difference will be 200; so that if we measure by the number of vibrations, we get two different values for the same interval, in different parts of the scale.

Of course this will not do, the same interval conveys the same musical idea of distance, wherever it be taken, and therefore any rule which is to determine its representation by space, must give, under all circumstances, the same value.

There is such a rule, but it involves a hard word; as it requires the use of what mathematicians call *logarithms*. But the difficulty is more in the name than in the reality, for although the theoretical nature and construction of logarithms require somewhat high science to understand, yet fortunately the practical *use* of them (which is all we have to do with here) is extremely easy—as easy, in fact, as a child's sum in arithmetic.

There are published what are called 'tables of logarithms,' by which the logarithm for any number may be found by simple inspection, and with the aid of these the rule for representing the exact magnitude of any interval becomes very simple:

> *Find in the table, first, the logarithm corresponding to the vibration number of the upper note, and then that for the lower note. Subtract the latter logarithm from the former, and the remainder will be a number which will correctly represent the interval desired.*

To show you how easy this is, I will apply it to the two cases above named. I may say that the published tables give the logarithms in several figures—five, six, seven, or more; but it is only the left-hand ones that are of importance for our purpose. The right-hand ones are of very small significance; and if we take enough from the left hand to give the required interval in three figures, it will be sufficiently accurate.

The first case was for notes having the vibration numbers 200 and 100 respectively:

The logarithm of 200 is found by the table to be*	2,301
The logarithm of 100 is	2,000
Hence the interval of an octave is expressed by the number	301

The second case is for the numbers 400 and 200:	
Logarithm of 400	2,602
Logarithm of 200	2,301
Interval of the octave as before	301

Take another example, say from middle C, of 264 vibrations to the G above, which has 396:

Logarithm of 396	2,598
Logarithm of 264	2,422
Hence the interval of a fifth will be expressed by the number	176

This is the general rule.

But for *ordinary* intervals, we may further simplify the operation. For instead of taking the vibration numbers of the two notes, we may simply take the two numbers forming what is called the *ratio* of the interval.

As a further example of this, I will now not only calculate the value of some of the best known intervals, but I will proceed to give them actual dimensions before your eyes on this sheet of paper.

For the Octave.

Ratio 2 to 1.

Logarithm of 2	301
Logarithm of 1	000
Interval of the octave	301

For the Fifth

Ratio 3 to 2.

Logarithm of 3	477
Logarithm of 2	301
Interval of the fifth	176

* The operator must recollect the usual rule, to put *before* the number found in the table, another number, being one less than the number of figures in the vibration number.

For the Fourth.

Ratio 4 to 3.

Logarithm of 4	602
Logarithm of 3	477
Interval of the fourth	125

For the Major Third.

Ratio 5 to 4.

Logarithm of 5	699
Logarithm of 4	602
Interval of the major third	97

For the Minor Third.

Ratio 6 to 5.

Logarithm of 6	778
Logarithm of 5	699
Interval of the minor third	79

For the Major Sixth.

Ratio 5 to 3.

Logarithm of 5	699
Logarithm of 3	477
Interval of a major sixth	222

For the Minor Sixth.

Ratio 8 to 5.

Logarithm of 8	903
Logarithm of 5	699
Interval of a minor sixth	204

And so on for any intervals whatever, no matter whether consonant or dissonant, or even whether they belong to the scale at all. If we only can identify the two sounds, we get by this simple process an accurate representation of the interval between them, in a way far exceeding any other method in intelligibility and practical clearness.

You may now see for yourselves how admirably these results correspond with the musician's ordinary practical notions of things.

For example, add some of the intervals together:

A fifth	176
Added to a fourth	125
Make an octave	301
A major sixth	222
Added to a minor third . .	79
Make an octave	301
A minor sixth	204
Added to a major third . .	97
Make an octave	301
A major third	97
Added to a minor third . .	79
Make a fifth	176
A fourth	125
Added to a major third . .	97
Make a major sixth . . .	222

And so on; these determinations representing most accurately the idea of the magnitudes of the various intervals, as we are accustomed to know them by their relations in practical harmony.

(*The above remarks were illustrated by diagrams.*)

Illustration of the Construction of the Musical Scale.

I propose now to give you a more extended practical example of the graphic method of representing intervals, by applying it to the construction of the modern musical scale, which I shall effect before your eyes.

I have already alluded to Mr Hullah's ladder. I am going to make a similar diagram, only I shall endeavour to do it more accurately, by giving to each of the steps the exact and proper length it ought to have. I shall draw it also to a pretty large size, so that the minute shades of difference may be made very distinct to your apprehension.

Now, settling the exact notes of the scale is not quite so easy a matter as is generally supposed. I avoid at present all reference to the scale of keyed instruments; we may take it for granted that they, however well tuned, only give an approximation

to correctness. If an accomplished vocalist or a violinist were asked to sound the scale, we should probably get it nearer; but we want now positive definition and absolute correctness.

The first thing, therefore, we have to do is to settle some *principle* on which we must proceed; and after a good deal of consideration, the only one that seems to me to be trustworthy for our modern music is,

That every note of the scale must have some definite HARMONIC RELATION *to some* OTHER *note*

This would seem obvious enough; but, as I shall show you hereafter, it leads to some points of controversy, and has been dissented from by good practical authorities. I must, however, adopt it here, as I do not see on what other principle we could construct a scale of true intonation.

The next question is, *What* harmonic relations shall we make use of in forming the scale? Omitting the octave, which we may consider as a duplicate of the key-note itself, we only require two, namely, the two which are given by nature in almost all musical sounds; which were taken by Rameau, the founder of the modern theory of harmony, as his basis; and which have formed ever since the first elements of harmonic science. These are the *fifth*, and the *major third* forming the triad, or common chord. With these we can do all that is necessary to form, not only the diatonic scale, but all the accidentals adjoining.

Thus, taking C as the key-note,

A fifth	above	C	gives	. .	G
A major third	„	C	„	. .	E
A fifth	„	G	„	. .	*D*
A major third	„	G	„	. .	B
A fifth	below	C	„	. .	F
A major third	above	F	„	. .	A

(*The whole of these determinations were illustrated by diagrams.* *)

We have thus got the whole of the *Diatonic Major Scale*; and we shall find, for the most part, the harmonic relations between its several notes well preserved.

But in some cases this is not so. For example, the interval,

D — A

is found not to be a true fifth; the A being one fifth of a semitone too flat.

If we were to alter the A by making it a true fifth to D, we

* Diagrams of a similar nature, contributed by the author of this paper, will be found in an appendix to Sir F. A. G. Ouseley's *Treatise on Harmony*. Although our modern musical scale may be taken to be constructed on harmonic principles as here laid down, yet it must not be forgotten that a scale very similar was in use for centuries before what we now call *harmony* had any practical existence. The origin of this ancient melodic series of notes involves some very interesting but abstruse speculations, which it would be impossible to introduce here.

should put it out of tune for the subdominant chord F A C. If, on the other hand, we altered the D, we should spoil the chord of the dominant, G B D; and as both these chords are of such importance to the harmonies belonging to the key, it is better to retain them pure, leaving the error in the less important fifth D A.

We shall also find that from D to F is not a true minor third. To remedy this we must either sharpen the F, which will spoil the subdominant fifth F C, or we must flatten the D, which will spoil the dominant fifth G D. But both these are so important, that they must remain true, and hence we must put up with a bad minor triad on the second of the scale: bad in two ways, both its third and fifth being wrong.

Before we go further, a remark or two on this imperfection present themselves.

In the first place it gives good evidence, to my mind at least, that the diatonic scale is a conventional and artificial series of notes, and not, as many people suppose, one dictated by any natural, physical, or physiological laws. If it had been so, it might have been expected to be perfect; whereas it is essentially imperfect, by its very nature and construction. We are so much accustomed to it, that we are apt to think that it is the true natural foundation of musical melody. But there are many facts which oppose this idea, and this is one of them. It is true that it lends itself easily to certain naturally harmonious and pleasant combinations; and this is, I believe, all that can be said in favour of such a view.

Secondly, in these out-of-tune relations between D, F, and A, we come upon the first and simplest of the difficulties in the way of getting what is called *just* or *true intonation* on keyed instruments. It is clear that no instrument with seven notes in the diatonic scale can be always in tune for that scale. We want other notes in addition, namely, alternatives for D, F, and A. We shall find other difficulties develop themselves as we proceed.

I will now go on to put in some of the notes called *accidentals*—sharps and flats.

Although these do not belong to the key in which we have been working, yet, as we must determine on some way of defining their places, the rule before adopted will still hold good; they must have harmonic relations with some of the notes in the diatonic scale. And, as we shall see, the same simple relations will suffice; in fact, with the major third, we can do all that is necessary.

For the Sharps.

A major third above	D	gives	F♯
,,	,,	A	,,	C♯
,,	,,	E	,,	G♯
,,	,,	B	,,	D♯
,,	,,	F♯	,,	A♯

For the Flats.

A major third below	D	gives	$B\flat$
"	"	G	"	$E\flat$
"	"	C	"	$A\flat$
"	"	F	"	$D\flat$
"	"	$B\flat$	"	$G\flat$

and we might go further in each case, if desired.

We have, however, in the above list got all the most common chromatic notes; but I am bound here, in candour and fairness, to mention an objection that has been raised to the accuracy of these determinations.

The diagrams will show that, comparing the two accidentals $C\sharp$ and $D\flat$, or $G\sharp$ and $A\flat$, the *flat* note is much the *higher* of the two. Now, if there is any violin player present, he will at once say that this is contrary to what he has been taught, and what he practises. It is, I believe, one of the positive instructions to violin students that the $C\sharp$ must be the nearest to D, and the $D\flat$ nearest to C.

Berlioz, no mean authority, considered the discrepancy so important and so positive, as to throw doubt on the whole theoretical system of harmonic relations; and an excellent little book on the elementary principles of violin playing, lately published under the sanction of no less a personage than Herr Joachim, embodies the instruction as to the relative position of the two notes in unequivocal terms.

I have felt this to be a very serious difficulty; for it would be out of the question to ignore the opinions of well-educated instrumentalists on such a question, while at the same time the principles on which these harmonic relations are constructed are so simple, and have been so clearly proved, both by theoretical and practical considerations, by every investigator, from Pythagoras to Helmholtz, that it would be equally out of the question to controvert *them*. I have never seen any attempt to explain or to reconcile this curious discrepancy. I have some ideas on the subject myself, but it is too complicated to enter into now: possibly I may state them at some future meeting of this Society.

In the meantime, as in duty bound, I mention the difficulty, and commend it to the attention of thoughtful musicians.

Recurring now to our scale, you will begin to see further the complexities and difficulties of true intonation. We have already provided for eleven keys, and have got seventeen different notes in an octave; but to get the accidentals required for modern music we ought to have gone still further. Moreover, there is another kind of difficulty. Even the keys that we have nominally provided for are not in tune; for if we test the series of notes just found by the diatonic scales of different keys, we shall find some such result as follows:

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In the key of	A	the intervals of the	2nd	will be out of tune.
„	D	„	2nd, 5th, 7th	„
„	A	„	4th, 6th	„
„	B	„	2nd	„
„	F	„	4th, 6th	„
„	B♭	„	2nd, 5th, 7th	„
„	E♭	„	2nd	„
„	D♭	„	4th, 6th	„

It is evident, therefore, that to get perfectly just intonation in all these keys, we must, in addition to the seventeen notes actually drawn, have many of them in duplicate or triplicate; and hence it is that all the science and industry of Col Thompson, Mr. Ellis, Mr Bosanquet and others, have been exerted to establish various *systems* of *intonation*, with the object of producing music perfectly or approximately in tune.

Now, I need hardly tell you, that in order to get over all this fearful complication, some ingenious person, a long time ago, was clever enough to see that by a process of *compromising*, it would be possible to simplify enormously the construction of the scale, particularly in its chromatic parts. He saw, in the first place, that the distance between E and F, and between B and C, was *nearly* half that between C and D, or G and A. He also saw that C♯ and D♭, G♯ and A♭, &c, were not very different from each other; and putting all these things together, he saw that if he divided the octave into twelve equal parts, he would produce a set of notes not much differing from the true ones, and with the wonderful simplification of being applicable to all keys. Hence arose the Modern Pianoforte Clavier, and the system of *equal temperament*, so well known.

I will now construct, graphically, an equal-tempered scale, and compare it with the one already before you. And this is the easiest thing possible. I have only to divide the octave into twelve equal spaces, and the thing is done. Each of these spaces represents a semitone, and two of them make a whole tone.

(*This was done on a diagram.*)

It is now very easy to compare the equal-tempered with the just scale, in order to see the nature and magnitude of the errors resulting from the compromise. The most important are as follows:—

Equal-tempered notes.			
C	.	Right.	
B	Major 7th	Too sharp by	$\frac{1}{81}$ of a semitone
B♭	Minor 7th	Too flat	„ $\frac{1}{9}$ „
A	Major 6th	Too sharp	„ $\frac{1}{9}$ „
A♭	Minor 6th	Too flat	„ $\frac{1}{9}$ „
G	Fifth	Too flat	„ $\frac{1}{80}$ „
F	Fourth	Too sharp	„ $\frac{1}{80}$ „
E	Major 3rd	Too sharp	„ $\frac{1}{9}$ „
E♭	Minor 3rd	Too flat	„ $\frac{1}{9}$ „
D	Major 2nd	Too flat	„ $\frac{1}{81}$ „
C	. .	Right.	

I have no wish, in this paper, to lead to a discussion on the vexed question of temperament; I will merely state, in a few sentences, what my own general views on the subject are.

In the first place, I do not agree with the thorough-going theorists who delight in reviling and despising the unfortunate equally tempered scale. On the contrary, I hold that it has been one of the most happy and ingenious simplifications ever known in the history of music; that this simplification has been the means of advancing the art to an incalculable extent; and that the modern enharmonic system, founded upon it, is so thoroughly incorporated into modern music, that it is difficult to imagine how it could be now abandoned. And then as to performance, one fears to think of the complication that must be entailed on keyed instruments if equal temperament were forbidden. The pianoforte, to which we are indebted for perhaps nine-tenths of the music in the world, could hardly be said to exist if it were attempted to put it in mathematical tune.

But having said this, I am equally at variance with that other extreme party who would force upon us the equal temperament in cases where perfect intonation can be obtained just as easily, namely, as in stringed instruments, or pure vocal music.

I hold that the too-sharp third, whatever may be said for its great utility, is still harsh and disagreeable, and ought never to be tolerated in sustained tones, if the natural and true harmony can be got. It is the possibility of getting this which gives such an inexpressible charm to stringed and vocal harmony when unaccompanied by the intractable keyed instruments; and in the true interests of sweet music, this kind of perfection ought to be encouraged by every means in our power.

The equal temperament is to a large extent a necessary evil; but *no* evil ought to be tolerated when it is *unnecessary*.

DISCUSSION.

Mr. DE PONTIGNY said that he was delighted to hear a scientific man admit that the equal temperament scale was possible. They had had much discussion on the subject.

The CHAIRMAN said that there had been frequent allusions to him in the paper, and it was rather unfortunate that the attitude which he, amongst others, had taken up with respect to this question should be, as he conceived, entirely misunderstood. He had never said that a tempered scale was impossible, or that he did not use it himself. He had always said and maintained that, for many practical purposes, the tempered scale must always be used; but why should they shut their eyes to all other possible forms? Why should they not develop the resources of their art?

In optics many minute questions were debated by the intellects of the country, and debated with such a power of thought that one would think that they were questions of national existence, while very often they had not even one practical application. Very often questions exactly of the same kind arose in music, but they were capable of practical application; and certain persons had tried to investigate them, and to put the difficulties before people in a simple manner, and show that these questions were not devoid of practical application. But when this was done it was immediately said that they wished to overturn the whole system of music as it at present existed. Nothing could be farther from the thoughts of himself and others who took up such questions. What they wanted was, that the material of music should be studied, and when that point was attained it was always followed, in the long run, by some practical advantage. Seeing that there were at present most interesting problems—problems of quite as much interest as those which existed in optics—why should not musicians study them? Having said so much—which, perhaps, was a little too much—he would now refer to the subject which had been dealt with in the paper. There were just one or two little points that he should like to mention. Three or four years ago, in giving a small course of lectures at Oxford to some musicians, he found it rather a good opportunity for ascertaining what was the best method for graphical representation—exactly the very point which Dr. Pole had been bringing before the Association, and he hit upon a method which he found extremely successful. He sketched an ordinary pianoforte key-board, in very light lines, upon a very large sheet of paper, the scale of the drawing being immaterial, and he shaded in the black keys very lightly. He then took the middle point of each key to represent the pitch of the corresponding note, and whatever he wanted to lay down he laid down from that as the scale. For instance, for harmonics he divided the key-board into portions corresponding with the number of octaves, and introduced lines corresponding to the harmonics. The result was that he had the whole of the harmonic scale mapped out, with every note in its exact place upon the pianoforte key-board—a representation which every musician knew intimately the meaning of, and which could not possibly be misunderstood. He never had any difficulty with the harmonic scale after that. Another point which struck him was as to the way in which the sharps were derived. Of course, historically speaking, they were in the first instance derived, he supposed, from what was called the old Pythagorean system, which was always that the sharps were in the ascending system of fifths, and the flats in the descending. Then gradually the fifths were flattened, and in the sequence they always retained the same value, but it was only when the fifths became flattened, as they were in the mean-tone system, that it was possible to use the C sharp as the third to A. They could not do that in the old Pythagorean system; but it was

merely a question of general usage, and he thought that if they looked to the books which were said to be authoritative on these points—though, for himself, he did not profess to know anything of authority—they would find that the only meaning that was attached authoritatively by modern musicians to the symbols of sharps and flats was that they represented proceeding upwards or downwards in a consecutive series of fifths. In the papers that he had read about this subject he had invariably employed equal temperament semitones as the unit of interval. Of course that arose out of the employment of the graphical method which he had just been describing. When he found that it was easy to show the intervals by laying them down upon the scale of pianoforte keys, it was the simplest thing in the world to find rules for expressing intervals in numbers having relation to that scale. That is to say, he always regarded the perfect fifth as seven equal-temperament semitones and a fraction. Thus.—

$$7{\cdot}01955 \text{ or } 7\tfrac{1}{51\cdot 152}$$

He had got so accustomed to this that it seemed probably more simple to him than to other people; but he thought that, while the numbers of the logarithmic scale conveyed in themselves no idea to the practical musician, unquestionably the numbers of a scale such as he employed did convey the idea in a way most easily and clearly understood by a practical musician.

Dr. POLE said that he had really nothing to say in reply, because there was nothing in which he disagreed from Mr. Bosanquet. It must not be supposed that in any remarks he had made in defence of the equal temperament he depreciated what Mr. Bosanquet and others had done. As to the relation of the true notes to each other, and the systems and modes of temperament, all that Mr. Bosanquet had written was exceedingly good, and deserving of study. He (Dr. Pole) merely wished to put on record his idea—which Mr. Bosanquet himself admitted—that in a practical point of view equal temperament had almost incalculable advantages; and that to it they were indebted, very much more than they considered, for the extension of the art of music. As to the use of the pianoforte keys, taking the equal-tempered semitone as the unit was a very good simplification; but he was not quite sure that a quantity like 7·01955, used to represent the perfect fifth, was a simpler thing than the logarithm scale. However, that was not very important, for if the thing was to be done graphically it must be founded upon logarithms in some way or other; and therefore there was really nothing in dispute. As to the remark made about the sharps, when, with some hesitation, he drew his diagram, he said that he did not exactly know what C sharp was, unless it was the major third to A; and therefore, in drawing C sharp, he did not know where else to put it. He was aware at the time that it was open to objection; but still, what was one to do? Let them ask a musician what C sharp was, and if he could tell

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them anything else than that it was the third to A, he should be rather surprised, because that was the musician's idea of it. If it was not that, what was it? It might be one of a series of fifths derived in a roundabout way, but the musician never thought of it so. He thought of A flat as a third below C. It was exactly in these points that doubt arose. He had taken the notes in the diagram in the simplest way he could; but that did not affect the principles of the Paper, for if anybody had any other way of defining C sharp he could do it just as easily on his (Dr. Pole's) method; and he claimed for this plan that it was a mode of representing to the eye the relations of the intervals in a way corresponding to the impressions they made upon the ear; and therefore it was useful, as it gave them, as they had found to-night, the opportunity of reasoning about the things in a better way than they could do by abstract words.

January 3, 1876.

JOHN HULLAH, Esq., LL.D., Vice-President, in the Chair.

CONSIDERATIONS on the HISTORY of ECCLESIASTICAL MUSIC of WESTERN EUROPE.

By the Rev. Sir Frederick Gore Ouseley, Bart.

M.A., Mus. Doc. Oxon., Professor of the University of Oxford, President of the Association.

It has been suggested to me that the subject of Ecclesiastical Music treated from the historical point of view might prove suitable and interesting for a paper to be read before this Association. It appears, however, too large a subject for a single paper, and moreover there are some branches of it which trench too much upon questions of religious observance to be fitting matter for such a meeting as the present. Under these circumstances it seems best, on the whole, to confine our attention this afternoon to a few important considerations arising out of the historical aspect of Church Music, some of which, as it appears to me, have not hitherto received that amount of attention which they deserve.

The first consideration which I would lay before you is the question, What is the connection between Christian Church Music and that of ancient nations, whether Pagan or Israelite, before the Christian era. On this point more than one theory has been maintained. The celebrated Padre Martini, of Bologna, in a dissertation contained in the third volume of his well-known 'History of Music,' contends stoutly for a theory first broached by himself, that the Ambrosian chants were traditionally derived from the very notes composed and sung originally to the Psalms by King David or the other authors of the Psalter. Considering the state of musical knowledge, and especially of the knowledge of Oriental music, which existed in Martini's days, it must be admitted that his theory was bold, clever, well argued, and not improbable. Subsequent research, however, has brought to light many facts which are utterly irreconcilable with such an idea. Let us devote a few minutes to the consideration of some of these facts. Now in the first place it will be conceded on all hands that the ancient Hebrew music must have been essentially Oriental in its character. The only time in the history of the Israelites in which they had ever had an opportunity of hearing any other than strictly Eastern music was during their sojourn

in Egypt. Before that time, if they had any music at all, it must have been Chaldean. We may form some idea of its character by studying the scales and melodies of the modern Bedonin Arabs, the descendants of Ishmael, and of all people in the world the most tenacious of old customs and habits, and consequently the least likely to vary the style and system of their music. Whatever the music of these Arabs is now, such must it probably have been in the days of Ishmael and his mother Hagar the Egyptian. And if of Ishmael, then also of his brother Isaac. We cannot imagine two brothers adopting not only different melodies, but a different division of the musical scale. Such a thing is inconceivable. Each would sound absolutely out of tune to the other. Each would deem his brother's ears false. The family of Abraham must have had but one scale-system, and one only. And that scale-system must surely have been the same which has been handed down from father to son by the descendants of Ishmael, even to the present day. It is almost needless, before such an audience as the present, to define what I mean by the expression 'a scale-system.' Suffice it to say, that whereas we divide our octave into tones and semitones, the Arabs use smaller subdivisions, so that our semitones are out of tune to their ears, while their intervals are no less abhorrent to ours. This was put to the test once by M. Villoteau, who went to Egypt with the first Napoleon. He was a good musician, and wanted to learn some of the Arab tunes. He therefore secured the assistance of an Arab singer, and tried to learn his songs by ear. But the lesson had hardly begun when the Arab stopped the Frenchman, telling him he was singing out of tune. M. Villoteau was equally certain that his teacher's intervals were false. And thus for some time they could make nothing of one another, until at last, by way of final test, they had recourse to a kind of stringed instrument of the guitar kind, in use among the Arabs, of which the neck was divided by frets, accurately giving the true intervals of the Arabian scale. Great was M. Villoteau's astonishment when he found that these intervals were not semitones at all, but thirds of tones, eighteen of them making up the octave. Of course the whole difficulty of the vocal intonation was instantly solved. It was not merely a question of new tunes, but of new scales, of a new system, of an entirely different music, of a differently derived melody. And from this it followed that any representation of Arab melodies by modern European notation could be but an approximation at best. All that can be done is to substitute the nearest notes we possess for the true Oriental ones. And so it comes to pass that whenever we see a transcription of any of these melodies, or hear an attempt to execute them on any of our instruments, we may be quite sure that the real tune is not exactly the same, but would probably sound absolutely out of tune to us if we could hear it performed by a native musician.

It is true indeed that since the time of Villoteau we have

learned much more about Arabic music, and probably his conclusions, as reported by Fétis (from whom the account you have just heard was derived), are not altogether trustworthy. But still the fact remains that the ancient Oriental scale was very different from our own; so different that no melody could by any possibility be common to both. The other fact also remains, that this same system was almost certainly that which was exclusively used by Ishmael, and therefore also by Isaac, by Abraham, by the old Patriarchs in general. Nor is it likely that during their sojourn in Egypt they can have unlearned their own system of music, although perhaps they may have developed and improved it. No amount of association with Egyptians or Europeans has made modern Arabs abandon their ancient scales, and it is unlikely that the children of Isaac should have been less conservative in such a matter than their cousins, the sons of Ishmael. Moreover, even if the Israelites had adopted the Egyptian system of music during their residence in that country, it would not have made very much difference to my argument. For the Egyptian scales were as unlike our modern music as were those of the Chaldeans, with whom they had much in common. It is known that some of the Psalms were written by Moses; if he also composed the music to them, it must have been of a similar nature, as to its intervals, to the Oriental or Egyptian music of which I have been speaking. Nor does it appear possible that the Israelites altered their system of music between the times of Moses and David. David's music was unquestionably Oriental in every respect. His melodies therefore could not have borne the slightest resemblance to the melodies of the ancient Western Church, founded as these were on the Greek system of tones, semitones, and superposed tetrachords.

If all this be so, then it necessarily follows that the whole of Padre Martini's argument crumbles to dust. The Ambrosian and Gregorian melodies, if derived from ancient sources at all, must have been Greek, not Hebrew, and so far from having any claim to Divine inspiration, were purely Pagan in their origin. The probability indeed is that SS. Ambrose and Gregory did exactly what has often been done since; they adopted popular and secular tunes to sacred words, probably systematising and simplifying them in the process of adaptation, and thus adopting the most obvious and the readiest means of securing congregational singing. Moreover there can be no manner of doubt but that St. Gregory thus actually secured for the use of the Western Church absolutely the best music which was available in those days. It were much to be wished, then (if I may dare to say so), that those who now so strongly press upon us the almost exclusive adoption of what is now called Gregorian music in our churches, would rather follow St. Gregory's example by selecting the best developments of the art of music for that sacred purpose, instead of pursuing the very retrograde course which they so strongly prefer. And what makes my case

stronger is the doubt which exists as to the antiquity of many of the melodies which go by the name of Gregorian, the vast difficulty of deciphering the early Christian notation in use for music, and the consequent probability that what we are accustomed to call Gregorian music is, after all, quite a different thing from what was sung in the churches of Europe in the 7th century. I do not wish, however, to push my remarks further in this direction to-day, only it seemed a good opportunity for throwing out this consideration, involving as it does some of the most important historical points connected with our art. Let us hope that it may elicit further research, and more distinct knowledge of what really was the system of sacred song in use during the earliest ages of the Western Church.

The next consideration which I wish to lay before this meeting is that of the various ways in which the musicians of former days dressed up the traditional plain song of the Church. Now it is almost universally admitted that in the seventh century all Church music was sung in unison and unaccompanied by instruments of any kind. Indeed what we understand by harmony did not exist for several centuries after this in southern Europe. It is very probable, nay, well nigh certain, that harmony was used and cultivated at a very remote period by the nations of the north. It is needless to go into all the proofs of this fact at present. 'Summer is a-coming in' would go a good way alone to prove it. So would some curious pieces of Welsh harp music given in Burney's History. So would the testimony of Giraldus Cambrensis. The argument to this effect is well worked out in the 'Discours Préliminaire,' prefixed to the 1833 edition of Fetis's 'Biographie des Musiciens.' But although it may be assumed that the nations of northern Europe were acquainted with harmony from a very distant epoch, perhaps as early as the commencement of the Christian era, yet it is none the less true that no attempts were made for several centuries to engraft this secular harmony upon the melodies of the Church. If we turn to the ancient treatises on music, as reproduced in Gerbertus and De Coussemaker, we shall see that the first attempts at harmony practised by the ecclesiastics who wrote these mediæval books were composed mostly of consecutive fourths, fifths, and octaves, of so crude and inharmonious a character, that it is a matter of astonishment how any ear could have tolerated such hideous sounds. It is perhaps hardly correct to consider these rude attempts as being harmony at all. Imagine a body of voices singing a piece of plain song in unisons and octaves, whilst a few picked singers sang the same melody a fifth higher or lower. We naturally should shrink aghast from such cacophony. Yet our ancestors thought such music a wonderful and beautiful piece of art, and had great respect for the clever people by whom it was developed. I know, indeed, that Dr. Crotch and many subsequent writers have imagined that the plain song was sung by such a powerful body of voice that the comparatively feeble intonation

of the fifths and fourths (called in those days the 'Organum'), produced an effect analogous to that of the mixture stops in an organ, the object of which is to strengthen the harmonics of the foundation stops. But I confess this idea seems to me to be utterly untenable, for in order to produce such an effect as is imagined, the various harmonics must be introduced in the right place, i.e. at the same intervals above the fundamental sound as the natural harmonics of a string or tube invariably occupy. In fact they ought to be placed at the same distances of pitch as are the principal, twelfth, and fifteenth in an organ. It is perfectly clear, however, that such was not the case in the days we are now considering; for the organum was sometimes a fifth or a fourth above or below the Cantus Firmus, and therefore utterly unlike the effect produced by the mutation stops and mixtures of an organ. We may therefore conclude that the earliest attempts at ecclesiastical harmony, or diaphony, as it was sometimes called, were utter failures, and only produced effects which would drive any modern musician distracted. Gradually these long periods of perpetual consecutives were diversified by the cautious admission of other intervals than mere octaves, fourths, and fifths; and even these were exchanged and varied among themselves. Thus arose the old art of descant. The treatises on music of the twelfth and two next centuries contain a vast number of minute rules for 'descanting' on a plainsong. Sometimes this descanting was extemporised at the moment of performance, and would be what the Italians called 'contrappunto alla mente.' Sometimes it was carefully elaborated and written down. And we must observe with respect to this improved harmony, that it does not appear to have been borrowed at all from secular music, but arose gradually among ecclesiastical musicians as time went on. We must also observe that it was modified, improved, and ultimately perfected, through the invention of signs to express the various duration of notes—called 'Musica Mensurabilis.' To this we undoubtedly owe the origin and rise of counterpoint. Like all new fashions, this art of adding florid counterpoint to the ecclesiastical plainsong was carried to an extravagant extent, and grossly abused. Nothing was thought of propriety of sentiment,—of the proper adaptation of music to words,—the one object seemed to be to clothe the canto fermo with such complicated and artificial ornaments as to render it nearly inaudible, nearly unintelligible, and utterly unmeaning to the uninitiated hearer.

This, then, was the way in which the old ecclesiastical melodies were treated before the days of Palestrina. Of course we know that they never ceased to be sung also in unison and octaves, and that there were some tolerably plain and decently correct harmonisations of them in the days of Jusquin Desprès and his contemporaries. Still the custom was to prefer the complicated and artificial harmonies to which I have alluded, and in the elaboration of which no one displayed more skill than Jusquin himself.

With Palestrina there was introduced a much more simple and effective way of composing contrapuntal music on the old canto fermo The melody was no longer smothered up in the intricacies of its accompaniment, but was rather brought out and invested with fresh beauty by being woven into a network of melodious part-writing Nothing can be more pure and elegant than the Italian school of Church music in the days of Palestrina and his successors. It was without instrumental accompaniment of any kind, and was analogous to the madrigalian style of the same period, though of course more solemn and sublime than any madrigal, so as to suit the words. Palestrina and his school did not by any means confine themselves to composition on the plainsong of the Church. Much of their music was *bonâ fide* original composition Still it always largely partook of the style proper to counterpoint on the plainsong, on account of its being written in some of the old ecclesiastical scales, for the most part, our present system of tonality not being then fixed After Monteverde had discovered the true use of dominant discords, and music had begun to pass into a new system of tonal development, when the relations of the key-note to the dominant chord, the force of the leading note, and the possibility of real modulation by the use of the dominant seventh, had begun to be recognised,—it followed, of course, that the style of Church music in Italy underwent considerable modifications. And another thing which contributed not a little to this change of style was the universal adoption of some sort of accompaniment to the voices, either the organ, or a small string band being so employed

But still the ecclesiastical musicians of Italy continued to compose on the basis of the cantus fermus, though in a somewhat freer manner than formerly And magnificent specimens of the effects they succeeded in thus producing may be seen in the works of such men as Leo, Clari, Scarlatti, Lotti, &c &c In Spain Church music ran a parallel course In the 'Lira Sacra Hispana' of Señor Eslava are contained a very fine series of compositions for the Church by all the best Spanish composers, from the 15th to the 19th centuries And it is interesting to observe the analogy which appears always to have existed between the Italian and Spanish Church music, while at the same time there is sufficient difference between the two to mark very clearly the character of the two countries. In France ecclesiastical music was not raised to anything like the pitch of perfection to which it attained in Italy and Spain in the sixteenth and seventeenth centuries. In Belgium, Orlando di Lasso and others might be said to rival the schools of southern Europe. In Germany also were many good composers who more or less followed the same track, and may be looked upon as the germ of the great German classical school of a more recent period, to which all others had eventually to give place. During the Elizabethan period we in England had a school of Church composers equal to any then in the world. But

owing to the Reformation and the translation of the Church service into the vernacular, we do not find either in their works, or in those of Protestant composers in Germany and Holland, the same plan pursued as to the retention of the old Church melodies as the groundwork of elaborate and contrapuntal works. Not but what we have some specimens also of that, e.g. Tallis's Harmonies for the Responses and Litany. And it would not be difficult to name many of our best English composers at the present date who have pursued the same course with equal success.

We have now followed the history of the musical treatment of the old ecclesiastical melodies from mediæval times down to nearly our own days. And the consideration which I wish to put before you as a deduction from this history is this—May it not be a very useful exercise for young composers to practise composing fugal music on ancient themes? There is, as it appears to me, a growing tendency in these days towards secularising Church music. I mean making the style of music for the church and for the concert-room almost identical. It has occurred to me that one antidote to this tendency would be to encourage all young musical students to give much more time than they usually do to the study of counterpoint on a plainsong. No one would compose worse secular music for having undergone this training, while all who wished to write music for Divine service would unquestionably feel the benefit of such a course.

All the greatest foreign composers up to some fifty years ago had been taught more or less on this plan, and it cannot be said to have produced any but good results in their case. If any one wishes for good examples of such music, I should recommend him to try and procure a copy of Padre Martini's 'Esemplare di Contrappunto sopra il Canto Fermo,' 4to. Bologna, 1773; and also Paolucci's 'Arte pratica di Contrappunto," 4to. Venice, 1765.

I now come to another consideration arising out of the history of ecclesiastical music. I allude to the use of various musical instruments in church. It is not intended, however, to take up the time of this meeting by reviving the old and well-worn controversy about the lawfulness of organs in churches. If any one here holds the view entertained mostly (if not exclusively) in Scotland, and in the Greek Church, that pure vocal music alone is admissible in public worship, let them not listen to the remarks I am about to make—they are not addressed to them. The consideration which I wished to lay before this meeting is this—Whether all the arguments which can be adduced in defence of the accompaniment of vocal music by the organ, during Divine service, do not equally vindicate the use of other instruments also. It is easy to understand a line being drawn between pure vocal music and instrumental accompaniments. But it is (as I think) quite impossible to draw a line between the exclusive use of the organ, and the employment of a full band. If we go to Scripture for examples, we are at once confronted with the

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enormous orchestra which played at the dedication of Solomon's Temple. We have to face the headings or dedications of many of David's Psalms, wherein not only are the various instruments named by which they were to be accompanied, but the names of some of the performers are specified. We have to encounter the employment of a large orchestra again by King Hezekiah, coupled with the express declaration that it was all done according to the express command of God (2 Chron. xxix. 25—28.) We cannot in the face of such evidence as this condemn the use of instrumental accompaniments to Divine service as unscriptural. At any rate, it is amply sanctioned by the Old Testament, and I defy any one to find a syllable in the New Testament which has the least appearance of countermanding or forbidding the established custom of the Jews in this matter. Our Lord attended the services in the Temple, and thence drove out the buyers and sellers, and exposed every prevailing abuse. Yet he never once said a single word against the use of Church music. In this, then, as in other matters, we may rest assured that 'the Old Testament is not contrary to the New.' And to corroborate this argument still further, let us remember the many passages in the Book of Revelation, which speak of 'Harpers harping with their harps,' as seen and heard in a vision by St. John at Patmos. Were I preaching a sermon instead of reading a paper, I could go on at length to bring forward argument upon argument, and fact upon fact, to establish the Scripturalness and consequent lawfulness of instrumental music in public worship. But, as it is, I must not enlarge further on this theological point. Suffice it to observe that the vast majority of passages which may be adduced referring to musical instruments in the Bible, referred to stringed instruments of various kinds, and others to trumpets—a very few to instruments of percussion. But, of course, *none whatever* to what we call organs, for these had not then been invented. Of all instruments, then, it may be said that organs are among the least Scriptural, while the harp might be defended with much more success were all arguments confined to the pages of Holy Writ.

Seeing, then, that there is Scriptural authority for the use of an orchestra in Divine service, but none for any particular instruments, and certainly none for the exclusive use of the organ, I think the consideration fairly arises whether those who object on Scriptural grounds to instruments in church, but make a special exemption in favour of the organ, are not illogical and inconsistent. The real question at issue is between *no* instruments and *any* instruments. The Greek Church and the Scotch Presbyterians are for the former plan; the Western Church for the latter. The exclusive use of the organ as an accompaniment to the voices in church is of very modern growth. Apparently it has arisen from two causes—1st, That organs are often available when a full band is not; 2ndly, That of all instruments none is so well suited for the purpose, when used alone, as is the

organ; but neither of these reasons constitutes a valid objection to the employment of a full band, where such an accompaniment can be obtained. It is, of course, obvious that such an expensive and troublesome appendage as a band of performers can only be procured on rare special occasions. It is also no less certain that when it is available it must be hedged in with many precautions in special rules to secure reverent demeanour and good discipline. Still all this may be done, and has been done, and the occasions on which it can be achieved are daily becoming more frequent. St. Paul's Cathedral and Westminster Abbey have set a good example; several London churches have worthily followed suit. Nor can it be said to be an innovation. Every great composer in France, Italy, Spain, Portugal, and Germany for the last 250 years has left behind him full scores of orchestral masses, motets, cantatas, and hymns. Oratorios in Latin, Italian, and German, including Bach's Passion Music and many similar works, were all intended for performance in church, and as an act of worship. Nor have we been without instances of Church of England services with band accompaniment at the old Festivals of the Sons of the Clergy in St. Paul's Cathedral, and formerly also on the first days of the Triennial Choir Festivals at Hereford, Worcester, and Gloucester. Many compositions exist by old English cathedral composers, expressly intended for the use of the Chapel Royal, in which not only the organ but also a string band is employed. Among these we may enumerate works by Gibbons, Weelks, Este, Purcell, Blow, Croft, Greene, Boyce, and others. We must especially remember Purcell's grand *Te Deum* and *Jubilate* in D, Handel's *Te Deum* and *Jubilate*, and his Chandos Anthems, not to mention the anthems composed for the coronation service by Blow, Purcell, Handel, Attwood, and others, and the Funeral Anthems by Handel, for Queen Caroline, and by Bononcini for the Duke of Marlborough, all which compositions were written with accompaniment for a full band, and so performed. We see, then, that the traditional use of the band in church has never been given up, although its use has become exceptional of late years. As to military bands, of course they have been used continuously to accompany military services, and no one has ever found fault with them. The miserable string bands, and still more distressing clarionets and bassoons, by which the services in country churches used formerly to be accompanied, can hardly be quoted as an example to be followed. Still, even these have their force as an argument against those who would tolerate no instrument in a church except an organ, or its wretched substitute, a harmonium. Surely, the best rule is to seize on all that is most perfect, in this as in every other art, and devote it to the service of the sanctuary.

If I am right, then, in hoping (and assuming indeed) that the introduction of the orchestra into our churches is likely to become a more frequent occurrence than of yore, then we are brought face to face with a new difficulty—I mean the lack of

good English Church music at once orchestral and ecclesiastical in character. Of this there is comparatively, as yet, very little. Surely this opens out a new and promising field of work for young English composers, in which great things may be done. Let me earnestly recommend it to their special attention. It is hard to imagine any theme more inspiring, more likely to evoke scintillations of musical genius, than the glorious *Te Deum*. Difficult I allow it to be—difficult both on account of the intrinsic sublimity of the words, and also because of the natural diffidence which any modest composer must feel when he knows that his work will be compared with the *Te Deums* of Purcell and Handel. But neither of these difficulties are insurmountable. I abstain purposely from naming any living composers, but a very fine orchestral *Te Deum* has been composed, and performed, not in church, indeed, but in the Crystal Palace, within the last few years, with no inconsiderable success. The other canticles and hymns of the Church also present most favourable opportunities for similar, and equally successful, treatment.

These, then, are the considerations, arising out of the history of ecclesiastical music, which it appeared desirable to lay before you to-day. That I have done this very imperfectly indeed, I am only too sensible. But such as it is, I am not without hope that this paper may be of some use. It is a subject which has not hitherto been broached at any of these meetings, and it is possible that subsequent discussion upon it may bring out some useful facts, some practical hints, some novel ideas, some necessary cautions, all in the service of our art, and therefore welcome both to ourselves and to our friends outside. In that hope, let me commend the subject to your best attention.

DISCUSSION.

Mr. W. Chappell said that some of the conclusions in the paper appeared to depend on the account given of Arab music by M. Fétis, but that gentleman's history did not go very far back, as it began with the treatise of Abd-el-Kadir, which was written, not in Arabic but in Persian, about the commencement of the sixteenth century. M. Fétis might have adopted a far better and higher authority for Arab music, in El Farabi, the Arab philosopher who flourished during the reign of the celebrated Caliph Haroun Arraschid, whose name would be familiar to many persons from their having read of him in the 'Arabian Nights' Entertainments.' El Farabi died in the year 339 of the Hegira (our tenth century), and Abd-el-Kadir in

the ninth century of the Hegira. Having recently examined the elaborate treatise of El Farabi upon music, through Kosegarten's translation from the Arabic into Latin, he was able to state that, in the reign of the Caliph Haroun, when Arab civilisation was perhaps at its highest point, Arab music was essentially of a Greek character, with tonos and semitones, and like music in a minor key, and that it was founded on the Greek scale. In the two-octave scale it had the major and minor tone alternately, so as to make the intervals of Thirds perfect, instead of the old ditones of Pythagoras, which were dissonant from consisting of two major tones; but upon the common Arab Kithara, the ditone was then still in use. The origin of thirds of tones was not to be traced back to that date, but seems to have been derived through the influence of later Persian music. In the time of El Farabi the 'Medius Persarum' was an interval of a semitone. Up to the period at which Islamism had attained its full strength, the songs or chants of the Arabs are said not to have been in musical modes. The study of music, as an art and a science, resulted from subsequent civilisation, and the still later use of such unmusical intervals as thirds of tones might be looked upon as a sign of decay in that civilisation. The next historical point was as to the question of the kind of music in use at and from the time of St. Ambrose to that of the great Pope Gregory. St. Augustine was the pupil of St. Ambrose, and he, as well as Basil and others, gave a most important account of the introduction of what is now called antiphonal singing, which was derived from Syrian and Jewish use. Choral music was preserved in the book called the 'Antiphonarium,' but he believed it did not originally mean singing from one side to the other, by two opposite choirs, as is now understood, but was derived from the Greek word *antiphon*, and really meant the combined singing of boys with men, according to the definition of Aristotle. If St. Ambrose had introduced any new kind of music for the Church it must have been well known to St. Augustine, who wrote six books upon the subject of music, but in none of them was there an allusion to anything of the kind, neither is there in the voluminous accounts of the life of Gregory. Between the time of St. Ambrose and the latter were Cassiodorus and Boetius; and after Gregory his young friend St. Isidore, of Seville. All these wrote works about music which are still extant, but they teach only the Greek system, and not a word about Gregorian music in any of them. He had carefully read through the life of every Pope, from Gregory, down to Vitalian, for the purpose of tracing any indications of change in Church music. Agatho sent John, the arch-chanter of St. Peter's at Rome, to the north of England, at the request of Benedict Biscop. About 170 years after Gregory, Adrian became Pope, and by him singers were sent to the Emperor Charlemagne; and then arose the notorious contention between the French and Italian singers. He had not yet gone through the entire history of those times,

but such are the earliest known indications of any desire to change or to regulate the style of Church music. The introduction of a complete system of Gregorian music could not have taken place before the time of Adrian, because the ecclesiastical notation for more than a century after was only by accents and elongated signs called neumes, as shown in the numerous specimens collected by the Padre Martini, by M. de Coussemaker, and by others. There are a few lines in the 'Micrologus,' of Guido d'Arezzo, in which he alludes to this kind of notation as of no musical use, because it was like a well without a rope; there were marks to show progression of the voice up or down, but no singer could tell how far to go, at what pitch to begin, or upon what note to end. Another point to be noticed was that Notker—a writer of the tenth century upon ecclesiastical music, whose work is printed by the Abbé Gerbert in his 'Scriptores de Musica Ecclesiæ' (i. 95)—gives the ecclesiastical tones as ending on B♭, C, D, or E, instead of upon D, E, F, or G, thus varying the positions of tones and semitones from the scales of later use. Gregorian music differed from all other by changing the position of the semitones in every scale or mode, and its eight scales were derived from one Greek scale and its dominant. The Greek Hypes or dominants were the same as ours, but taken a Fourth below the key-note instead of a Fifth above it. The *hypo* of the Greek Dorian, or D minor, was A minor, each having its minor Seventh. It was from these the Church tones or modes were constructed. The only difference of note between the two scales was the B flat, derived from D minor in the second octave, and that was the only accidental in Gregorian music or (as he preferred to call it) Plain Chant. Such a system of music could not have been intended to charm, but to disenchant the ear. It was originally sung without harmony. He could only look upon it as having emanated from Church discipline when conducted in the ascetic spirit by which monachism had before been engendered. It taught that men was to avoid all present pleasures and gratifications, even of a harmless kind, and study to make himself miserable here in order to be made happy hereafter.

Dr. Stainer said he honestly confessed that some of the Gregorian music was very pleasing to him, and he had never heard anything to suit one of the Psalms, in particular, so well as the *Tonus Peregrinus*. He thought the claim of Gregorian music to consideration had been rather strengthened by the argument brought forward by Mr. Chappell, for if the Gregorian tones were not written by Ambrose or Gregory, who did write them? His own impression was that they were the growth of people who had barbarous music at the time, and did the best they could with it, though no doubt they had not reached us in anything like the form in which they were first promulgated. The question then arose whether they should be discarded because they were old

and barbarous and were not Gregorian; and this opened an entirely new question. The question of their being barbarous was a mere matter of opinion. His nerves had been more shocked by some of the progressions in early English Church music than by anything Gregorian. But as regards the very general opinion now entertained that the early music must have inspired horror in those who heard it, he thought that was a great mistake. All ideas of the beautiful must be relative, and the proper frame of mind in which to view that music was that it was purely historical. Some people when they went to the National Gallery entirely passed by the early paintings, because they did not come up to their modern ideas, but he considered anybody who could not stop and appreciate the beautiful paintings of the 15th century to be deficient in culture. Every one should as far as possible cultivate such a frame of mind as to appreciate beauty in different ages and under different phases. A very important question was opened by the President as to how far the Gregorian tones were now rendered in the way in which they were written, and he confessed he had great doubt about it. He was quite clear that the laws of rhythm of those days was not now understood, and his own opinion was that they never sang rhythmical words to such totally unrhythmical music as it was now considered fashionable to associate them with. In the words they sacrificed almost everything to rhythm, perpetrating the most frightful false quantities both in Latin and Greek in order to obtain rhythm; and that being the case, he could not believe they associated those words with music which had no rhythm at all. He considered that to be a logical dilemma for Gregorianists to solve if they could. As to requiring pupils to write on a *Canto Fermo*, he considered it rather a retrograde movement in the present day of free modulation and beautiful forms in music. At the same time he should like everybody who had any pretensions to be a thorough musician to have gone through those old writings, and to have some of them at his fingers' ends. But to entertain the idea of bringing up a pupil to consider that not as a means, but as an end, he believed to be vicious. Let it be a part of his musical education to treat *Canto Fermos*, but still let it be subordinate to something higher to be attained afterwards. With regard to the introduction of orchestras in church, he thought all would agree, although people had sometimes rather confused notions as to what an orchestra was. The other day he received a letter from a clergyman who said he had always been in the habit on the Odd Fellows' Fête day of having the brass band play up to the church door, which he did not very well like, because they only played secular music, he proposed that next time they should go inside and play sacred music, and wished him to write something appropriate for the occasion. Now if it were a very good brass band he did not so much object, but if it was an ordinary Odd Fellows' band, he thought they had better stay outside the church doors.

Mr. C. E. STEPHENS said he quite sympathised with Sir Frederick Ouseley with regard to Gregorian music, and thought Dr. Stainer's remarks were rather inconsistent. In the first place Dr. Stainer said we should revere this music as a relic of the past, while in the next breath he admitted that what we now call the 'Gregorian tones' are not at all what they were originally, so that the ground on which Dr. Stainer advocated them was thus at once cut away.

Sir F. G. OUSELEY said the great principle he put forward, following the example set by Gregory, St Ambrose, and the originators of what was now called the plain chant, was to choose the best they could for the service of the Church. Therefore, until he was convinced that Gregorian music was the best, he was not prepared to agree with those who voted for its exclusive use. It was not a question of the beauty of any of these particular tones, but of the exclusive use of them, which he was arguing against, and the superior advantage of taking the best in every style of art. It was certainly true that they did not know what these tones were originally, they did not know what the rhythm was, or the accent, and he did not suppose they ever should, because they had no notation to express it; it was probably a something traditional handed down from one to another and was now irrecoverable, and modern students could only at best conjecture what it was. Therefore, when people talked about the antiquity of these old plain songs they really did not know what they were; so that there was really no antiquity left. It was the mere skeleton of former days which we had now to clothe with our own inventions, and therefore, as presented, it was probably totally different from the original. The argument really reduced itself to a nutshell; if anybody would show him exactly the very notes, the accent, and the time in which these tones were sung in the seventh century, they would have a strong argument on the point of antiquity, and the deference due to antiquity: but he defied anyone to do so, and therefore the argument came to nothing.

Mr. W. H. CUMMINGS said that many musicians who ventured to question the beauty of Gregorian music were put down, not answered, by being told that it was undoubtedly derived from a Divine source, and thereupon, of course, they had no more to say. He begged to thank Sir Frederick Ouseley very much for having brought forward this paper, which had set that question at rest. He thought they ought to take the best music from every source for Church purposes. As to the introduction of an orchestra in churches, there would be probably few in that room who would dissent or object, if it could be obtained in perfection; but sometimes it must have been their lot to have heard an organ and an orchestra associated when the effect did not at all tend to edification, either musically or religiously. There were questions of quality, quantity, and expense: if the cathedral bodies were prepared to get an orchestra suitable and adequate to the

service of the Church, by all means let them do so; but certainly to have an orchestra out of tune, and when it did play almost drowned by the organ, was not a thing to be desired.

Mr. W. Pabbatt said, as regards the *Tonus Peregrinus*, it would be rather remarkable if, with all the Gregorian music, they did not sometimes blunder into something fit to be heard. The fact was, musicians did not so much object to Gregorians in themselves, but because they were dressed up in modern ways and associated with modern harmonies. He had heard Gregorian music very effective in the streets of a foreign town, when it was sung in unison with only the aid of one brass instrument, which also played in unison with the voices; and he did not say but that if they had music of that sort occasionally it would be very effective. He hardly thought Dr. Stainer's analogy of old paintings and old music could hold good. Mr. Hullah had pointed out in his book that music had been the very last of the arts to be brought to anything like perfection, and he believed the music of the Gregorian times was parallel to the stage of pictorial art which might be found on a Chinese tea chest. He entirely sympathised with Sir Frederick Ouseley in his wish that people should study the art of writing on the *Canto Fermo*; and probably Dr. Stainer hardly knew how much he owed to this practice, and how much those owed to it who had the pleasure of hearing his compositions. He was in the position of constantly hearing both the old and the new music, and while he could go on hearing old things over and over again with no sense of weariness, he must say he got excessively bored with the constant free modulation now so much introduced, in which freedom was certainly carried to a great excess. With all the sensational effects introduced in modern services, he must say that the more he heard of old music the more he liked it, and if people would only cultivate the old style a little more, and add the orchestra to it, introducing effects which the old writers were not able to do, they might be able to found a new school of Church music of which they had not yet seen any signs.

Sir F. G. Ouseley, with regard to the introduction of an orchestra, said, in many cases a powerful string band might be very well combined with an organ when wind instruments could not. The strings could always be tuned to the organ if the temperature altered the pitch.

Mr. C. Macpherson said one point occurred to him as bearing upon the question under discussion, namely, whether Church composers of the present day sufficiently bore in mind that what was wanted now to a much greater extent than formerly, was music for the people rather than music for the choir. It was new to him to hear that Gregorian music was attributed to Divine authority, although it was said that those tones were sung by the Jews in the wilderness. He believed the reason they had been so much defended by many writers and practical musicians was, that they did meet a great modern want; they were like

some old-fashioned articles which came again into use and met a want which was perhaps not in the first instance their design. They were especially suited for popular use. If you went into a cathedral at the time of a Great Festival and expected to hear the voice of a great multitude, you very often found something very much like silence instead; and he could not help thinking, that if this idea were worked upon by those who were well able to do so, they would be conferring a great benefit not only on music, but on the Church.

Mr. CUMMINGS said he had quoted from a Report, printed and published at Truro, in Cornwall, of a lecture delivered by a clergyman, who was the Precentor of that portion of the Diocese, in which he positively asserted that Gregorian music was of Divine origin.

Mr. PARRATT remarked that Anglican chants had never been tried in unison as Gregorians were. At the same time he believed that in the very churches to which Mr. Mackeson referred he would find a congregation singing the hymns, which were probably modern, with quite as much heartiness as the Gregorian chants. Mr. Hopkins had now published a volume of Anglican chants suited for unison singing, which he believed would be sung with much greater heartiness than Gregorians.

The CHAIRMAN said there was one point especially referred to in the paper that had been read, on which he should like to say a word. His musical studies had led him to set little store by musical tradition. He greatly distrusted it even in relation to national melodies, and he distrusted it entirely in regard to anything like a system of musical scales. He thought, therefore, the assumption that the present Egyptians or any other Eastern people had preserved a particular kind of scale through long periods of time, was one which ought to be supported by other than 'traditional' evidence, and he did not see where such evidence was to come from. All he knew with regard to keeping in mind, even for a few years, melodies constructed on a system upon which all were agreed, confirmed his distrust in musical tradition of whatever kind; and he could give a good instance of this in his own case. A great many years ago he was occasionally in the habit of singing many of Moore's Irish Melodies, and he went on doing so, without reference to copies of them, for perhaps twenty or twenty-five years. One evening Mr. Moore himself, in his last days, was brought to his house by Mr. Rogers, and after asking him (Mr. Moore) to sing, which he declined to do, he (the Chairman) asked to be allowed himself to sing one of these Irish melodies. He did so, choosing one of which he had not seen the notes since he had first committed it to memory. Mr. Moore, after expressing very politely the pleasure which he had felt, and so on, as an amiable old gentleman of his character would be sure to do, said, 'I see you have found out it does not do to sing them as they are written.' Of course he was very much horrified, and after Mr. Moore had gone,

he looked at the book and discovered that the melody before him certainly had the same sort of outline as that which he had just sung, but that he had altered its details very considerably indeed. With regard to the sources from which modern harmony was derived, it was generally understood to have come to us from the Northern nations. On the other hand, it was assumed that the Eastern races had no harmony, nor could they have had any, if their scales were of the nature described by Villoteau. Now it was generally understood that the Northern people came from the East, as did also the great Celtic race, whose music, or at any rate something which was supposed to be their music, was older than that of any other people, and more beautiful than that of any other people so old. The Celtic race and the Northern people both coming from the East was something like an argument in favour of the probability of harmony being very much more ancient than was generally supposed. He had made a note with regard to the use of *organizing* in the Middle Ages, but Sir Frederick had almost forestalled him in the very words he should have used in respect to it. The practice was identical with that of combining the composition stops with the diapasons of the organ, and he confessed he thought an exceedingly beautiful and similar effect might be produced by employing a very large body of men's voices on a plainsong, and a very few of women's or boys' singing consecutive fifths and octaves above them.

Sir F. O. Ouseley: How about the *fourths?*

The Chairman said he would not be responsible for the fourths. No one was more competent to try such an experiment as that to which he had referred than Dr. Stainer, and he hoped he would do so. He thought the French musicians in early days had been rather deprecated, because many of those described as Belgians were really Gallo-Belgians. The distinction between secular and sacred music was a very nice question, and he was not sure it was possible to trace it. At any rate, it was quite certain that in the finest ages of mediæval architecture both houses and cathedrals were built in exactly the same style. Something was said, too, about Scotland not having instrumental music, but he was happy to say that organs were being introduced as fast as possible, not only into the Church of Scotland, but into the Free Church as well. He was extremely desirous of seeing orchestras introduced into churches, but for the present he thought it would be desirable to limit them to stringed instruments. That might be done with great advantage, and he hoped they would have music written expressly for the purpose, with the proper organ and stringed instrument parts. With reference to that subject, he was inclined to think that in the great Church movement of forty years since, out of which a great deal which was now going on with reference to music had arisen, the clergy had been rather in too great a hurry in getting rid of parochial orchestras. In closing the music galleries, they had driven out of church a great many worthy people who had

worshipped with their clarinets and bassoons for many years; and they had given great offence and had done a great deal of mischief thereby. The thing to have done would have been to improve, not destroy, those orchestras, and he trusted they might yet see small bodies of instrumentalists in churches, a little better governed than those he could remember. A remark had been made with respect to ancient and modern music; by ancient, he referred to that of the sixteenth century, treating Orlando Gibbons (who lived into the seventeenth century) as perhaps the last of our old masters. Whilst he could quite understand anyone not liking ancient English or Italian music, and could allow for their taste in that matter, he could not understand the possibility of anyone getting tired of Gibbons in F. They might as soon become tired of the air, the clouds, the trees, or their daily bread, or anything else they met with every day. It seemed to him to be the most healthy music it was possible to conceive, and a little more study of that kind of music, and perhaps a little less of the ultra-modern—especially the French—school would, he thought, lead to a higher style of ecclesiastical music than anything we had yet seen.

February 7, 1876

WILLIAM CHAPPELL, Esq., F.S.A., in the Chair.

ON KETTLEDRUMS

By Victor de Pontigny, Esq.

The earliest musical instruments were most probably those of percussion. Music consists of two parts: rhythm and tone. To produce a tone requires a certain amount of constructive ingenuity; to obtain a variety of tones from one instrument requires considerably more, whereas rhythm may be produced by beating together any solid substances, or even by clapping the hands. By degrees, various as well as improved qualities of rhythmical sound would be discovered; and the stretching of skins over hoops or hollow vessels would soon suggest itself. In the latter case, especially, a musical tone or note would be the result.

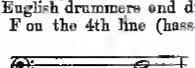
Various materials, as wood, pottery, and metal, have been used for making the vessel or body of this kind of instrument. There is in the Indian Museum, at South Kensington, a red earthenware pan, hemispherical, like a modern kettledrum, with a skin stretched over it, and here, as well as elsewhere, there are drums of fantastic shapes, some with one head (or skin) and some with two. Most of these drums have no contrivance for tightening the head. Once stretched by the maker, so it would remain. This was probably of no inconvenience where the pitch or actual note was of no consequence, and therefore did not require changing. Nor would the quality of the sound be subject to deterioration in the warm, dry climates of the East. Very different would it be in this country, where, with all our modern mechanism, drums lose their quality if exposed to the damp. Animal membranes are very good hygrometers, and I could sometimes have told the state of the external atmosphere merely by hearing the flabby tone of the kettledrums in the Crystal Palace orchestra, when they have accidentally been left uncovered for a day in damp weather. The same occurs with the side drums of a regiment.

I hardly know how to draw the line between tambourines and drums. It may be said the tambourine has only one head and is open at the bottom; but so are some of the tubular drums to be seen in various museums. So also is the gigantic tambourine called the gong-drum in modern orchestras, which is used as a convenient substitute for the bass drum, because it takes less

room, though very inferior in quality of tone. The tambourine is a skin stretched on a narrow hoop, light enough to be carried in one hand, and beaten with the other. There is in the Crystal Palace Museum a modern Egyptian tambourine; and as fashions remain unchanged for ages in the East, it is probable that Miriam's timbrel, 3,000 years ago, is practically identical with the tambourine used nightly by the Christy Minstrels at St James's Hall.

I have no intention of going seriatim through these 3,000 years; but will rather at once come to the subject of the modern kettledrum, the only really musical instrument of the drum family. Very little has been done towards investigating the theory and practice of kettledrum making. It is well understood that the instrument is to be a metallic vessel, like a pitch-kettle or cauldron, covered with a skin or head of vellum, and with sundry screws to vary the tension of the skin, so as to tune it to the required note. These screws work upon an iron ring, round which the skin in a moist state has been securely lapped. But the exact shape and size of the shell seem to be left rather to the fancy of the coppersmith than to the scientific musician. Now the best shape or curvature of the kettle, or shell, as it is called, and indeed the exact function of the shell, are subjects requiring scientific investigation; and my principal object in speaking of drums has been the hope of inducing some of our members to give us an explanation of the true theory of the functions of the shell. For if the theory of the shell can be properly ascertained, it might be easier to decide upon the best shape to be given to it. At present, as I have said, it is a matter of fancy. Either a hemisphere, or a little less than a hemisphere, or one of these forms with a cylindrical addition, are the usual varieties. Sometimes the shell is even semi-oviform, which gives two varieties; for amongst kettledrum makers there are big-endians and little-endians, as in Laputa. The head alone gives a good musical sound without any shell at all; witness the drums exhibited by M. Sax, the celebrated brass-instrument maker. But the addition of a shell unquestionably improves the quality of the sound.

The size is a much easier question than the shape; it depends merely on the range of notes required. Now what is that range? A drum may be fairly expected to give, by means of its screws, a fifth or five notes of the diatonic scale, all of good quality; and every orchestra has two drums, one larger than the other. The two combined can therefore be made so as to give a complete octave, one overlapping the other by a whole tone. But which octave is it to be? It appears to be well understood abroad, though ignored by English drummers and drum-makers, that F below the lines to F on the 4th line (bass-clef) is the octave required:



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and foreign drums are made of the requisite size to produce this octave. This point may be settled beyond dispute by referring to Beethoven's works. In his 8th and 9th Symphonies he has given to the drums this very octave in F:

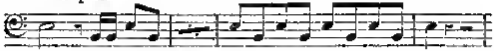
8th Symphony. 9th Symphony.

I would observe, on the authority of Berlioz, that these are the real notes sounded (the lowest violoncello F and its octave above), and not the octave below that range, as some people think.

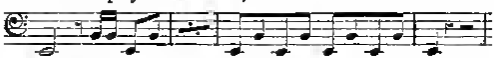
It is generally supposed that kettledrums cannot be too large. I once asked a drummer in a London theatre why he had such an enormous pair, and he said he had bought the largest he could find. Some say that a very large orchestra should have large drums. But I would just ask whether, in a band of several hundred performers, the violoncellos are replaced by double-basses; or whether, instead of each bassoon, you would use Dr. Stone's splendid contra-fagotto? Certainly not; you would double the number of bassoons, as is done at the Opera in Paris, and double or treble that of the kettledrums, as in the Handel Festivals at the Crystal Palace; but excluding, I hope, the monster drums, which only produce a kind of thunder undistinguishable as musical notes, and which might just as well be performed on one bass drum as on two kettledrums.

Another disadvantage of having drums too large, even when they do retain their value as musical notes, is that they may frustrate the intention of the composer. I remember being at a rehearsal of Meyerbeer's "Crociato in Egitto" at the old Opera House in the Haymarket between forty and fifty years ago, when Bochsa was the conductor, and Goodwin, whom we all know as a copyist and librarian, was at the drums. The passage (solo) was this:

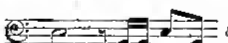
Timpani in E♭.



but Goodwin played it inverted, thus:



which sounded absurd. Bochsa immediately screamed out, 'Goodween! Goodween! I want

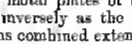


&c.'

'Then, sir, you can't have it,' answered Goodwin. Now, why could not Bochsa have it? Simply because the lesser drum was

so large that it could not be screwed up to the higher E flat, and therefore that note had to be got from the larger drum an octave too low, whereby the passage became necessarily inverted. With proper drums, F to F, all would have gone right as the composer intended.

No drum ought to exceed twenty-nine or thirty inches in diameter. What then ought to be the size of the smaller drum, if the larger is thirty inches? Here we want some experiments on the vibrations of membranes, for I cannot find in Chladni or elsewhere that any theory has been established. The difficulty of obtaining homogeneous membranes may have deterred philosophers from prosecuting the subject. Meanwhile we may assume as probable that the number of vibrations per second of membranes (tension being equal) is inversely as their areas, which is the case with metal plates of the same thickness. In strings we know it is inversely as the lengths. Now we have seen that the two drums combined extend from F to F, and that each one can have a range of a fifth. The larger drum can therefore give every note from the lower F to C,



and the smaller one all notes from B flat to the upper F,

that is to say, the smaller drum is a fourth higher than the larger. But the numbers of vibrations producing two notes at an interval of a fourth are to each other as 3 : 4; therefore the areas of the membranes or the squares of the diameters of the two drums must be to each other as 4 : 3, and the diameters themselves as $\sqrt{4}$. $\sqrt{3}$, which is as 2 : 1·732, or very nearly as 30 : 26. This comes true in practice, for the drums at the late French Opera House were 29 and 25½ inches, and those lately at the Crystal Palace 28 and 24½. I would again observe that no drum should exceed 29 inches or thereabouts.

I have said in an earlier part of this paper, that kettledrums are tuned by means of screws, generally about eight to each, a key being applied successively to each screw. This takes some time, besides causing a slight metallic noise, quite audible if the orchestra is playing softly. Foreign drums have a fixed T-shaped key to each screw, which avoids this, and also saves time. But these fixed keys are in the performer's way in passing from one drum to the other, unless a few of them, at what I may call the tangential point, are made to turn down. Composers should always allow a sufficient number of bars' rest for tuning, and conductors should remember that the drums cannot be ready if there is a change of key between two movements of a symphony, unless they allow sufficient time between those movements.

There are also several inventions for tuning by means of one motion. An ingenious musical-instrument maker, the late Cornelius Ward, took out a patent in 1837 for this purpose, the specifications of which may be seen any day at the Patent Office in Southampton Buildings. An endless cord passes over pulleys attached in a few places to the iron ring round which the head is lapped, and thence from the outside to the inside of the drum, where a long horizontal screw, worked by a handle outside, is made to tighten or slacken the cord, and so tune the drum. The tuning is done so rapidly that it is possible to play 'God save the Queen' on a single drum. The tension of the cord, shown by a spring indicator, is read off outside, so that the drum may be tuned by the eye as well as by the ear. For the note depends on the tension of the head, which is shown by that of the cord *. The patent having expired, these drums can be made by anybody that chooses. Potter makes a drum in which curved bars come down outside from the head to the bottom of the shell, where they are tightened or slackened by a screw turned by the performer's foot; or else by turning the whole drum bodily round.

Einbigler, of Frankfort-on-the-Main, has a contrivance consisting of a movable hoop just inside the shell, which can be pressed upwards more or less, so as to vary the tension of the skin. This is worked by a handle outside the shell. I heard these drums last summer in the theatre at Frankfort, and they seemed to answer very well. The price was 400 florins (about £34) for the pair. It is very desirable in any contrivance of this sort to have small screws all round, by which *equality* of tension may be secured. In ordinary drums, if carelessly tuned, we often find that different parts of the circumference present a variety of different notes. And even if the tension is equal, a slight difference of thickness in any part of the head would require a slight correction of tension in order to obtain equality of pitch. It is not to be expected that any membrane can be perfectly homogeneous. Einbigler's drums possess this means of adjustment. But a wide field remains for inventors to improve upon these several plans.

Kettledrums are generally made of copper in this country, and of brass abroad. No particular reason beyond habit is assignable for this difference. As regards the heads, we generally see a thick opaque white skin used, about the colour of ivory. But a thinner and more transparent skin gives a far finer tone, and such should be always used.

Another important point is the choice of the sticks. The old-fashioned ones have a globular knob, about the size of a small orange, and do not bring out the true ringing tone. Those ending in a disc of felt are much better. But the best

* Mr. Ward told me that in the course of his experiments he had found that the note given by a drum under a tension of 37 cwt. was an octave above that given by the same drum with a tension of only 11 cwt.

of all are those having wooden ends in the form of a button, covered with a thin piece of very fine sponge, the stick itself being of whalebone. It is not always easy to get whalebone thick enough or sponge fine enough, and both are always dear: I have therefore devised, and Rudall & Co. have made for me, a substitute in which whalebone is replaced by vulcanite and sponge by felt, but without any interior button. The felt should be either in one or three pieces, otherwise a zone of hardened cement as well as the felt will strike the drum. These two kinds of sticks answer very well, and enable the performer to produce the loudest as well as the softest effects. The heads of all sticks should be of a very moderate size, not exceeding $1\frac{1}{4}$ inch in diameter, so that only a small surface may come into contact with the head of the drum. The quality of the sound is thus clearer and more definite. It is true that a sphere can only touch a plane in one point theoretically, but that refers to a solid sphere and plane, whereas in our case both are of yielding materials.

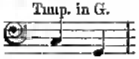
Kettledrums should be placed in a slanting position towards the performer, as the blow then falls easier to the hand than when they stand horizontally. They should never be struck in the centre, but at a point distant about one-fourth of the diameter from the circumference. The bass drum, which is a large cylinder with two heads, must on the contrary be struck in the centre of one of the heads. The stick ends in a soft round knob. The side drum is of similar shape, only very much smaller, and is struck in the centre by two sticks, made entirely of hard wood, ending in a small knob. Across the lower skin are several pieces of catgut, called snares, which rap against it at every stroke, and merely produce rhythmical noise without tone. The kettledrum roll is produced very differently from that on the side drum. In the former each stick gives a single stroke alternately, but on the side drum each gives alternately *two* strokes, commonly called 'daddy-mammy.' This latter is very difficult to acquire, and must be learned at an early age.

The kettledrum roll is not so difficult, but still everybody is not able to do it. It is quite a fallacy to suppose that any fool will do to put at the drums. I have seen a yeomanry corps march into a town, headed by its very tolerable band; but a youth was put on horseback to beat the drums, who had not the remotest idea that it could signify which drum he struck; so he flourished about, right and left, in the most picturesque manner he could, as often beating the right note as the wrong one. And at a professional concert in a fashionable town near London, with an excellent orchestra, a boy was set to play the drums who could not even be made to beat a triplet in time. A kettle-drummer ought to be an excellent musician as regards time, both when playing as when counting some 50 or 100 bars' rest; and also able to feel exactly what his part is contributing to the effect of the whole score. The late Mr. Hogarth says that a single stroke

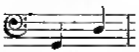
may determine the character of a whole movement, and the slightest hesitation, or the misapprehension of the requisite degree of force, may ruin the design of the composer. Even the late Mr. Jenkinson, the chief drummer of his day (the predecessor of Chipp), once came in a bar too soon in a chorus of 'Joshua,' and was so mortified that he inflicted summary punishment on himself by beating his own head with his sticks. Fétis says that there is a notable difference between drummers that have been taught in the same school, and that a certain tact is required which cannot be analysed, but is nevertheless essential and real. Another difficulty is that of tuning the drums, as it requires some experience to appreciate the exact note sounded. To illustrate this, allow me to ask, how many of the able musicians in this room would undertake to tune the last four or five strings in the bass of their pianos?

The old practice of writing drum parts invariably in the key of C, like trumpets and horns, is very inconvenient. For instance, if the composer writes

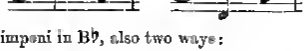
Timp. in G.



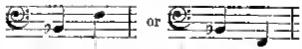
the C becomes a G, and the G a D; and as the G is too high to be got out of the smaller drum, it must be taken an octave lower on the larger, and the real notes will be



inverting the passage and confusing the performer. If the same passage is for Timpani in F, there are two possible ways of executing it, viz.:



and if for Timpani in B♭, also two ways:



The composer should therefore indicate which of the two ways he wants, by writing the real notes. (It will be remembered that the united range of the two drums is from F to F, one octave.) When three drums are used together, as in Spohr's Historical Symphony, no other method of writing would be intelligible. The same with Mendelssohn's Capriccio in B minor, where the drums are in D and E, a most ingenious contrivance, whereby they are available, without any change, in the key of B minor as well as in that of D major.

Drums are heavy and inconvenient to move about, especially

in travelling; but by taking off the head of the larger, and screwing the lesser firmly inside of it, and putting on the head again, the hulk, at least, may be diminished.

If I thought copyists and engravers could hear me, I would entreat them to discontinue spelling timpani with a *y*. The word is Italian, and the letter *y* does not exist in that language.

I would just mention another instrument of percussion—the triangle; the shape and size of which, in this country, seem to be left to the blacksmith's taste. But I have here a very good one of French manufacture, such as is used at the opera in Paris. It is an isosceles triangle, of which the height is 7 inches, and the base 6½. The beater is tapered, so as to produce loud or soft tones, according to the part used. This instrument suits all keys, for it gives out many subordinate tones (not harmonics) besides the fundamental one, and thus produces an indefinite clang like cymbals.

To sum up, these are the points I wish to insist upon:—1st. That no drum should exceed 30 inches in diameter, and that the range of the two drums together should be from F to F. 2nd. That the transparent thin vellum heads should be used instead of the thick opaque ones. 3rd. That sticks with small knobs of sponge or felt should be adopted.

If the Association see fit to support my views, the uncertainty in the make of these instruments would cease, and their effect become generally improved. In conclusion, I would repeat the hope that some one will undertake to explain to us, theoretically, the way in which the shell of a kettledrum modifies and improves the tone of the head. Experiments are also wanted to determine the best shape for the shell. Such investigations are perfectly legitimate objects of our Association, and we fortunately possess many members highly competent to carry them out.

DISCUSSION.

Dr. Stone said the subject was one of great importance, to which he had given some attention, and perhaps it was one which had not hitherto received sufficient notice. He wrote to Mr. de Pontigny, asking him what was the literature on the subject, and received as reply, that it was a blank; which he found to be the case. The subject was an exceedingly difficult one, incompetent to be met by mathematical investigation. Here and there a proximate formula might be found; but without going into abstruse points, he would like to mention one or two matters, and before doing so would say that he thought Mr. de Pontigny had done good service by bringing the subject forward. Everybody would agree, he thought, that the function of drums of all kinds was to accentuate certain notes, or to reinforce the bass tone of the orchestra. Besides this, there was their melodic use, and there

were many specimens of this in Beethoven The case of Bochsa was that there were only two drums present, and thus the first had to be inverted for that which belonged to the third What was wanted was a third drum in the interval, to be written without transposition. In the case of the melodic instrument, the time-keeping was done by the side-drums, which kept up a sort of terrible noise, made more *crassant* by adding a piece of catgut, and by a bass gong and drums of various kinds, which uttered a sort of boom. The drum, as a melodic instrument, he thought, should be on a sixteen-feet tone. He had a very old hobby on that subject: he considered himself the apostle of the sixteen-feet tone—the thirty-two feet tone, if possible. It would be agreed, he thought, that when they got a fine tone in the sixteen-feet octave, it supported everything, and seemed to give a foundation which hardly anything else was competent to give In the double basses and trombones you might take half in the sixteen-feet octave, and half in the eight-feet; but no doubt drums ought to be of size enough to bring out a good sixteen-feet note. His own experience was that in our large orchestras, like the Sacred Harmonic, the Crystal Palace and the Handel Festival, the drums did speak a sixteen-feet note If so the drums sounded in unison, and were not playing an octave above. There should be, he thought, a great predominance of the sixteen-feet tone, the eight and twelve coming in to give the name and the character to the note. Then, as to mechanical construction, we were intensely behind They were playing the music of the future with the drum of the past. Owing to the unfortunate mechanism, the drummer had to go round ticking, and making a nasty noise, which ought to be exorcised and driven out of the musical world as soon as possible Mr. Cornelius Ward's plan was very good, except that in about one evening in three it broke down There was a German plan which he believed was much the same as Potter's, and also a plan by which there was a lever under the drum. The drum was very difficult to tune; it required great experience, and a certain knack had to be acquired Perhaps the drum, from its very compound note, was even more difficult than other bass notes; he thought a good deal might be done towards getting an accurate note, by attending to the construction of the kettle, which seemed to be made rather by a rule of thumb He had had a good many experiments made, and was now continuing them, the result of which he hoped to communicate to the Association on some future day He believed the hemispherical shape answered very well, and also the cylindrical shape Why they should not make the kettle a regular shape, and tune the kettle so as to consonate with the membrane, he did not know. The difficulty in appreciating what the drum was doing, arose from the fact that it was doing two things at one time The membrane was doing one thing, and the kettle another. There was a difficulty in tuning the kettledrum, because it was somewhat unwieldy; and he would suggest, as you could tune a

cavity, by opening that which connected the cavity with the air, that there might be a closable cavity, and thus a drum could be made to vocalise as the lips of a speaker vocalised. There should be some standard of pitch, by which the drummer should be guided, and it should not be left merely to the ear. He believed a good deal might be done if the drummer had beside him a set of reeds corresponding with the possible note to which the drum should be tuned. If the drummer had a simple octave of reeds, he could take a reed, compare the note, and be able to tune his drum accurately.

Mr. DE PONTIGNY thought the idea of being able to open the cavity would yield good fruit, and hoped some one would go minutely into the functions of the shell, because he believed there was much to be done

FEB. 7, 1876

WILLIAM CHAPPELL, ESQ., IN THE CHAIR

ON SOME POINTS IN THE RECEIVED METHOD OF WRITING AN ORCHESTRAL SCORE

By Professor W. H. MONK, of King's College.

I VERY much fear that the observations I have undertaken to bring before you to-day, under the dignified title of a 'Paper,' may be disappointing, for more reasons than one. I fear that they should have been illustrated by diagrams, for one thing, but I found that their adequate illustration in such a manner would have been too cumbrous for this, or any other like room, since they have to do with an orchestral score. Thou I fear you may think me very revolutionary, for I am proposing to quarrel with old-established customs: with the way in which the pitch of certain orchestral instruments is represented on paper; and with which I cannot, probably, give any very scientific reasons for quarrelling.

In the short experience which this Society has, up to this time, given us, we have enjoyed a succession of papers remarkable for the width of their scope and for the completeness with which they have been treated.

It appears to me, however, that there may be found many points in the theory and practice of our beautiful art, which would afford interesting topics of discussion here, and on which we should derive great advantage from an interchange of opinions; which are yet not of the importance to occupy an entire sitting. Take the doctrine of forbidden consecutives as an instance. Every writer in music has tried his hand at a definition of the rule on this subject: what the forbidden thing is, and why it is forbidden; but there seems, in practice, to be anything but agreement about it.

It has fallen to my lot, during the last ten or twelve years, to receive almost a house-full of contributions of the shorter kind of sacred musical compositions, on which it was my duty to express an opinion. I do not speak of the voluminous contributions of amateurs, in which every conceivable progression was licensed by the writer for the occasion; but of the work of acknowledged musicians. Occasionally an instance of such quasi-forbidden consecutives cropped up. I then invariably made inquiry of the author, as to his intentions, and he invariably said, 'O yes, I know all about this: it is quite permissible,

in this way: pray allow it to remain. I take all responsibility:' and so on. Couple with this the fact, that when I was reprinting the Chorale from Mendelssohn's 'St. Paul,' 'To God on High,' I was recommended by one of the highest musical authorities in this country to 'correct' the consecutive fifth to be found in it. You will then perhaps agree with me in thinking that there must be underlying all the given rules on this subject some principle of good or bad, allowable or not, the *expression* of which we have not yet been happy enough to discover; and that in discussing such points in a meeting like this, some word or thought might escape, which we should be glad to seize and appropriate as the right way out of the difficulty. For that there is a difficulty in persuading a young student that a rule is just and necessary, which he sees, and you have to confess, has not been always acted upon by the great masters, all who have any experience as teachers will allow.

But I have undertaken to bring before you to-day a different point, as to which the statement I shall have to make will cover a very small compass, and which will derive its importance entirely from the discussion I trust it will provoke.

If there is a part of musical practice which it is natural to bring into unison with scientific knowledge as far as possible, it is in the exactness, or truthfulness, in which the written character shall represent the performed effect. I imagine we are all agreed upon this. Though there are some who think it advisable to invent a new system of writing music which does not possess this pictorial quality, the advocates of the old notation cling to it because it claims to represent to the sense of the eye what the sense of the ear is to expect. We derive one of our greatest pleasures from the perusal of the scores of works which we may never actually hear, and it is a matter of importance, therefore, that the relation between eye and ear shall be as closely maintained as possible; especially when it is remembered that the orchestra is daily more and more freely used by modern composers, and that the score becomes, correspondingly, more intricate to read. I hope that we may not be exposed to blame if some of us should think we have fallen into a method in which eye and ear occasionally perplex and even contradict each other.

The question which I venture to ask you, then, is this: Is there any good or sufficient reason why the parts to be played on 'Transposing Instruments' such as clarinets, horns, trumpets, drums, should not appear in the full score at the pitch we are to hear them played? I maintain that such a plan would greatly simplify the perusal of the score; and that it can be done without sacrificing any advantage of the present custom: indeed, I doubt that any such advantage exists.

The transposing instrument which plays the most important part in the orchestra is the clarinet. No more important addition has ever been made to the old original orchestra of violins and hautboys than this lovely development of the ancient chalumeau.

We all know that a passage written in the key of C would, on the C clarinet, sound as it stands:

On the A clarinet, a minor 3rd lower.
On the B flat clarinet, a major 2nd lower.
On the small E flat clarinet (used only in military bands), a minor 3rd higher.

To assist those who may like to start from the beginning, and to trace the connection between the natural instrument and the way in which its music has come to be written, let us suppose that the clarinet was originally long enough to sound the note C. It was then a tube, bored on a plan to produce a scale of a certain number of notes. In such a tube, giving tones of a certain desired quality, some notes are much more difficult to produce than others, and there has always been an endeavour by all concerned to add to the compass, both up and down.

Still preserving the desired quality of tone, it is possible, by lengthening the tube a trifle, to make it sound B flat, a tone below the normal pitch, and even, by a still further addition to its length, to add another semitone to it, A. Further than this it would not be possible to proceed, without destroying in the upper part more than was gained in the lower.

But, this having been done, it has been found that certain notes are best on the C clarinet, certain others on the B flat, certain others on the A; and this is one of the reasons why, instead of making the longer clarinet and being satisfied with it, we have retained all three, which is accomplished by manufacturing a C clarinet, and then furnishing the performer with a varying set of tubes which, fitting into the parent tube, so to speak, produce it to the B flat or to the A length, at pleasure. This has the great advantage of assimilating the fingering of the three sets of scales which can be best commanded by the three lengths of tube respectively, of making, for instance, a scale which would be very difficult on a C clarinet, easy on that in A.

It has thus arisen that the C clarinet is considered the normal instrument, and because of the fingering and plan of the boring and keys being the same, the scale of C has been also considered the normal scale, and the scale of the B flat clarinet, and of the A clarinet, has been also *written* as C, with a special direction at the beginning of the movement that the B flat or the A instrument is to be used. For all, the player fingers as for the C clarinet, but the varying length of tubing at his command enables him to arrange the instrument so as to speak at the pitch required. Now all this is perfectly natural, simple, and inevitable, unless we are to be satisfied with such sounds only as are given by the parent tube.

The C clarinet would thus play all the music written, *as* written: but the B flat clarinet would play a tone lower, and the A clarinet a minor third lower, the difference in pitch between C and the A below it. To look at the same fact in another

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application of it: if we write a passage for the C clarinet we write the notes we expect to hear; but if we prefer the tone of the instrument in B flat, we write as much higher than the notes we expect to hear, as the instrument is lower than C, i.e. a tone (or in the key of D), and if we prefer again the characteristics of the A instrument, we write as much higher than the notes we expect to hear as A is lower than C, i.e. a minor third (or in the key of E flat).

The skill of the composer is shown in his choice of that particular clarinet which will produce the best effect in the key in which his composition lies, and it is because this key is liable to change, that he sometimes changes his clarinet in the course of the movement.

This is part of that large knowledge of effect which a judicious use of all resources of the orchestra implies, and the study of which, in all its endless variety of detail and combination, can only terminate with life itself.

For those to whom the consideration of this process is new, it may be permitted to add that the working of it throughout all keys brings the *signature* of the part for the B flat clarinet to represent always *a key* a major second above that in which the parts for the violin quartet (or for the oboe and other non-transposing wind instruments) appear; and that for the A clarinet a minor third above. For a composition in C (or A minor) the C clarinet would be written in unison apparent, as well as real, with the violin quartet. But if the B flat clarinet be used, as is frequently the case, even for the key of C, then the part would be written a note higher, with the signature of the key of D (two sharps).

If the composition be in B flat major (or G minor), the signature of the B flat clarinet part would be that of the natural scale.

If the composition be in F (or D minor), the signature of the B flat clarinet would be that of G with one sharp.

If the composition be in E flat (or C minor), the signature of the B flat clarinet would be that of F (or D minor).

If the composition be in D (or B minor), the clarinet in A would be employed, and its signature would be that of F, with one flat.

What I ask you to observe is that the *apparent difference* between the key signature of the composition and that of the clarinet is continually changing; and the connection between the sense of the eye and ear is as often and as variously contradicted.

I have confined my statements purposely to the two clarinets most in use. It would be interminable to recite examples of the transpositions of the D clarinet (not much used, however) and of the two small clarinets used in military bands. The case of the corno di bassetto, and of the corno Inglese is, of course, similar.

The transpositions of the horn are more numerous still. If a given passage in the natural key were played on the B flat alto horn, it would be transposed a second below; if on the A horn, a minor third; if on the G horn, a fourth; if on the F horn, a fifth; if on the E horn, a minor sixth; if on the E flat horn, a major sixth; if on the D horn, a seventh; and if on the C horn, an octave below: so that a written passage of the horn part may be *anything within an octave lower than it looks*—nay, within a ninth, for I have omitted to mention the B flat basso horn, which transposes to that interval. Moreover, when the pair of horns is doubled, two are usually in the key of the tonic, and the other two either in the key of the dominant or of the mediant, so that their transpositions *differ* accordingly.

As I said before, these transpositions are natural and necessary, as far as the instruments themselves are concerned. They start, indeed, imprimis, from the natural imperfections of the instruments, whence the necessity of a lengthened tube in the clarinet, and of a system of crooks in the horns. What I complain of is, that as soon as we get a new length on to the tube, or a new crook on, we have a new notation of the instrument. Nor should I object to this, if it were carried out only in the printed 'part' used by the performer; but why it should ever have been brought into the score is a thing I cannot conceive. It is a matter of the structure of the tube and of its influence on the details of the fingering, and it ought never to have made its mark elsewhere. You will say, perhaps, that the natural imperfection of the instrument should follow it, and be represented in the score; that we should be reminded by the very appearance of the line of its part, that it has imperfections; but this, to my mind, is an exceedingly fanciful and sentimental argument, and one in which I can see no force.

Compare the transpositions made in the tube of the clarinet, or by the crooks of the horn, with those of the mutation stops on the organ. Here we have stops either sounding one, two, or three octaves above the notes played, or a 12th, or a tierce (major 10th) in combination with it. Each note of the most simple, or of the most far-fetched harmony, is accompanied by these harmonics. Each note becomes a prime or root bearing its own invariable accompaniment of 5, 8, 12, 15, 17, 19, 22. Do we expect to see all this on paper? It belongs to the mechanism of the instrument, by which its effects are produced; and so do the crooks and the tubings of the orchestral instruments of which we speak. What we want to *see* is what we should be expecting to *hear*.

But I anticipate the possible statement of a difficulty as to the intention of the composer, were these parts written into the score as they should sound. How about the performer? it will be asked. Let him be provided, I reply, with his part, exactly as at present, copied and transposed from the score, under the eye of the composer. No difficulty will be experienced in this our time,

in finding a copyist fully equal to the task. Such people make transpositions of all sorts, every day, and many of them are competent for much more than this mechanical employment. I see no reason why the performer himself, in a constituted orchestra, should not do, or superintend the doing of this, which involves no labour of which a musician need be ashamed, or think beneath his attention. If the part be printed, once right should be always right: and if not, the first rehearsal would find all faults; and then again, once right always right. If what I recommend be an improvement, no *clerical* objection like this should be a serious hindrance.

Nor should it be supposed, either, that I am desirous of sacrificing anything in the scientific exhibition of music which is worth preserving, or of reducing the intricacies of the art to a supposed lower standard of intelligence: of 'popularising' the art of reading from score. On the contrary, I am desirous of undoing much that has been done (I am sure, unwillingly) within the last century in that direction. I regret, as utterly uncalled for, the exhibition of the alto and tenor parts of the vocal score on the treble clef, as if the man who has any capacity for sustaining the part can have any difficulty in seeing it in its proper character, and in its true relation to other vocal parts. There exists no small quantity of vocal concerted music in which it is difficult to say by what voices the various parts should be performed, for the want of the proper clefs; and I need hardly mention, in this connection, the absurdity of some pianoforte scores of operas, in which even the bass voice part is printed, like the rest, in the treble stave.

For the same reason, I should prefer to see the upper part of the violoncello part printed with the C clef, in *its proper register*: not with the G clef 'to be played an octave lower.'

So with the lowest octave of the clarinet part,—the chalumeau part, as it is termed: let it go on to the stave with the C clef on either the 3rd or 4th line as may be best.

And I doubt whether we have not lost something of 'vraisemblance' in the disuse in the vocal score of the soprano clef on the 1st line, for we lose the distinction between it and the 'violin' clef, that of G on the 2nd line.

But we should not, on the other hand, needlessly encumber any portion of science or practice, so as to deter the moderately informed amateur from further study. There is many a man who cannot play a note, who can yet make out very fairly the intention of a vocal score, to whom the transposed lines of a full score are as a tall dead wall in the middle of a mountain ramble, not to be seen through and particularly disagreeable to climb over. Amateurs of our art are valuable to it in proportion to their acquirements; and the time is past when in every inquirer a professional clique saw an enemy in disguise.

That there ought to be no objection to what is proposed on

the scientific side, however, may be considered proved by the simple fact that it *has* been done *already*, and that, among others, by one of the very few musicians who have earned lasting fame as *composers*, and as *teachers too*. I mean the illustrious Cherubini. His celebrated 'Requiem,' the opera 'Les deux Journées,' the Mass for three voices in F, and the opera 'Anacreon,' all present examples of the clarinet parts printed without transposition. In the latter is a part also for the 'cor Inglese' (which transposes a fifth), printed also in the playing key.

Nor is this the only illustrious name to be cited of men who have in their published works shown the possibility and reasonableness of what I advance. Boieldieu, in his 'Caliph of Bagdad' (of which two editions were published in full score within two years), and Méhul, in his 'Joseph,' and in 'Ariodant,' an opera dedicated to Cherubini, have pursued the plan desired, apparently without accedant to the performed effect of their works, as assuredly without injury to their own reputation.

There exists, indeed, one small opera, which from our point of view is a curiosity. It is entitled 'Bayard à Mézières, opéra comique en un acte; musique de MM. Chérubini, Boieldieu, Nicolo et Catel; représenté pour la première fois à Paris, sur le Théâtre Impérial de l'Opéra Comique, Samedi, le 12 Février, 1814.'

It was a work commissioned by the Government to inflame the military ardour of the Parisians, and consists of an overture by Nicolo, and of ten vocal numbers, of which Cherubini wrote three, Boieldieu two, Nicolo two, and Catel three. In the published full score the clarinet parts are printed in the playing key without transposition, in the numbers contributed by Cherubini and Boieldieu, while in those written by Nicolo and Catel they *are* transposed.

After this it cannot be said that there is anything scientifically wrong in my proposition; it is at *least* reduced to a matter of indifference; and if I show a convenience and a truthfulness on the one side of the revolution, I have shown enough. Practically, I believe, that this habit of transposition in the printed or written score is a mistake on the face of it, and of no more practical use than was the mediæval doctrine of *Prolation*, by which the semibreve contained at one time two, or at another time three minims as its equivalent, according as the prolation was perfect or imperfect, and which 'perfect or imperfect prolation might also occur in perfect or imperfect time, that is, in time having three semibreves equal to the breve or two.' A very pretty state of things, and provocative of a terrible misappropriation of a line of Shakespeare. These notations—

> Are deceivers ever,
> One foot in sea, and one on shore,
> To one thing constant never.

DISCUSSION.

Mr. Chappell having vacated the chair, it was taken by Mr. Osborne.

The CHAIRMAN said he saw no reason why the clarinet part should not always be written in the key of the composition; but if an overture were in the key of C, the person who had to play the clarinet invariably played it on a B flat clarinet. He would be glad to hear some reason assigned why the C clarinet should not be used when the composition played was in the key of C. Some gentlemen present, who were in the habit of writing scores, might perhaps elucidate the subject.

Mr MANNS said he could state why they were compelled to use different clarinets. It was simply on account of the mechanism of the instrument. He illustrated this by a bar or two of music, showing the almost impossibility of the fingers keying the notes. As regarded notation, he said, to write always for a C clarinet would cause an immense amount of labour; and added that, from motives of economy, a clarinet player often had only two instead of three instruments.

The CHAIRMAN repeated his inquiry, why a clarinet player should take a clarinet in B flat when the composition was in the key of C?

Mr MANNS replied that a player preferred to play on one instrument as long as he could.

Mr. STEPHENS remarked that Professor Monk had not told them the keys of the pieces in which the clarinets referred to were used. If the pieces were written in extreme keys, he would like to ask what indication there was at the commencement of the score that the orchestral parts were to be kept for clarinets of a different pitch; or was it left simply to the skill of the performer?

Mr. BOSANQUET read some observations which had been forwarded to him by Mr. Walter Parratt, Mus. Bac. Oxon., who was unable to be present, to the effect that if the question concerned only conductors of orchestras, or even professional musicians, there need be no attempt to disturb it, because they ought to be able to read the scores now in use with tolerable ease, notwithstanding the rapid changes of an operatic full score. But in view of the intelligent interest shown by many amateurs in full scores, it became important to discover some means by which the reading of them should be made somewhat more easy. Greater clearness might be obtained by writing the real sounds by transposing instruments, and fixing the order in which they should appear on the page. He suggested the employment of different colours for the various families of instruments, as being the most ready way of showing the place of each, and did not think the difficulty and cost of printing need stand in the way. Upon the point of colours, he had found a remarkable agreement

amongst musicians; and he suggested Black for strings and voices, Red for brass and drums, and Blue for wood.

Mr. H. C. Banister said he understood Professor Monk to speak against the use of the soprano clef with regard to alto and tenor voices, whereas he thought the Professor meant the treble clef.

Professor Monk replied that when he spoke of the soprano clef of the first line he meant Do clef, but he advocated the employment of the Do clef for the alto and tenor voices of the vocal quartet. With regard to what Mr. Manns had said, he would add that in his paper he expressly stated that the actual transposition in the use of the various kinds of clarinet was perfectly indispensable, unless they made up their minds to do with the notes which were only to be produced on one of the three clarinets, which was not to be conceived. All he advocated was, that the clarinet part should always be written in the score as if it were for a C clarinet. But he anticipated a possible objection on the part of the performer, and replied that he would have the performer provided with his part exactly as at present. He was afraid the employment of the G clef for the inner parts of the vocal score had been of the family of commercial matters which cropped up occasionally amongst them. He supposed the great incentive to the employment of the G clef in the inner and alto parts came from Dr. Clarke, the thing was perpetuated when Mr. Alfred Novello commenced his cheap editions, and so it had gone on. He might mention that some years ago Mr. Alfred Novello said to him, at the conclusion of a lecture he was delivering at the London Institution, that if he had to begin his series of Oratorios again, he would use the proper clefs. With regard to the Do clef on the first line, he agreed it was unnecessary, and it would be expedient to remove it; and he had spoken of that in the language of doubt. His own preference would lead him always to use the Do clefs for the alto and inner parts, if he had the opportunity of doing so. The very gist of his idea had been that they ought actually to see the note to be produced represented at its proper pitch, whether producible by any voice of the vocal quartette or by any instrument whatever. As to Cherubini's indication of the scores, everyone gave him credit for being able to use the three instruments, and therefore using them when necessary.

Mr. Stephens said it did not appear, from what Professor Monk had said, that Cherubini gave any indication.

Professor Monk replied that he would not be expected to write in the key of four sharps.

The Chairman said Professor Monk had really anticipated the objections which had been made, and they were very much indebted to Mr. Manns for his practical illustration.

The meeting then closed.

March 4, 1878.

JOHN HULLAH, Esq., LL.D., Vice-President, in the Chair.

ON STANDARDS OF MUSICAL PITCH

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

Dr. Stone said he did not intend to go into the question of any particular pitch, but rather to deal with the difficulties of keeping to a pitch when it was obtained. This was a constant source of difficulty, particularly in orchestras, where the wood instruments were constantly varying. In almost all cases the pitch tended upwards. The process of ascertaining with exactness the number of vibrations per second, either by means of the siren or any other instrument, was long and tedious; but in taking the French pitch as a standard, there was this advantage, that it had been ascertained once for all, by very competent men, and tuning forks had been made in accordance with it which varied very little, and could be produced in great numbers with considerable accuracy. Such forks, therefore, formed a good practical standard for experimental use, because, if you set two forks in vibration the beats were clearly perceptible. On the other hand, they had disadvantages. In the first place, the sound was very feeble and evanescent, and in the noise of an orchestra almost inaudible; besides which the beats, on account of the pure and rather dull character of the tone, were very faint at a distance; and after all it was by means of beats that tuning must be accomplished. Temperature again affected these forks very much. He had on the table several common tuning forks, such as were generally supplied by the trade, and although they were not so well made as the French, still they were very fair. There was a slight amount of beating usually perceptible between two of the same pitch arising from defective workmanship, but on warming one fork even to the temperature of the body, the difference became greatly increased.* A tuning fork, then, was not absolutely accurate. Their evanescent tone might be made more permanent by exciting it with a fiddle bow, but with an ordinary high-pitched fork you rapidly wore away the hair of the bow without producing much effect. There was no doubt a better way which deserved to be tried, although he had not been able yet to carry it out, namely, to put them in vibration by means

* Perronet Thompson showed that a fork giving treble c a or middle c at freezing point flattened by the third of a comma when dipped in boiling water.

of galvanism On passing an intermittent current through them you might obtain a permanent tone; but it would require care to bring it to pitch Helmholtz had succeeded in doing this, and it was no doubt sufficient for the purposes of the physical cabinet, but for an orchestra, or for tuning an organ, it was hardly practicable.

The next thing which suggested itself was the string, but strings of course were eminently affected by temperature, even if made of metal, and those of catgut were also very much affected by moisture, so that they not only varied in consequence of heat, but also in thickness, being swelled by moisture, even that of a damp hand A violin string therefore could never be for two moments exactly of the same pitch, and this was fortunate in one respect, because it compelled the player to depend entirely on his ear, which thus had to be cultivated very specially Ultimately no instrument gave so accurate intonation as the violin He would now repeat an experiment which he brought some time ago before the Physical Society of London, for showing the difference in the tone of strings caused by variation in temperature It was well known that when a current of electricity passed through an insufficient conductor, the latter became heated according to definite laws when a metal string was heated it lengthened, and its elasticity also became to a certain extent altered On the table was a sonometer, with two strings upon it of different metals, very nearly in unison, the beats being only about one per second But on passing a current of electricity through one of them, the tone immediately began to alter, not only in pitch but in quality. The pitch varied very nearly an octave: a difference no one would have expected to arise from such a comparatively slight variation in temperature That result was obtained with a brass string; on repeating the experiment with a steel string, heated by the electric current, it soon sank far beyond an octave, a result which as a musician he should *a priori* not have deemed possible It would be recollected that some time ago Mr. Baillie-Hamilton, in a paper read before the Society, described coiled springs which he had invented, and which appeared to possess very valuable properties, one being that they varied very little in tune. Now by this method of experiment that quality could be tested This he would proceed to do The coiled string was found to vary very slightly in pitch, sinking barely half a tone

In wind instruments they had a much more complicated problem to deal with, because in such instruments there was a sort of compensating action under the influence of warmth and climate In the first place, the material of the instrument, especially if it were metal, expanded with heat, and thus the whole instrument became flattened; in this way, when taken out to hot climates, they were found to decline in pitch very much; but brass instruments in this country, where the climate was generally cold, whilst they enlarged slightly by heat and thus flattened,

the air passing through them, especially if it were the human breath, became rarefied, and the tone in consequence was raised or sharpened. In this country the latter action predominated. Not long ago he obtained conclusive evidence on this point. A full brass band was sent out to India, the instruments being very carefully tuned beforehand to orchestral pitch, by a competent person. When they arrived in India an intelligent bandmaster, who had the means of ascertaining their pitch very accurately, took charge of them, and he found them far below the proper pitch. The fact was, the metal in that warm climate, which ranges generally above 100°, expanded, and there was no compensatory action going on at all, because the normal temperature of the healthy human body does not vary much, being generally about 98°·4, whilst it seldom, even in the hottest climates, rises above 99°, so that there a cold player was blowing into a hot instrument, instead of what occurred in England, a hot player blowing into a cold tube. A French horn, for instance, was really about 26 feet in length, though ingeniously coiled up into a small compass; hence it sank very appreciably with heat, owing to the expansion of the metal.

In speaking of organ pipes, he should point out that the expansion and rarefaction of the air caused considerable sharpening of tone, not that they varied so much as orchestral instruments, because in ordinary cases they were played with wind at ordinary temperatures; but still, as they all knew, they were sometimes exposed to extraordinary variations—sometimes falling as low as 32°, and at others as high as 80°; the differences in pitch were very much greater than might have been expected. He had constructed a simple apparatus for the purpose of illustrating this effect. It consisted of a voicing bellows, the air from which passed through two vessels, in each of which was a spiral pipe; one of the vessels contained ice and the other boiling water, so that there was a definite difference of temperature of 100° centigrade between the two. The effect of thus cooling or heating the air on the resulting tone in an organ pipe was very remarkable. It was shown in the first instance by means of a flue pipe, which being attached to the orifice whence the air at 32° was issuing and tuned in unison with a wooden stopped pipe, was then transferred to the hot air tube, when the beats became very marked indeed. The same experiment was next tried with a metal stopped pipe, which underwent a slightly different course, taking rather longer for the effect to be produced, but still it was quite as perceptible ultimately. He attributed that to the fact that the upper part of the pipe kept cooler than in the open flue pipe. Metal and wood of course differed decidedly in variation, because pine wood, such as was used for organ pipes, was very little sensible to expansion, and the whole effect was due to the included air. The difference in pitch caused by rarefaction was also shown in another way, by affixing a pipe to a receiver in which hydrogen gas was collected, when a total change both in pitch and quality of tone

was at once noticeable. Good organ tuners were perfectly aware of this effect of heat on pipes, and were always careful not to handle them much in voicing, finding that if they were tuned when warm they would not be in tune when cold. On the possibility of tuning an organ by means of temperature, he did not think enough use had been made. Mr Lewis some years ago told him that the very beautiful little organ which he put into the Hanover Square rooms would not speak at all until he opened a large grating into the open air at the back of the room, which ventilated the room and allowed the hot air from it to pass through the organ, warming and drying it. He suggested that the same process should be applied to the large cumbrous, unwieldy organ at Exeter Hall. The pipes there drew their supply of air from the cold corridors at the back, the stone passages which made one almost shudder in passing through, and the organ itself suffered in its own way. He was accustomed to play a large bass reed in the orchestra there, and found the alterations considerable; the organ at first was down very low indeed, but as the air of the hall became warm, at length even the corridors got warm also, and the organ rose gradually in pitch, sharpening during the whole evening. It was shifting perpetually, which was very trying to the instruments in the orchestra. If, instead of drawing air from the back, it were drawn from the roof by some kind of wind-sail or tube, it would be a great improvement.

Reed instruments followed a somewhat different course, because the vibrating reed, the dominance of which was so great, expanded appreciably, and therefore when in good condition they ought not to vary much. As a matter of fact, the reeds in an organ were known by every organist to be extremely unruly. He believed, however, that much of the blame cast on the reeds as to getting out of tune was really due to the flue pipes altering; reed pipes were sensitive to moisture more than flue pipes, though not so sensitive to heat and cold, as he would show by experiment, blowing the reed pipe and a flue pipe in unison with hot and cold air, and then transposing them. The influence of moisture or vapour of any kind was very great on reeds. This he had proved by introducing into one of those pipes a little chloroform, which had a very heavy vapour, and caused the pipe to sink in pitch. That experiment, however, he must ask them to take upon trust. His next observation would be upon orchestral instruments; he would choose the clarinet as the type, because it varied the most. In cold weather an ordinary B♭ clarinet sank very considerably. He went on one occasion to Kingston with the Wandering Minstrels during a severe frost, having to sit outside the coach and carrying his instrument. When he went into the orchestra for rehearsal the conductor accused him of having the A clarinet instead of the B♭; the fact being that the cold air had lowered the instrument a full semitone. But when it was put before a warm fire it recovered its equanimity. This was shown by sounding the note A on a cold clarinet in unison with a French

pitch tuning-fork; and then blowing hot air through it, it was found to rise considerably.

Lastly, he would refer to harmonium reeds, which were found to vary very little, and somewhat differently, according to the material of which they were made. He had had some constructed of steel, of brass, and of German silver; the last he found to be least liable to be affected, whilst the steel were worst of the three. On sounding them first with cold air, and next with hot, they were found to change very slightly, but a great advantage in their use as a standard of a pitch was that their beats were so very perceptible. Many persons might notice that a tuning fork was very flat or sharp without the beats being distinctly audible, but he would defy the hardest headed fiddler in existence to be out of tune if he had an harmonium reed for tuning to. It could also be kept constantly sounding. For both reasons he believed it would prove the most effective standard of pitch for the orchestra.

DISCUSSION.

Mr. DE PONTIGNY said heat and moisture had a great effect upon drums; the heat of a warm room rendered the skin drier, and consequently sharpened the tone.

Mr. BOSANQUET said he had paid a great deal of attention to the subject Dr. Stone had so admirably brought before them, especially with regard to organ pipes. He did not know whether Dr. Stone had seen General Perronet Thompson's investigations on the change in pitch of organ pipes and tuning forks by variations in temperature. He there directed particular attention to one point which Dr. Stone had not alluded to, namely, that the effect of temperature on pipes of a high pitch and a low pitch was not the same; in fact, that the pipes of high pitch separated in a body from the bass. Probably the same thing would apply to a smaller extent in tuning forks. He might also mention that General Thompson devised an ingenious mechanism, consisting of bars put across the months of the pipes, by which this variation in tone was got rid of. He had noticed in Dr. Stone's experiments that it was difficult to separate the effect due to temperature from the effect of the bellows, and this was a difficulty which all acoustic experimenters constantly encountered. He should like to know, therefore, whether the common inverted rib bellows was really found to be sufficiently accurate for these experiments, or whether some additional arrangement might not be desirable for the purpose. He had constantly used harmonium reeds in questions of

absolute pitch, and he thought they might be trusted for anything except real physical accuracy. Their beats were very easily heard, and they were easily manipulated. He had a little tuning machine in which he could put a number of reeds and file them to the exact pitch required, with the greatest ease. He had hoped to hear a little more about the determination of absolute pitch, because, after all, they could not always get the French standards, nor was it always easy to work from a French standard tuning fork. It was very desirable, therefore, that they should have some accurate and tolerably easy means of determining the pitch of harmonium reeds, and anything which enabled them to count the total number of beats between notes, constituting an accurately tuned interval, would meet the difficulty. If you tuned two notes to a major tone (C—D), by making them perfect fourth and fifth to a third note (G), and then interpolated between them so many other notes that you could count the beats between each successive pair, and then added all the beats together, a simple arithmetical rule gave you the absolute pitch of the C with considerable accuracy.* The only thing required, then, was an instrument for observing the beats. This could be done to some extent with a pendulum arranged for the purpose; but he was constructing a metronome, which he exhibited at the recent *soirée*, though it was not yet quite finished. He thought something of that kind must be the basis upon which the ordinary observer must depend, and by its means, with a few harmonium reeds, they could always secure an absolute pitch.

Dr. Stone said he agreed with everything Mr. Bosanquet had stated, but he had not been able to go into the important question of the separation of the bass from the treble in organ pipes, because it would have taken too long.

Mr. Stephens inquired in which direction the difference took place. Was it to sharpen or flatten the tone? If it were the latter, it might be accounted for by the greater weight of metal in the larger pipes.

Mr Bosanquet said it was found the small pipes were most affected, and became sharper. General Thompson proposed a somewhat more workable method than the one he had himself adopted for getting over the difficulty; namely, as the variation in the pitch of the pipes, arising from the strength of the wind, followed very nearly the same law as that arising from variations of temperature, it was possible that the difference between the treble and bass might be compensated by altering the weights of the bellows, if the pipes were so voiced as to speak under a variable amount of wind.

Mr Stephens asked if Mr. Bosanquet had formed any hypothesis as to the physical reason for this change. Pre-

* The sum of all the beats that would be heard in eight seconds is the vibration number of the C.

conceived notions would rather have led one to suppose that the change would have taken place in the larger pipes.

Mr. Bosanquet said he thought in organ pipes the air was the most material cause of the change in pitch. The whole question was very complicated, and very little as yet had been done to determine it.*

Dr. Stone said that in his own experiments he had used a much larger reservoir of air than he had been able to bring down for the purposes of the present paper.

Mr. Chappell said that if we start with thirty-two vibrations for the lower C, we can never have the F in perfect tune, because the ratio of F in the scale of C will not allow it. This is also an objection to the French pitch; at the same time, it is nearly right

Mr. Stephens asked why they could not take the French pitch and reckon downwards.

Mr. Chappell said in that case we can neither have the lower octaves nor the C in perfect tune.

Mr. Bosanquet did not quite understand the objection

Mr. Chappell explained further that, in the scale of C, if we start with 33 vibrations, the octave above will have 66; then F, a true fifth below, will have 22, and its octave 44; thus we have perfect scales for F and for C. Whatever variations we may make in the temperament of certain intervals, we should start with mathematical accuracy, and if the calculation were made it would be found, taking those figures, that the A would have 880 vibrations instead of the 870 of the French pitch. We can neither arrive at French pitch from C with 32 nor 33 vibrations. Again, if we take 870 for the upper A, its octave below will have 435 vibrations. If halved again, the note must be out of tune, because we cannot halve a vibration

Mr. Bosanquet said the objection amounted to this, that the French pitch did not coincide with either of the theoretical pitches proposed.

Mr. Chappell said that ten vibrations in a high note was a very small difference, but one which ought to be taken into account by men of science in settling perfect intonation. This was very much insisted upon by French men of science at the time the pitch was established in France. In a pamphlet, reprinted from *Concordia*, he had included the two harmonic scales, C and F, showing that C would have 528 vibrations, starting with 33, the present pitch: a more complete scale of C would be had by starting from 32 vibrations, but as long as we have F in the scale, we cannot take any ratio which would exactly agree with it. If we take 33 we can make the F coincide

* General Thompson refers this effect to the increase of scale in the smaller pipes. He states that the effect of heat varies inversely as the length, and directly as the diameter, so that for pipes of constant scale the effect should vanish. But this requires confirmation.

Mr. Bosanquet said he had no fear of fractions in these matters. What was required was practical convenience.

Mr. Chappell said it was not a question of fractions, but of sound; fractions are divisible, but we cannot split a vibration into parts. The cycles will continue, and non-coincidence must ensue.

The Chairman, in proposing a vote of thanks to Dr. Stone, said he never heard a lecture on acoustics without being left in a state of absolute astonishment that there could be any music in the world which was at all tolerable. When one considered the vast difficulties there were in ascertaining what was in tune and what was not, about which no two people seemed to agree, he thought they could only rejoice that they got as near practical perfection as they did.

April 3, 1876.

WILLIAM CHAPPELL, Esq., F.S.A., in the Chair.

ON OUR PERCEPTION OF THE DIRECTION OF A SOURCE OF SOUND

By Lord Rayleigh, M.A., F.R.S.

When Mr. Spottiswoode asked me some time since to take his place in reading a paper before this Society, I called to mind some acoustical experiments I made last summer, with a view to making out how we detect so easily and generally the direction of a source of sound, and hoped to be able to complete the experiments to some extent, so that I might be able to present the matter in a little more complete form. Unfortunately, however, my health is not good enough to allow of my making acoustic experiments in the open air at this time of the year, and therefore I have but little to add to what I discovered last summer.

In the case of the eye it is well known in what way we are able to locate the source of the excitation. The eye is provided with a lens, the effect of which is to concentrate on one point of the retina all the light which reaches the eye from a luminous point at a distance. If the lens of the eye were removed, that light would be distributed uniformly over the retina, and the effect produced would not depend to any considerable extent on the situation of the source from which it came. By means of the lens, however, the effect produced depends with extreme nicety on the exact situation of the source of excitation, so that if the luminous point is moved from one position to another, the part of the retina which is excited will be altered, and that is a sign to us that the source of light has been moved. There is no difficulty in explaining exactly how this happens, but the operation of a lens depends on the fact that its aperture is a great number of times the wave length of the vibrations which fall upon it. In the case of the eye the diameter of the pupil may be about one quarter of an inch, whereas the length of a wave of light is about $\frac{1}{40000}$ of an inch, so that the diameter of the lens which concentrates the light is perhaps 10,000 times the length of the wave of light which it concentrates. Under these circumstances the concentration is extremely perfect, and the result is that the effect produced is altered by the very smallest shifting of the luminous point.

Now it is evident at once, that in the case of the ear the same kind of machinery is not applicable. When a man speaks, the wave length of the sounds he produces is perhaps eight feet, and

it is evident we could not carry about with us any kind of lens which would be many multiples of eight feet; in fact, the human body is not big enough to do for sound anything like the same thing as the eye does for light. One must look therefore for the explanation of the possibility of telling in what direction a sound is, in an entirely different quarter. It has long been conjectured that the explanation of the difficulty was to be sought in the fact that we have two ears, and that we use the evidence derived from them to give us the requisite indications, but I am not aware that much has been done hitherto to bring that view to the test of exact experiment.

The first experiments I made were with the object of determining with how great accuracy this kind of judgment is really effected. An observer with his eyes closed was placed in the middle of a lawn, and several assistants moved round about him, and, speaking at intervals, asked him to point out where they were. We found that this could be done, after a little practice, with considerable accuracy, the error not being more than a few degrees in extent, from a single word or even a single vowel. We found also that it made very little difference whether the speaker was to the right or to the left, in front or behind the hearer, who could in every case tell without any difficulty or uncertainty, within a little, from what quarter the sound proceeded. But there was some difference when the voice was used in an unnatural manner. A very forced squeak or a mere grunt in the throat did not give so infallible an indication, and when a low whistle was tried it was found that, although when it was to the right or left its position could be told with accuracy, a doubt would sometimes arise whether it was in front or behind. This tended to show that the possibility of detecting whether a source of sound was in front or behind depended in the case of the human voice upon the compound character of the sound, and it was obviously the next step to inquire whether that same certainty existed when a simple sound was used—that is, one not capable of being analysed into simpler components. When a tuning fork mounted on a resonant box was tried, the observer could tell at once whether it was in front or behind him by the noises which accompanied the excitation of the fork; so that, in order to get a satisfactory result, it was necessary to modify the experiment. Two exactly similar tuning forks were provided, and two resonant cavities of the same pitch as the forks, capable of reinforcing their sound, were used. When a fork of this kind is set in vibration by striking it, very little is heard at first, but when it is held over a suitably tuned cavity, the sound becomes audible. When the cavity is in tune to the principal note of the fork, but is not in tune to any other note which the fork might produce and from which it is desired to purify it, the tone is about the purest we know how to make. Two assistants, therefore, took the resonators and forks, the observer being situated midway between them, at equal distances. They were instructed at a given signal

to simultaneously excite the forks, and then, in response to a signal, one only was held over its resonator, so that the noise produced by the exciting of the fork could give no indication as to which side the sound came from. It was then found that the observer had no difficulty in detecting when the fork was on his right or his left, but when he turned a quarter round, so that one was immediately in front and the other immediately behind, he was quite at a loss, and could form no opinion as to whether the sound was in front or behind him. The difference was so striking, that, whilst in the one case you would have been willing to lay almost any odds you were correct, in the other case you would not back your opinion at all, and really felt that you were only guessing. The result was to some extent unexpected. I had heard of the experiment being tried with the human voice, with the result that it was easy to distinguish whether a friend speaking was in front or behind, but when one comes to think of it, the difficulty is rather to explain how it is done in that case, than why it is not done with the tuning-fork. When a simple source of sound such as a tuning-fork is in front or behind, it would seem there is scarcely any indication by which you could tell from whence it comes. The effect upon both ears must be almost exactly the same in both cases, because the sound of the tuning-fork is not capable of being altered in quality when purified in this way. It can only be affected in loudness, and as you have no means of knowing what the original loudness was, it would appear that you can have no possible clue by which to tell whether the origin of the sound is in front or behind. As to the explanation of how you tell it when the voice is used, I can hardly offer any conjecture. It is clear that the fact of our having two ears can be of no great service, because both would be affected alike; but I have little doubt it must depend to some extent on the familiarity which we have with the human voice, and that we are frequently practising so as to estimate from what quarter the sound comes, particularly in the case of any one whose voice we know, so that we can detect with accuracy very slight alterations in its quality. But even so it is not easy to understand how sufficient alterations in the quality could occur to account for the possibility of distinguishing whether the sound is in front or behind.

In the case where one has to distinguish whether the sound comes from the right or the left, it is generally supposed that the explanation is simply that the ear nearest the sound would hear it much louder than the one farthest from it; so that we might find out which ear hears the sound better, and conclude from that which side it comes from, but even that explanation is not so easy to receive as it might at first appear. It is not difficult to try whether we can hear much better with the ear that is presented to the source of sound than with the one which is turned from it. The simplest way is to stop one ear and listen to a steadily sounding musical note, while you turn slowly round.

The difference in the two positions is not very marked. I think most people who have tried it for me agree that they hear the sound rather less when the open ear is turned from than when it is turned towards the sound, but the difference is by no means very marked. Such experiments are not capable of great accuracy, but theoretical considerations lead to the same conclusion. We must remember that the human head is scarcely a sufficiently large obstacle, with relation to the length of ordinary waves of sound, to throw anything like a complete sound shadow. Some two or three years ago I made some calculations with reference to this particular point. Of course, in such matters one must select for calculation such cases as are practicable, and these calculations referred to the effect of a rigid and fixed sphere on a distant source of simple sound. It is not everybody's head which can properly be treated as being a rigid and fixed sphere, and therefore the calculations cannot be strictly applicable to the case of the head, but still they ought to give some indications of the kind of thing which would happen. If one calls the point of the sphere nearest the source of sound the anterior pole, and the point farthest removed the posterior pole, and the circle midway between the two the equatorial circle, it is found that the intensity at the two poles depends on the relative magnitudes of the radius of the sphere and the wave length of the sound. Of course, when the sphere is extremely large in comparison with the length of the wave, the space behind the sphere is left in a sort of sound shadow, and at the posterior pole itself the sound would be very much weakened. At the anterior pole—immediately under the source—the sound would be about doubly as intense as it would have been had there been no obstacle at the same point, but the case is quite different when the sphere is small. In that case nothing which can properly be called a shadow is formed at all. It may even happen there is very little difference of intensity at the two poles, the amount of the vibration being nearly as great at the point of the sphere farthest from the source of sound as at the point nearest.

The first case to which my calculations refer was that in which the circumference of the spherical obstacle was twice the length of the wave, and it was found in that case that the intensity at the anterior pole was 69, at the opposite pole 32, and in the equatorial region 35, the intensity at the anterior pole being about double that at the posterior one. If anything of this kind happened in the case of the head and the two ears, there would be no great difficulty in understanding the advantage the ear takes of the difference, but that estimate is out of all proportion to the actual facts of the case. If the circumference of the sphere were equal to the length of the wave, the intensity at the anterior pole being 50, at the posterior it would be 28, and in the equatorial region about 23. One point we must notice here is, that in this case, where the circumference of the sphere is equal

to the length of the wave of sound, the intensity immediately in the rear of the obstacle is greater than in the equatorial region. That might be thought paradoxical, because if a sphere is regarded as casting a shadow, one would naturally expect the shadow to be most intense in its middle region, whereas that was not the case. When the circumference of the sphere is only half the length of the wave, which approaches more nearly to the case of the head, the intensity at the anterior pole was 29, at the posterior 26, and in the equatorial region 28, so that the difference (between 29 and 26) is only 10 per cent., and that would hardly be supposed to be enough to found this very delicate distinction upon; but even that supposition exaggerates the case of the head as applied to all ordinary musical notes. If the sphere were only half as big—that is to say, if the circumference were a quarter the length of the wave—the difference in intensity at the two poles of the sphere would then be only about one per cent.; in fact, it would be so small that one could not suppose it possible for the difference to be perceived in the case of the two ears. From what I have said, you will understand that the case depends to some extent on the pitch of the note, that there would be more chance of the difference occurring in a very high note than with a very grave one; and I thought it worth while to try whether the faculty of distinguishing whether a sound is on one's right or left had any tendency to disappear when the note was grave. For that purpose I tried the experiment I have described, only with forks much graver than those first used, making only 128 vibrations in a second instead of 256. When held over suitable resonators the sound was not very loud, and therefore the experiment was not quite so satisfactory, but we found there was no great difficulty in distinguishing between the right or left. In fact, I came to the conclusion that the difficulty there was only such as might fairly be attributed to the diminished loudness of the sound, so that it would appear that even with waves of 8 feet long, which was the length of those produced by the forks in question, the head being only about six inches diameter, according to these calculations, which referred to the case of a sphere, the difference in intensity at the two sides would be so slight that it could hardly be enough to account for the fact that one was able to tell, as one could, whether the fork was on one's right or on one's left.

I am obliged to leave the question in rather an unsatisfactory state, for my calculations are very far from explaining the facts; in fact, they rather go to take away the force from what had hitherto been supposed to be the explanation. At one time I was almost inclined to suppose that we did not distinguish through our ears at all, but in some other mysterious way. I suppose it depends, in fact, on some very minute indications which, from an *a priori* point of view, would be thought quite inadequate, but which long practice, and the great importance of being able to do so, has enabled us to avail ourselves of.

DISCUSSION.

Dr. Stone said every one must see the interest of the calculations, because an actual definition of the amount of obstacle was a thing entirely new. There was one other explanation of the subject which he should like to ask Lord Rayleigh if he had investigated, namely, the function of the semicircular canals which with the cochlea formed important parts of the internal ear, and which it had been generally supposed furnished the means by which the direction of sound was determined. He had always found difficulty in explaining how they did so, but on the other hand there were reasons which made it appear as if they were intended for some such purpose, particularly the fact that they stood parallel with the three dimensions of a solid body: one vertical, and the others in two directions at right angles, as though each had the function to take cognisance of one element of space. They contained a most elaborate nervous apparatus, and one could not suppose they had no object, whilst if the determination of direction were not their object, he had not the least idea what that object was. A very interesting question would be to find the mathematical element, which being given, these grooved canals in three directions could be shown to enable one to determine the direction of a sound, or it would even be valuable if it were shown that they could not do so in any way. He did not know on what ground physiologists had given them that function, but they had universally done so. That was only speaking of one ear, but when you got to two the question was different; there was between them a parallax very similar to that between the two eyes, and it was really learning how that parallax occasioned the amount of squinting necessary for any near object, and the amount of nervous force thrown into the muscles of the eyes to produce that motion by which we were enabled to judge of the distance of objects. Probably the ears did the same thing to a great extent. There was also another means possessed by the ear which the eye had not, because there would be a slight difference of time at which the sound reached the two ears, since the sound waves were so very much slower, so that one impression would be slightly behind the other.

Mr. Sedley Taylor said the subject was quite new to him, but he should like to ask whether Lord Rayleigh had made any experiments with only one ear. It would be possible to stop one ear and make the observation with the other, and if a person with only one ear could determine the direction of a sound, it would almost do away with the theory that double hearing was an essential point.

Lord Rayleigh said this was a natural question, but he could not give it a very satisfactory answer. They had tried what could be done with one ear, but had got very curious results. Much more can be done with one ear only than one could have expected if the use of both ears was the principal means of determination, but you could not tell as well with one

ear only as with both. With the pure sound of a tuning-fork one might easily be deceived as to whether the sound was at the right or the left if one ear were closed, but very rarely was that the case with the human voice. It was well-known that you could not close the ears with anything like completeness, though you could make one ear deaf relatively to the other. It certainly seemed to him that one could do more with one ear closed than was at all easy to understand in accordance with the views hitherto held. With regard to Dr. Stone's observations he was quite ignorant of the anatomy of the ear, but the fact that the ear passage was quite small in relation to the length of wave seemed sufficient to prevent its being possible for the direction of sound to be determined by anything inside the ear, because, whatever there might be inside the ear, it would be affected in exactly the same way whether the sound came from one direction or another. The only effect of sound was to produce in the passage of the ear certain alternate rarefactions and condensations which the subsequent apparatus had to take account of, and he did not understand how the ear had any means of knowing what was the origin of that alternate condensation and rarefaction.

Mr. Sedley Taylor asked if it were correct that a simple sound was much more difficult of determination by a single ear than a compound sound.

Lord Rayleigh. Yes.

Mr. Sedley Taylor asked if it were not possible that a change of position of the external framework of the ear might cause a similar diffractive effect to be produced on the overtones so as to alter the quality of the sound, so that when the ear was entirely presented to it the quality of the sound would be different to what it would be when presented at an angle of 45 degrees.

Lord Rayleigh thought that was the sole possible view to take. It was very difficult to understand how so comparatively small a diffraction would produce such a great effect.

Mr. Bosanquet said he had taken several occasions in the open air of observing the sort of accuracy with which one could determine the source of sound. It was certainly possible to locate sounds in a surprisingly exact manner, though it was hardly necessary to remark that in a closed place of any kind experiments of this sort became perfectly useless. It was familiar to any one accustomed to play the organ, that it often happened that a pane of glass or something in the building would resound to one particular note and become a great nuisance; and he remembered on one particular occasion he had to search over the whole frame of the organ and all round the hall, until he at last found the offending object in a frame of glass in a case of stuffed birds at the other end. In fact it was utterly impossible, until you touched the object, to tell in the least degree where the sound came from. What Lord Rayleigh said seemed to afford some foundation for a theory on this subject. As he had said, you could only calculate for certain things, but it must be remembered that the head was

not a sphere at all and preserved a very peculiar outline in front and a very different outline at the back, so that no one could suppose that a wave of sound impinging on a man's forehead would be affected in the same way as one falling on the back of the head. As to the right and left direction, there could be little doubt that the principal element in the ordinary perception must be that the sound was heard a little later by the ear farthest from the sound. There was also an element which might possibly bring in the semi-circular canals. If you took a tuning-fork and applied it to the bone of the ear, you heard the tone much more clearly than by any other means, and it was quite possible that some amount of sound might in the same way get through the surface. He did not know how far the air could communicate vibrations to the bone of the head, but it was quite clear the tuning-fork did so; and therefore the passage of the ear was not by any means the only source by which vibrations could get to the interior mechanism. It might be of importance to know the result of these calculations with reference to the wave-lengths actually used and the normal size of the head, because there would be certain limits of importance. There would be the limit of Lord Rayleigh's four cases as applied to any ordinary sized head, which would give data suitable for comparison with observation. The human voice contained harmonics of great intensity and of a very high pitch, which would furnish a foundation for an explanation of the much greater facility in determining the directions of the human voice, than of such tones as the low-pitch tuning-fork employed in these experiments.

Lord Rayleigh had no doubt that some of the higher elements in a highly compound sound, like the human voice, would be sufficiently small in wave-length as to give a very different result as regards an obstacle the size of the head, from the graver notes of which he had spoken. But even the grave notes were easily distinguished as right or left, which was the point as to which the calculations mainly applied. Even with a tone of eight feet wave-length it was very rare to make a mistake, although there was not the same feeling of certainty. It would be interesting to know what were the other modes in which sound would reach the organ of hearing beside the external ear. It was well known that you could not stop the ear passage completely, and it would be important to know whether the sound penetrated in any other manner.

The Chairman remarked that it penetrated through the Eustachian tube into the mouth, as had been shown by Sir Charles Wheatstone.

Dr. Stone remarked that they had not heard anything about the *puna*, which was a very powerful guiding apparatus, as they could see in their friends the donkeys, which were in the habit of doing what mankind had lost the power of doing—they appeared to erect their ears instinctively, to distinguish where a sound came from.

Mr. Bosanquet remarked that it would be interesting to

observe how far the perception was due to a tentative process, and whether the action of moving the head did not accompany the mental effort of determining the direction of the sound Almost invariably, when he had thought of it, he had found himself moving his head, and it seemed as if one tried in which direction a sound appeared to be strongest, in order to determine where it came from

Lord Rayleigh said great pains had been taken in his experiments that the head should not be moved, but there was no doubt a natural instinct to move the head, and that a material assistance could be obtained in that way When the question was, whether the sound of the fork was in front or behind, you could not tell with the head still, but if it were turned round through a right angle you could discriminate it immediately. The instinct was to turn about until you did hear some difference, and when you were in such a position that the sound was on your right or left, you knew with certainty where it was

Mr. de Pontigny asked if some light might not be thrown on the question by investigating the manner in which ventriloquists deceived their audience It was said that they could make the sound come apparently from any part they liked

Lord Rayleigh had never had any opportunity of observing the phenomenon, but the explanation he had read was that they mainly depended on deceiving the imagination

Dr Stone said that was so He had watched a great many celebrated ventriloquists, and found their practice was to direct the attention to a particular point from which the sound was supposed to come, at the same time carrying on a mechanical process, as in the case of a doll which opened and shut its mouth He was not aware, either, whether they were ever able to make the sound come from a great distance from themselves. There was a Lieutenant Cole who was very clever in this sort of thing, who had several wooden dolls whose mouths opened and shut by mechanical means, and he carried on a conversation with them in such a way that the sound appeared to come from them.

Mr Bosanquet remembered seeing Robert Houdin perform a very clever trick with a glass box swinging in the middle of the room, and sounding as if there were a lot of money in it, but at the time he thought he made out the trick—that he simply held the money in his hand behind his back, and chinked it to keep time with the motion of the glass At the same time the illusion was most perfect, and it was almost impossible to detect it

Dr Stone observed that all these tricks took place in a closed room, where the power of determining the direction of sound was almost destroyed He did not know that ventriloquists ever performed in the open air

Mr Sedley Taylor said there was an old experiment in which a sound is heard more acutely than in the ordinary way, namely, to fasten a poker to a short piece of string and hold the string

between the teeth, when a blow on the poker sounded like a cathedral bell.

Professor Monk narrated an incident which had occurred to himself, as shewing the strength of the imagination in deceiving the mind with regard to sound. On one occasion he was walking through a Welsh valley in a district in which he had walked some time previously, and remarked to himself with painful retrospection that on this occasion the thousand rills which had formerly assailed his sense of hearing were now entirely silent, the fact being that there had been no rain for a long time, and there was no water to fall. Every one knew the charming effect of the dropping of water, and as he was thinking of this subject all at once he thought he heard the sounds, still, as the weather was so dry, he immediately looked about to see where the water could be falling from, and after a little observation he discovered that the cause of what he had heard was this—some workmen a little way off up the hill-side had made a fire, and the sound which the twigs made in burning had appeared to him like that of falling water.

Mr. Bosanquet said he had been making some experiments with one of Kœnig's large tuning-forks, and he found the harmonics of the ordinary scale were produced by them with an intensity much greater than would be supposed. He did not know how far such harmonics could be produced by the forks employed by Lord Rayleigh, but it might well be the case that a large fork giving 120 vibrations might have produced notes of a higher tone to such an extent as to materially assist the determination of the direction. It was admitted, he thought, that it was much easier to determine the source of sounds of a high pitch than of low ones.

Lord Rayleigh said it was difficult to be sure that you had entirely purified a tone from its harmonics, but the mode he had employed was the most perfect known.

He produced and shewed to the audience a resonator, which was about to be included in the Exhibition at South Kensington, constructed for hearing overtones, the pitch of which might be altered from one harmonic to another by a movement of the fingers, so that when a single note was sounded on an instrument giving a highly compound sound, the upper tones could be easily detected by shifting the pitch of the resonator.

Mr. Bosanquet said his experiments had been performed with stopped organ pipes, and he used a Kœnig's tuning-fork giving 100 double vibrations. With a disc on the end of a fork you could hear the first seven overtones quite distinctly;—up to the harmonic 7th. The fierce was very strong, quite sufficiently so to produce a sensible effect on the quality of the tone. The 12th was not so strong. An ordinary fork when struck gave to his ear more the effect of the octave than of the fundamental note.

The Chairman said Sir Charles Wheatstone's resonating tube produced two octaves in rapid succession by simply moving the slide and striking the jew's-harp, or a tuning-fork, at the end.

May 1, 1876

ALEXANDER JOHN ELLIS, Esq., B.A., F.R.S., F.S.A., IN THE CHAIR.

ON THE MUSICAL INVENTIONS AND DISCOVERIES OF THE LATE SIR CHARLES WHEATSTONE, F.R.S.

By Professor William Grylls Adams, F.R.S.

The work of the late Sir Charles Wheatstone was very varied in character, and was not limited to one, or even two, of the branches of physics. He investigated the laws of sound, of ordinary and polarised light, and he greatly advanced our knowledge of electricity and magnetism. But there is one characteristic, at least, which runs through all his investigations: he always sought to embody the results of his study of the laws of nature in a practical form, so that they might be beneficial to mankind. Thus he made use of the polarisation of the light of the sky to determine the correct solar time by means of his solar clocks; and again, in his electric instruments, he has enabled us to make electric measurements, and also to interchange ideas with our fellow-creatures all over the globe.

In the short time which is at my disposal this afternoon, I can only attempt to review a part of his work on sound, and its relation to music. I therefore propose to devote myself principally to one special branch of that work, in which he explained the modes of vibration, and the resonance of tubes and columns of air, and accounted for the distinct qualities of tone of various musical wind instruments.

If we take a tuning-fork and hold it in front of the opening of an organ pipe, suitable to sound to it, the sound produced by the fork will be reinforced. Thus, the sound of this fork can hardly be heard by itself, but when I bring it in front of a tube of proper length, we get a note very much reinforced by the pipe. If I take a pipe which does not resound to that tuning-fork, I shall not get that resonance. In this case we have an open pipe, about two feet in length, and as the tuning-fork is middle C, the two agree, and the pipe will reinforce the fork. If we take a tube of half this length and close one end of it, we shall also get resonance when we bring the same fork in front of the end of the tube. Now, the state of vibration of air within this open tube is this: the air in the middle is perfectly at rest, and at the two ends the air is moving in opposite directions at the same time. There is very great motion, comparatively, at the ends; as we go down the tube there is less and less motion of the particles of air,

end at the middle none whatever. So that, if we place in an open pipe a disc in the middle to form a separation between the two parts, we shall form two such tubes as this one—closed at the end—and we get the same note produced. The state of vibration in a tube is represented on these diagrams: particles of air moving from each end towards the centre, so that when the density in the centre is greatest from an increase of pressure towards the centre, then the particles move outwards again, and there is a change of pressure and density in the middle of the tube greater than at any other part, but no change of density at all at the ends; so that where we have the greatest motion we have no change of pressure, and where we have no motion whatever, there we get the greatest change of density.

There are several ways of exciting vibrations of air in tubes, one is by means of a sharp edge, as in the case of a diapason organ pipe. The air comes out through a narrow slit against a sharp edge, and the tone produced will depend on the distance of the sharp edge from the opening, as well as on the length and size of the pipe. The air may also be set in vibration by means of a reed, or vibrating tongue, as in a clarinet or reed organ pipes, or by the vibration of the lips where the muscles of the lips act the part of the vibrating tongue, as in the trumpet and horn. In the case of the oboe and bassoon, the reed resembles the action of the lips. Only those vibrations are excited which the air in the tube is capable of maintaining; that is, the tube must be such that in one vibration of the fork, from its position of rest, the pulse would have travelled from one end of the open tube to the other, or in the closed tube down it and back again; so that in the complete vibration of the tuning-fork—that is, going to its extreme limit on both sides, and returning to its position of rest again—the length of the wave which will have been started at first from the tuning-fork will be twice the length of this open tube, or four feet. From such a pipe no intermediate sounds can be produced. If I take, for instance, this pipe, there is a certain amount of resonance from the air, but there is no increase when I bring the fork near to the end of the tube, because it is too sharp to respond to it. But if I take a pipe which corresponds to the fork, then we get the resonance as we did in the other case. The same may be shown with a closed organ pipe. But from such a pipe we may get more than one set of vibrations. We can get the fundamental note of the pipe, and by altering the rate at which the air enters the pipe we can divide it up into parts, which are represented on the diagram, thus making as it were two pipes each of half the length, and an opening may be made in the middle without producing any change at that point; so that the octave of the fundamental may thereby be produced. In this case we get it by increasing the pressure, but we may also divide it differently and have three divisions or nodal lines instead of two, and, in fact, any number. We may increase by 1, 2, 3, or 4, and so get separate vibrations dividing the tube

into lengths of one-half, one-third, one-fourth, one-fifth, and so on, and get notes with numbers of vibrations, or in those ratios. Suppose, for instance, we take a pipe sounding CC, and divide it into three parts, we shall get two notes related to one another, the number of vibrations of the one being three times the number of the other in the same time. There we get the 12th, the 3rd in the harmonic series, and the double octave where the number of double vibrations are in the ratio of 4 to 1 of the fundamental notes. We can see these are the divisions very readily by means of an organ pipe, where, at the position of the node in the first case, we have a gas jet, and at the position of the nodes of the second position, when the octave is produced, we have also two gas jets. When these are lighted, you will see how the pressure is altered according to the note which is sounded. When the fundamental is produced there is very little alteration in the pressure at the two outside points, but the one in the centre would go out, whilst, when the octave is sounded, the pressure would be altered most at the two ends, and there would be no alteration of pressure at the middle. Consequently, as the alteration of pressure will affect the gas flame when the octave is sounded, the gas flame will go out at the two ends, and in the middle there will be no alteration, and *vice versâ*.

Sir Charles Wheatstone showed, by means of a circular tube, that the air is moving from the two ends towards the centre of the tube at the same time, which had not been done experimentally before. He did it by bringing the two ends of the circular tube over a vibrating plate, which, in vibrating, moved from one end of the tube and towards the other at the same time. Consequently, the air at one end would be compressed whilst the air at the other end is expanded, and there would not be a travelling of the air of the two ends towards the middle. In that case the two ends of the tube are over the same plate, but when it is turned halfway round, so that only one end is over the vibrating plate, then the tube will resound with the plate, just in the same way as one of these tubes; it corresponds to the treble C. It is difficult to show this experiment, because the vibrating plate itself would give out a note which is too powerful for the note of the tube to be heard distinctly at any distance.

If we took a closed pipe of three-quarters the length of the original, the note of that would be one in which the vibrations would be at the ratio of 4 to 3 of the original; and if we divide that so as to get the first harmonic to it, then the division is precisely the same as that for the octave in the first case. Thus the octave of an open pipe from the first harmonic and a closed pipe of three-quarters of the length give the same note. You can see readily from this that the harmonics from an open pipe are very different from those obtained from a closed one. In fact, the closed pipe can only give the odd harmonics 1, 3, 5, and 7. This difference between the open and closed pipes shows the difference between the harmonics we get from the flute or open

pipes, and from the clarinet or closed pipes of an organ, and would account in part for the difference in quality of tone produced from those stops. In the case of the clarinet, the vibrations are produced by means of a reed at the closed end of the pipe. In such a case the tones produced are more powerful than when the tone is produced in the same pipe from the open end, and the same would be the case in all reed instruments where the reed is at the closed end of the pipe.

Vibrations may be excited in columns of air by means of gas. This also was investigated by Sir Charles Wheatstone more than 40 years ago, and he found that, provided the flame were of suitable size, then the note of the tube could be produced when the flame was quite at the end of the tube, if it was not too long; and that as the flame is passed up the tube it could be more and more easily excited until the position of the node is reached. In the case of long tubes usually the note produced is not the fundamental, but some harmonic. Here is an apparatus for producing these tones, and if the gas flame could be watched in a mirror, it would be seen that the gas almost goes out at each vibration of the air. Sir Charles Wheatstone found that on removing the gas jet nearly to a node in the tube, the intensity of the note was increased, and it was also necessary to increase the size of the flame in order to produce it. The note was produced with the smallest flame at the end of the tube, and it could be gradually enlarged in passing from the end towards the centre. He used very short tubes, so as to avoid the harmonics which are produced in the long ones. An instrument was constructed by Sir Charles Wheatstone of this description. There was a succession of tubes of different lengths, and gas flames which might be raised to the proper point by means of keys like a piano keyboard, so that each one might be sounded and the flames then caused to fall down again, and so any succession of sounds might be played by that instrument. He remarks that it is probable that organs may be constructed in which columns of air excited by flames of hydrogen gas might be substituted for the organ pipes now employed, and that instruments might be made possessing greater power in crescendos and diminuendos than any we are at present acquainted with. About three weeks ago I saw in the *Times* that there had been a meeting of scientific men in Paris who had been invited to witness the qualities of a musical instrument which had been introduced as a new invention, where gas flames were made use of to excite the tubes.

If, instead of taking cylindrical tubes, we make use of conical ones, then a note may also be obtained from these, and the succession of harmonics which may be produced from such tubes will be the same as the succession from open cylindrical tubes of the same length. Those from this cylindrical open pipe, and this other closed cone, we get the same note produced; it responds to the same tuning-fork. If we take a cone which is not complete, but open at both ends, of the same length, then

also from that we get the same note produced as from the cylindrical one. The resonance of the column of air is the same whichever end of the tube we take, although the amount of air set in vibration will not be the same, so that there may be a difference of intensity according to which end we set the air in vibration from. Thus, if we take a cone four feet in length, closed at the end, the fundamental note of that cone will be an octave below middle C. That will be the fundamental note when the whole of the air in the tube will be moving in the same direction at the same time. The vibrations are excited at the end, and the pulse travels down to the other end, when it reaches the other end all the particles of air begin to move backwards, so that whether they are going in or out they are all moving in the same direction at the same time. We saw that in the cylindrical pipe that was not the case, and if we took off the closed end of this cone it would not be the case, because then the pipe is open at both ends, and we then have a node between the two ends of the pipe. If we cut this in half again we shall have a note produced the octave of the original, the tube being just half the length. However we subdivide it, we shall get a similar arrangement, and whichever part we take we get the same note enforced. In such a conical pipe we may expect to get the same harmonics as in the case of open cylindrical pipes.

Professor Adams then showed a number of conical pipes fitting one into the other, and the mode in which the vibrations took place in such pipes—which were illustrated by a diagram—pointing out particularly that as you approached the apex of the pipes the nodal line moved further and further from the ventral section, until at the end the nodal line was found at the apex. He then continued as follows:—The greater the difference between the diameters of the two ends of the conical tubes, the greater will be the difference between the notes produced, and the note of the highest pitch will be produced when the open end is the largest of the two. If the open end is four times the diameter of the smallest one, then the note produced is an octave below the cylindrical closed pipe; so that from the same tube it is possible to produce two octaves. Here are some of the pipes made use of by Sir Charles Wheatstone in his experiments on cones, showing the different intervals between two notes. The production of different harmonics of conical tubes may be illustrated in a more pleasant way, as follows.—Dr. Stone has kindly consented to illustrate this fact by giving the different harmonics with the same fingering on the contrafagotto. The one great object in musical instruments generally is to avoid having a mixture of notes, and with the clarinet generally it is not possible to produce harmonics. With this instrument, however, Dr. Stone, as you hear, is able to produce the fundamental, the octave, and the twelfth from the same fingering, and in this case the instrument is a perfect cone. It illustrates perfectly Sir Charles Wheatstone's statement with regard to conical pipes, and shows

that the harmonics are the same as those obtained from a cylindrical tube

There are one or two other points I should have liked to have touched upon, but time has gone very rapidly. One point I must mention, namely, that the resonance of a tube is such that it will only give a note when its length is such as to give one of the harmonics of the fundamental sounding body. That may be seen if we take a tuning-fork and alter this length of tube, which we may do by moving the piston from one point to another along the inside of the tube. At the open end there is a jew's-harp, which has this great advantage over a tuning-fork—the sound of the jew's-harp itself is not loud enough to interfere with the sound of the pipe. At present there is very little sound heard, but if I alter the length of the tube so as to give a note which is one of the harmonics of the jew's-harp, there will be a reinforcement of the note. The number of vibrations of this instrument, the fundamental note, would be that of a closed pipe four feet long, or two octaves below the present position of the piston, and that position being such, the tube will respond to the treble C. Now, if I alter the position and place it at the position of the 3rd harmonic, we get a certain amount of reinforcement; and so with the higher harmonics, though not so distinctly. In the intervals between no note is sounded, though when the position of the piston is near the right point the tone is sounded rather weaker than when in its proper position.

There is one other point which bears a close relation to the resonance of the column of air, and that is the reinforcement or transmission of sound along rods of wood, or other materials, and it is well known that Sir Charles Wheatstone made many experiments of that kind, connecting a musical instrument in one room with the sounding-board of another instrument in another room; and although the instruments might be of different kinds —for instance, a clarinet or harp attached to the sound-board of a piano—if the clarinet or harp were played the sound-board of the piano would give out the quality of tone of the instrument played. One experiment of this kind I may make this afternoon, showing the transmission of sound through what may be considered to correspond to various rooms. Here I take a musical box and wrap it up carefully in flannel, which will not conduct sound readily. I place it inside one box and cover it up, and then place it in another, and no sound will be heard until we establish a communication with it. As soon, however, as I make a connection with that musical box, by putting a rod of wood attached to a sound-board through a hole in the enclosing box, so as to touch it, the sound is distinctly heard. That shows the direct relation of the resonance produced in the air by means of a sounding-board such as this or other sounding instruments.

The Chairman asked which in particular of the matters spoken of by the lecturer were those brought forward by Sir Charles Wheatstone.

Professor ADAMS replied that the cylindrical pipes, the motion of the air from the ends towards the middle, and at the same time from the middle towards the ends, and the whole theory of conical tubes, was entirely due to Sir Charles Wheatstone. In fact, the whole theory of harmonics when applied to wind instruments might be said to be made out by Sir Charles Wheatstone.

DISCUSSION.

Mr. R. H. M. BOSANQUET said this occasion was very important for musicians in connection with certain points of musical theory. The late Sir Charles Wheatstone formed certain opinions at an early time of his life, and illustrated them in the peculiarly clear manner which was his own, but he never changed those opinions or admitted any modification which might afterwards come forward. Of course, anything he continued to maintain had much in its favour, and any ideas of his ought to be very seriously considered, and not lightly put aside. At the *soirée* of this Association last summer he had the honour to be introduced to Sir Charles Wheatstone, when he was astonished at several things which fell from him. Amongst other things, he considered that Helmholtz was all wrong, and that the problem of the resonance of tubes was to be solved on the principle which he discovered years before, and described under the name of reciprocation. He had some difficulty in finding the papers referred to by Sir Charles Wheatstone, they being mostly in the journal of the Royal Institution about the years 1828 and 1830, but he had since read them with great care, and felt that they required a deal of consideration. This was a point which seemed to require an authoritative settlement very much, but of course he was not prepared to give one. Sir Charles Wheatstone believed that when you had a simple pendulum vibration produced in air by means of a tuning-fork, that was capable, mechanically, of reinforcing vibrations having multiple periods in pipes and resonators of suitable length. The evidence brought forward was that of the remarkable experiment which had just been shown, on which he must make one observation—namely, that the sounding part was not a tuning-fork, but a jew's-harp, which was a very different thing. No doubt it was analogous to a tuning-fork, but had much larger vibrations, and the tongue was enclosed between two jaws of metal, so that it was more like a harmonium reed. It was quite clear there must be some deviation from the simple law of motion of a vibrating plate under these circumstances, and he believed it was to this circumstance to a great extent that the production of these harmonics was due. No one supposed that the harmonics were in the rods, or that they could vibrate in octaves and twelfths. As he had mentioned at the last meeting, he had made some experiments with

a large fork of Kœnig's, not subject to such conditions as these, but simply by presenting it to the mouths of suitable organ pipes, when he had clearly heard the first seven harmonics beyond the possibility of a doubt. The question was, what the phenomenon was due to? Was it true that the fork would so act upon the resounding body? Was it mechanically possible that the simple vibration of a resonant body could excite vibrations 1, 2, 3, 4, 5, 6, 7 times, and so on, per second of the vibrations of the fork? That was a question for mathematicians and mechanicians, but hitherto they had considered it impossible, and that the solution must be sought from another source. He believed it simply arose from the properties of the air, which did not admit of its transmitting to any extent or distance simple pendulum vibrations without transforming them, but really he could not give any authoritative statement on the subject, and perhaps this was not the place to attempt it. Still, this was one of the most grave questions to be considered at the present time, especially considering that Sir Charles Wheatstone's opinion was, to say the least, not on that side which was most generally taken by theorists.

Mr. William Chappell remarked that Sir Charles Wheatstone, in his papers, said that he had made the experiments with a tuning-fork as well as with a jew's-harp. He had a perfect recollection of that, because Sir Charles had ordered one to be made for him which would be shown at the International Exhibition of Scientific Instruments.

The Chairman said he was reading Sir Charles Wheatstone's papers a fortnight before his death, and was struck by the sentence Mr. Chappell interpreted to mean that he had tried the experiment with a tuning-fork. After reading the sentence with great care, he could not make up his mind as to whether he really meant to state that or not, and he wrote to Sir Charles Wheatstone to inquire; unfortunately Sir Charles was in Paris at the time and died before it was possible to answer the question, so that he was afraid it remained at present rather in doubt whether he really did get these harmonics with a tuning-fork or not.

Professor Adams thought, from Sir Charles Wheatstone's paper, that he had tried the experiment with a tuning-fork, but it would be very easy to do so, although he had not a fork with him sufficiently large to try the experiment properly, the lowest he had being a middle C, which was a long way above the tone of the jew's-harp.

Mr. Chappell said Sir Charles Wheatstone proposed to him to try circular cards to make the sound more audible, and therefore he presumed it could be produced in any way. He himself had not had time or the convenience for trying it, but he thought that anything which would set the air in vibrations at the mouth of the tube would produce the same effect.

Mr. Bosanquet said there was no doubt the tone could be got.

The way he had set to work was to take various organ pipes corresponding to the pitch of the large fork he had spoken of out of an organ, and lay them side by side on a table. He made the observation himself with Mr Parratt, of Magdalen, and they found that with this large fork and a disc of wood about four inches in diameter fastened to it, so as to increase the agitation of the air, they could hear distinctly up to the seventh harmonic. The tone was exceedingly strong, and could be heard plainly without a disc.

Professor Adams said he had noticed in this sliding tube that the odd harmonics were much stronger than the even ones.

The Chairman asked what was the amplitude of vibration of the fork used by Mr Bosanquet?

Mr Bosanquet. About a third of an inch.

The Chairman thought that might have something to do with it. Mr W. W. Parkinson, in writing to him recently, stated that he had got beats from two tuning-forks a fifth apart. He did not know whether he had taken means to get rid of any combinational tone, so that he could be quite sure there were two simple tones. If you could produce so many harmonics as those Mr. Bosanquet mentioned, there would be no difficulty in getting beats with the interval of a fifth. This was evidently a case which required very strict examination.

Mr. Bosanquet said by far the greatest series of experiments in this direction were those recounted in a paper by Koenig in the last number of *Poggendorf*. He appeared to be fully satisfied that he had obtained perfectly pure tones, and if that were so, certainly the results were most startling and entirely contradicted. Helmholtz's proposition as to the absence of beats. He thought, however, there could be no doubt the sounds were not pure, for what investigations he had been able to make left no doubt on his mind that it was quite impossible to produce a pure simple tone in air.

Mr Lea Southgate, referring to the singing flames, said M. Kastner had made an instrument, to which he gave the name of Pyrophone, by which musical notes could be obtained from a key-board similar to a pianoforte.

The Chairman said this instrument was noticed in an appendix to his translation of Helmholtz. The peculiarity of it was that the tone was produced and stopped, not by raising the flame, but by a number of coincident flames, which were made to come together or separate. It was tried at the Society of Arts, but it was found extremely difficult to get it in tune, and the result was not very satisfactory. It was also shown at the Royal Institution, but there there was not sufficient gas, and they could not get any tone out of it at all.

June 5, 1876.

JOHN HULLAH, Esq., LL.D., in the Chair

ON MEDICAL SCIENCE IN RELATION TO THE VOICE AS A MUSICAL INSTRUMENT.

By Lennox Browne, F.R.C.S. Edin.,

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The subject which I have chosen for the consideration of the Musical Association presents to the most casual observer so many obstacles in the way of treatment that it will be easily believed I approach my task with feelings of diffidence. The largeness of the field for discussion, the difficulty of treating the musical or, to me, unfamiliar portion in a manner worthy of this Association, and the fear lest the medical portion may be tediously or too technically dwelt upon, have tended to render me distrustful of success. Were I not well assured of the generous forbearance shown by professional men to those who have real desire to contribute to our common knowledge, I had many times turned back from the plough to which I have put my hand.

I shall, in consideration of the musical character of many of my audience, probably treat my subject most acceptably by suggesting rather than asserting points on which I venture to differ from or to think unnoticed by those who have written on the voice as a musical instrument, while to those who may expect some advice as to the medical management of the voice, I shall as far as possible direct attention how to form and educate it so as to perfect it in health; and I shall not at all attempt to dwell on the treatment of the organs of voice, when from various causes, whatever their nature, they may fall into a state of disease.

This limitation of the subject embraces, however, a sufficiently wide ground, and I will therefore, without further preface, proceed to consider, very briefly it must be, some of the principal points offered for our notice. They are—

1. The laws of musical sound bearing on the question to be discussed.

2. The organs of human voice combining to form a musical instrument, with the various functions of each organ.

3. The management of those parts under control of the vocalist which may perfect the voice, and by inference,

4 The defects occasioned by mismanagement

Lastly, such directions of hygiene as may apply to all who wish to exercise their voice as a musical instrument

Musical sound is produced by communication to the auditory nerve of sonorous shocks following each other at regular intervals with a sufficient rapidity of succession, the regularity of the intervals distinguishing it from noise, which is an irregular succession of sonorous shocks.

The pitch of a musical note depends solely on the number of vibrations concerned in its production, the more rapid the vibration the higher being the pitch.

The amount of motion communicated by a vibrating string to the air is too small to be perceived as sound, even at a small distance from the string. Hence, when strings are employed as sources of musical sounds, they must be associated with surfaces of larger area, which take up their vibrations and transfer them to the surrounding air—in other words, by a sound-board or box. The *timbre* or quality of a sound depends almost wholly on the quality and disposition of the sound-boards, as in the harp, the violin, the piano; and it may be noted that these sound-boards are not of variable size, but of equal capacity, whether for high or low notes.

The laws of vibrations of stringed instruments bearing on our subject are that the number of vibrations depends—first, on the power of lengthening or shortening of the string; secondly, on the tension or relaxation of the string; thirdly, on the variations in the thickness of the string; and lastly, on the density of the string—that is to say, the shorter, the tighter, the finer, and the lighter in weight is the string, the more rapid will be the vibrations in a given time; in other words, the higher will be the pitch of the note produced

When we come to reed instruments or reed pipes, the reed or tongue takes the place of the string, so far as the generation of the sound is concerned; but the length and calibre of the pipe determine the pitch, and determine it in as definite proportion as is the case with stringed instruments. It is not necessary to trouble you with figures, but the bearing of these laws on our subject will presently be made evident.

I have only enumerated as axioms a few laws of sound necessary to be borne in mind in consideration of the present communication. I need not, however, say that there are many other laws of sound bearing on the question of the production of the human voice of equal importance, but to which it is unnecessary on the present occasion to allude, seeing that I do not intend to make reference to facts based on them in this paper.

Before looking at the structures concerned in the production of the voice, let us define as clearly as we can what is this voice. Well, it is a sonorous vibration or series of vibrations produced by air driven from a bellows along an elastic pipe across two reeds or cords placed in that pipe; the consequent musical

sounds or voice issuing by certain canals and passages of varying calibre and length.

Speech or spoken voice is composed of the articulation or formation into letters and words of these sonorous vibrations. This articulation is produced by parts in no way connected with the production of sound, and by parts placed quite at the point of exit of that sound, in fact, by the lips, tongue, and soft palate, the soft palate being the backward boundary of articulation.

Song or singing voice differs from speech only that it is a higher development of the same power. It consists in the variation and modulation of the emitted sounds. According to the musician, it is the faculty of producing by means of the voice all the notes of the different musical scales.

Beethoven frequently treated the voice as a musical instrument, irrespective of the expression of words. This is exemplified in his Choral Symphony and Fantasia. Some singers unconsciously treat the voice in the same way by entirely neglecting or by slurring the articulation of their words; but in general acceptation singing implies expression of words uttered on the various musical notes. It may be said that the power of the artist is exhibited in proportion as the hearer is struck with the force and beauty of these words musically pronounced by a singer. I may say in passing that I am fully aware that the foregoing, like all arbitrary definitions, falls far short of indicating either the likenesses or differences between speech and song. Musical intonation is as necessary to the former as the latter, so much so that, as Professor Hullah well puts it in his admirable lectures on the *Speaking Voice*, 'that which is effectively and agreeably said must be (partially) sung.' We all know this by experience when we say that such or such an orator has a musical voice. Signor Salvini is a striking example of a man whose voice may be almost said to sing to his hearers, so beautifully true and flexible is it. Italian recitative is not much more than impassioned perfect speaking.

For the complete development of the power of conveying words and sentiments in song many qualifications are necessary, with only some of which can we now deal.

It is only with voice production that we are now concerned, and it is our object to consider how these various musical notes forming the voice may be so produced as to allow the singer to retain to himself the power to express on them any emotion he may will. For the right understanding of this matter we must look at the formation of the parts concerned, and endeavour to find for each part its proper function. In other words, we must know something of the anatomy and physiology of the vocal organs.

The vocal apparatus may be conveniently divided into five parts. They are generally divided into only four:—

1. The lungs or bellows.
2. The trachea or windpipe, carrying air to—

3. The larynx or voice-box, in which are situated the vocal cords or reeds.

4. The variable cavity, being that portion above the voice-box to the soft palate called the pharynx, as well as the nasal passages, the latter common to some extent also to—

5. The articulating cavity, comprising that portion from the soft palate to the lips, whence the sound is emitted.

[Short anatomical description of the various parts omitted. The reader may be referred for such information to Professor Huxley's or any other Manual of Physiology.]

Voice is produced by vibration of the vocal cords caused by the passage of air driven from the lungs. The first desideratum, therefore, for voice production is to have a bellows full of air, and then to know how best to economise that air. On this depends the whole art of voice production. The lungs may be expanded or inflated in three different ways:—

1. By pressing them downwards against the lower wall, which is purely muscular and elastic, and has on its opposite or inferior side soft and yielding parts. In this method the shoulders and chest wall or ribs remain unmoved.

2. By pressing the lungs outwards against the more or less elastic framework of the ribs. In this method also the upper part is not brought into movement.

3. By drawing the lungs upwards with the collar-bone or clavicle and shoulder-blades; these parts which are fixed in the first and second methods. The first way is called the abdominal or diaphragmatic (after the muscles which regulate the movement), the second is known as the lateral, the third as the clavicular. All breath-taking in singing, as in speaking and in ordinary life, should be abdominal. As the abdominal breathing is prolonged it becomes lateral, which in its turn may, if further prolonged, become clavicular; but clavicular breathing is a method of respiration totally vicious, and to be avoided. It is a method never exercised by nature in a state of health, but only when from disease either the abdominal or chest muscles cannot act, and it is the method least efficacious in filling, as it is the one calculated most to fatigue the chest, for it compresses the vessels and nerves of the throat, and thus leads to engorgement and spasmodic action of the muscles. The lateral method is more commonly exercised by women than by men, and under some circumstances is necessary to them; but it is an error to suppose that the clavicular method is ever necessary to either sex under any condition of health.

Whilst the inspiration should be as gradual and as imperceptible as possible, it should also be as full as possible, so that it need not be repeated more frequently than is absolutely necessary. The expiration should not be wasted, jerky, or in gasps, but steady and gradual; for it is on the extension with regularity of expiration that depends the intensity or force, the duration, and the steadiness of vocal vibrations. And here it may be remarked

that he is the best singer who can so control the expiration that the least possible amount of air sufficient to cause vibration is poured with continuous effect upon the vocal organs.* Hence, as one so well knows, the greatest singers appear to have an inexhaustible supply of breath. The method of respiration I have indicated as the natural, and therefore the best, was the one taught by the Italian school of the last century. There is just as much teaching of what may be called the decorations of the voice in the present day as then, but the art of forming a solid basis of voice by long exercise on a right method of breath-taking seems to be almost lost, or, if not lost, is overlooked. Forming the voice, or placing the voice, means nothing more than practice of scales on a right method. To attempt florid passages before such practice has been thoroughly carried out is as futile as to attempt to draw from the life or to colour before one can make straight and curved lines in black and white. It is astonishing how perseverance on a right method will make an agreeable and effective voice out of a naturally poor organ. I could mention the instance of two young ladies who made their *débuts* last year on the London Italian stage. One, with but slight *physique* and but few natural gifts, sings the most difficult music with such rare precision and accuracy as to give complete satisfaction; the other at once inspires her hearers with only feelings of regret that a really charming natural voice has not been made more flexible by the practice of simple scale singing before opera was attempted. I venture to think that more error has been promulgated in vocal instruction and more injury done to voices from faulty methods of breath-taking than from any other cause. As has just been said, the force, intensity, and sustaining power of the voice depend on a good method of breath-taking and emission. When it is considered that the Conservatoire of Music of Paris† teaches that it is necessary to breathe differently for singing than for speech, it is not to be wondered at that the voices of French singers become so often trembling, small, and early fatigued ‡

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* The direction of Signor Garcia for a singer to practise his voice with a lighted candle before the mouth is known to many. If the flame is extinguished, or even wavers, it is a sign that too much air is being expended.

† 'Quand on respire pour parler ou pour renouveler simplement l'air des poumons, le premier mouvement est celui de l'aspiration, alors le ventre se gonfle et sa partie postérieure s'avance un peu . . . . Au contraire, dans l'action de respirer pour chanter, en aspirant il faut aplatir le ventre et le faire remonter avec promptitude, en gonflant et avançant la poitrine.'—*Méthode de Chant du Conservatoire de Musique*

‡ I cannot forbear mentioning that I have received a most interesting communication from a lady in Amsterdam, who, having read a translation of the brief abstract of my paper which appeared in the daily press, recounts how sad were the results to her voice of the teaching in a certain Conservatoire on the Continent; how that four years of rest and medical treatment did nothing for her, but how that Mons Wartel, the able instructor of Mesdames Nilsson and Trebelli, at once recognised the cause of her loss of voice, and placed her in the way of regaining it 'in three months as strong as it ever was

The air carried from the lungs by the windpipe (which we shall presently see is not a mere passive tube) impels against the vocal cords, which act as reeded tongues, and divide the air into a number of puffs or explosions. The series of musical notes thus produced vary in pitch, according to most writers, solely as these cords are tightened or relaxed, so as to vary the configuration of the space between them, called the glottis, and thereby to modify the character of the explosions.

The notes having been formed by vibration of the vocal cords, are carried into a very variable cavity, the pharynx. This variable cavity is not only, as is generally taught, a simple resonant box, but it plays, in my opinion, a very important part in the actual alteration of pitch. The formation of notes into articulate sounds commences only at the fauces and soft palate; but the pharyngeal tube before that point possesses a power of lengthening and shortening itself, of expansion and compression, that is quite independent of articulation, of resonance, or of *timbre* or tone quality. Without going further into the anatomy of the subject, it may be stated that the peculiarity of all the parts connected with the organs of voice is their extreme mobility and variable capacity, and, it may be added, their mutual inter-dependence. It is on true economy of the air in the lungs that depends the intensity of the vibration of the vocal cords. It is in a great measure on the power to stretch or relax those cords that the extent or pitch of the voice depends. This much is admitted; but the tube that carries the air from the lungs to the vocal cords has a power to modify the voice, as has that portion of the tube above the cords before it arrives at the point where articulation begins. These are facts on which I wish particularly to dwell, because I think they are not sufficiently considered by those occupied in voice production. Pupils are generally told that the whole variation of pitch in the human voice—a variation of from two to three, or even, as in the rare instances of Sass, Catalani, and one or two others, three octaves and a half of voice—depends solely on the variation of tension of two small membranous reeds, less than an inch long, which, in the case of a man, have a power of alteration in length of only one-sixth of an inch between their highest and lowest note, while in women they do not vary in length more than one-eighth of an inch. Between these two cords is a space—the glottis—which, as it is taught, can be lengthened, shortened, narrowed, or widened, by the tension, relaxation, the approach or the separation of the vocal bands; and it is these different configurations, formed, let it be borne in mind, by ends of extremely limited power of tension and relaxation, which, say physiologists, determine the pitch of the voice. Dr Mandl, a physician devoting

before.' This lady very sensibly suggests that 'a kind of diaphragmatic *gymnastique* would not only enlarge the respiratory organs, as does singing with good breath-taking, but that it would thus cause women who are not singers to make more healthy blood, and to gain more strength in general.'

himself to throat affections, and of high repute in Paris, and who is Professor of Hygiene of the Voice at the Conservatoire of Music—a post as yet unknown in the academies of this country—remarks that, because the larynx or voice-box can move in its totality, as in the act of swallowing, or in protruding and retracting the tongue, it is proved that the position of the larynx is independent of the height of the sound. In the same way we are told that because the windpipe—that is, the portion between the lungs and the voice-box—has but a limited power to shorten itself, therefore that portion of the vocal apparatus plays also only the passive part of an air-conducting pipe. One might as well say that because the vocal cords separate in inspiration and approach in expiration, that is all they have to do, or that because the tongue is the organ of taste, it plays no part in the articulation of words. I have on more than one occasion seen how very small an interference with the rhythmical action of the windpipe will cause extreme disturbance of breathing, in the same way that a very slight constriction of the gullet will interfere with the swallowing of a bolus much smaller than the strictured orifice. With this disturbance of the breathing from a very slight alteration of the calibre of the windpipe ensues an enfeeblement of the voice out of all proportion to the interruption in the current of air.

I must confess that I have not seen that variation in the shape of the glottic orifice during vocalisation that has been dwelt upon by various writers since the discovery of the laryngoscope; and, as it has been my practice to make drawings of the laryngeal condition of almost every patient presenting abnormal appearances, as well as the larynx of many hundred persons presenting no abnormality, I should, I think, have noticed these changes in configuration, at any rate, in some instances. I mention this fact of my making drawings because, although the figures drawn might not be perfect, the habit of observation is rendered much more accurate by the mere act of delineating what one sees. Nor can I think of any provision of nature by which the vocal cords are stopped so as to produce all the varied notes in the vocal scale.* We must look, therefore, for something more to account for the causation of variation of vocal pitch, and this something is to be found, I suggest, in the conditions of the vocal pipe, by which I mean that portion leading from the lungs to the vocal cords as well as that portion which is above them.

* I do not forget in making this statement that Signor Garcia, in his masterly communication to the Royal Society (Society's Proceedings, Vol. vii. No. 13, 1855), came to the conclusion that 'the remarkable arrangement of the fibres (of the intrinsic muscles of the larynx—i.e. those acting on the vocal cords themselves) enables us to explain the elevation of the voice', nor do I for a moment venture to dispute his facts, but I think that he and all other teachers since him, following in his wake, attempt to prove more than can be proved from the action of the vocal cords alone. He admits that the trachea may modify the force of the air from the lungs, and that the pharynx modifies the *quality* of the voice. My suggestion is that pitch and quality are both modified by these causes.

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The experiments of Savart long ago proved that a tube of constant length may be made to produce a great range of sounds by making it of elastic sides susceptible of variations in tension. The analogy between such a tube and the trachea is perfect. The windpipe cannot shorten or lengthen to any very great extent, but it can be increased in tension by two sources, one the action of the transverse muscular fibres which bind the ends of the cartilages together, the second the elevation of the larynx which accompanies to so remarkable an extent the elevation of the pitch of the voice, a movement which Dr. Mandl would have us believe is totally independent of the alteration in pitch. Sir Charles Wheatstone* more than forty years ago drew attention to this relation of the variation in tension of a tube to a free reed, and illustrated it by the instrument known as the jew's-harp, in which the reed being once set in motion by air from the mouth produces one steady bass sound. The variation of sounds is produced wholly in proportion as the skill and will of the performer varies the cavity of the mouth so as to present a succession of volumes of air calculated to vibrate the different multiples of the primary bass sound. This influence of the tube is by experiment found to be the same, whether the tube is placed after the reed, as in several wind instruments, or before (and after) it, as in the vocal organs. By my observations a very similar thing takes place above the larynx as below it. When one looks at the vocal organ by means of the laryngoscope, the note 'ah' being sounded, the vocal cords are seen to approximate, and the larynx or voice-box is not moved. On the low note 'o' or 'oo' being sounded down goes the larynx, drawing with it the epiglottis, the tube above the vocal cords is lengthened. Then let the person under examination sound 'a,' 'o,' or 'i,' all high vowel sounds; up goes the voice-box, often so close to the tongue as to get almost out of sight. The tube is shortened with the elevation of pitch. But also the soft palate is pressed back against the back wall of the pharynx, so that the tube is diminished still further by the cutting off the nasal portion of the canal, and the actual calibre of the pharyngeal tube is enlarged or diminished (as we have seen to be the case with the windpipe) by the action of the constrictor muscles of the pharynx and the pillars of the fauces. Nothing so destroys the high notes of the voice as enlarged tonsils. Dr. Bennati, who wrote some forty years ago a work, *Sur le mécanisme de la voix humaine*, mentions as an unexpected effect of removing the tonsils that he found the operation to be followed by the raising of the voice half an octave. This I can readily believe, because the presence of these enlarged glands so very much diminishes the power of the pharynx to modify the higher notes. For the consolation of those who suffer from enlarged tonsils, and are deterred from having them removed by fear of

* See the interesting paper of Professor Grylls Adams in the present volume, pp. 84 *et seq.*

the voice being injured, it may be mentioned that many of our greatest singers, from Madame Patti downwards, have undergone the operation with the greatest comfort to themselves and with the result of increasing rather than of diminishing the range of the voice.

I am well aware that I have left altogether untouched many points of great importance in voice production, as, for example, the resisting power of the inspiratory muscles to control the exit of the air from the lungs, and the influence of the ventricles of the larynx in controlling both the entrance and exit of air in the glottis. I have been obliged to pass over interesting points, as the difference between male and female voices, as well as the varieties of voice known as tenor, baritone, and bass, soprano, mezzo-soprano, and contralto. A matter on which more knowledge is greatly wanted is the cause of the power to pass from one register, as it is called, to another without a break. One of the most noteworthy facts concerning the human voice as a musical instrument is the marvellous power which it possesses to sound the very smallest musical intervals, a faculty strikingly evidenced in the voices of the Orientals* and the New Zealanders. I should have wished also to have dwelt for a little on the production of the falsetto, a problem full of interest and never yet satisfactorily solved. Signor Garcia thinks that 'the lips of the glottis (vocal cords) come in contact by their edges alone, and offer little resistance to the air; hence arises the great loss of this agent and the general weakness of the sounds produced here.' He places it as between the chest and head registers. I am not able to give much information as the result of my own observation concerning the production of the falsetto for two reasons. One is that the epiglottis always rises as soon as formation of such notes is attempted, drawing up with it the larynx, so as to very frequently obscure the image in the laryngeal mirror. My observation on this point is exactly contrary to that of Signor Garcia, who says that 'every time the epiglottis lowers itself, and nearly closes the orifice of the larynx, the voice gains in brilliancy, and when, on the other hand, it is drawn up the voice becomes immediately veiled. Another reason why it is difficult to see in the mirror the exact appearance of the organs when falsetto notes are produced is the fact that the pressure of the mirror against the soft palate necessary to see the larynx appears to interfere with that perfect tension of this part inseparable from the production of these notes. I have not been able, by actual observation, to confirm or, indeed, to contradict Signor Garcia's theory. In those few cases in which I have well seen the larynx I have failed to discover any appreciable difference in the opposing edges of the vocal cords.

[It may be interesting to quote some remarks on this subject

* This subject is referred to by the Rev. Sir Gore Ousseley in his communication in the present volume, page 31.

of Mr Sims Reeves, in a letter he did me the honour to write since this paper was read. He suggests 'that the falsetto is like a false note made by flute players; it is, as it were, outside the tone. The same with violinists when they make the harmonic sounds.']

I have been asked to say something of the connection of the throat and ear in music. This question is based on a wrong understanding of the connection of these parts. In cases of so-called throat deafness the passage leading from the back of the throat (posterior nostrils) to the ear may be obstructed and thickened, and so the intonation and articulation will be more or less impaired; but the fact of a person singing true or false depends on causes independent of any such connection. In those cases where it is not due to wrong voice production, it may be caused by what may be called sympathetic disturbances, as nervousness, indigestion, and general *malaise*. The singer almost always knows in such a case when he is out of tune. The instances in which the auditory nerve is impaired so that the subject of it is not aware of his faulty intonation are fortunately rare, and are, of course, hopeless. Song practice on a right method of voice production and learning to play a musical instrument are probably the best means for bringing the voice into accord with the ear.

My object has been to draw attention to the fact that, valuable as has been the laryngoscope in a physiological, as it is undoubtedly in a medical sense, it has been the means of making all theories of production of voice too dependent on the vocal cords, and that the importance of the other parts of the vocal apparatus in their actual influence on the pitch has been overlooked. It is therefore impossible to say that the voice is this musical instrument or that. It has been at various times treated as a wind instrument, a reed instrument, a string instrument, and as a flute instrument. Efforts to make an artificial human voice on any one separate principle have signally failed; witness the so-called *vox humana* stop of the organ, or the attempts of Muller and Helmholtz to imitate the voice by means of hands of india-rubber placed in apposition at one end of a glass tube. Many vocal notes strongly resemble those of the clarinet, others those of the violoncello; while, in the higher register, the instrument which appears to me to act most perfectly in musical unison with the human voice is the flute. One has only to listen to Madame Patti in the song with double flute accompaniment in the last act of *L'Etoile du Nord*, or to Sir Julius Benedict's lovely composition, 'The bird that came in spring,' with similar accompaniment, to appreciate what I mean. Not that I would imply that the vocal organ is a flute instrument, or indeed any of the other instruments to which it has been likened. It is probably a combination of all. To quote again Professor Hullah: 'The *vox humana* of the Divine artificer is an incomparably more complex as it is an incomparably more beautiful instrument than any of

its compeers. Fearfully and wonderfully is it made. Not only is its mechanism more intricate, not only are its constituent parts more numerous and delicate than those of any artificial organ, but the action of these is complicated by conditions from which every other instrument is free.' In studying its nature we must not look at one part or two, but at all parts as units of a whole. Dr. Marcet relates a case in which a man regained his (speaking) voice, having lost by disease his vocal cords; and an American physician has published how he artificially constructed a vocal cord lost by disease. One sees daily amongst the common causes of loss of voice a too feeble current of air to cause sonorous vibration of the cords, inflammatory conditions of the cords preventing their approximation or elasticity, a disordered state of the secretory membranes and glands of the air passages destroying their whole tone, or conditions which may interfere with correct articulation. These are only enumerated to give a few instances of the many causes of disease which may act separately or in combination to destroy or weaken the voice; but, setting disease aside, I venture to say that three-fourths at least of the professional voice-using people, clergymen, barristers, vocalists, and actors, who suffer from fatigue of the voice, are victims to vicious voice production, and that many of the most common of the diseased conditions are due to this cause. Although it is most desirable in any given case of enfeeblement of the voice to examine the voice-box, it is simply astonishing how seldom is the cause to be found in the vocal cords, or, to put it another way, how seldom it is necessary or even judicious to treat the disease only or at all locally. In offering, therefore, a few suggestions as to the hygienic management of the voice, it is necessary to direct attention to matters which apparently are entirely outside the question. One hears of this lozenge or that gargle or syrup as a universal panacea for all the troubles to which vocalists are subject. I am sorry to say that singing masters not unfrequently err in this respect, and prescribe for their pupils remedies of which they know nothing, except that they may have been serviceable to themselves or their friends, probably for totally different diseased conditions.* I shall not be surprised if singing masters retort that I have taken my revenge in the present communication by trenching on their ground. If, however, I tell of no universal medicine to regenerate a lost voice, or to cause one to form on barren soil, it is simply because I know of none.

Remarks on the general medical management of the voice must be brief for two reasons: first, for want of space; and,

* I have had analyses made of, I think, every variety of patent voice lozenge. There is not one that does not contain more or less Cayenne pepper or some like irritant, and that is not consequently harmful. I take this opportunity of disavowing any connection with some lozenges bearing the same name as my own. However useful they may be as 'bronchial troches,' they are totally unsuited for voice lozenges.

secondly, because there is so little to be said that can be applied generally. The best advice I can offer is that the voice should be treated by its possessor as a musical instrument. No one would expose his piano to all changes of weather or temperature, nor would he leave his violin out in open air all night. On the other hand, it is not necessary that the one should be kept in a room of specially prepared even temperature nor that the other should be constantly swathed in flannel. One hears a great deal of the injurious effects of climate on the voice, especially of the climate of this country and of America. Presupposing a naturally healthy constitution—and it is worth noting what good general health the best singers enjoy—I do not believe that climate is nearly as much to blame as is generally supposed. Sopranos who have never learnt to produce the voice properly, and foreign tenors who have used up all the voice they ever had before they come here, may complain of '*ce vilain climat*,' but when we consider that Madame Patti can sing equally well in such varying climates as those of a winter in Moscow or St Petersburg, a spring in Vienna or Buda-Pesth, then in Paris, Brussels, or London, with an autumn tour through the English provinces, and with often no longer interval of time between two engagements, say from Vienna to London, than is occupied in the journey; when one finds that Mr Santley and Mdlle. Albani have both returned from long tours through America without losing one iota of the quality of their voice, and that Mdlle Tietjens has actually come back from the same country with renewed vocal beauty and strength, it will be agreed that the cause of frequent non-appearances is not always truly, however conveniently, explained by the state of the barometer.

All who use their voice should, then, guard carefully their general health on rational but not exaggerated principles. While good health is essentially necessary to good voice, it may be said that, as a simple matter of hygiene, practice of the respiratory muscles, on a right method, be it always remembered, such as singing implies, is often of the greatest service in improving the health of the lungs.

The singer should not be afraid of air, but he should avoid sudden changes of atmosphere, and also dust. His diet should be liberal, but always of food most easily digested and free from all irritating ingredients. Above all, he should never foster the idea that alcoholic stimulant of any kind is necessary to the exercise of his art any more than it is to that of the painter or the author.*

* It is impossible to say how much mischief has been done by the absurd accounts of the variety of beverages indispensable to our former great singers. Whatever may have been the practice in the past, such notions as that the drinking of so many bottles of beer or stout per evening will give voice are no obsolete as, I am happy to say, is the idea that no man is a hospitable gentleman who allows his guests to go home sober. I am glad to quote here Mr. Sims Reeves' observations on this point in a letter already referred to—'I was much interested in the remarks made by you at the meeting of the Musical

Remembering how much the abdominal muscles have to do with voice productions, he should sing when the food is digested and the stomach is of least capacity, and therefore least likely to interfere with that of the chest. I would say that an hour and a half to two hours is necessary to elapse after food for singing in public or company, and an interval of at least an hour should occur before practice. In like manner the garments of both male and female singers should be free, especially should they be so about the waist and at the neck.

The voice should be always exercised on notes well within the range of the singer; indeed, it might be said on all grounds that, except on the rarest occasions, the extreme limit of the voice should never be attempted, for it is certain that, not only is it most injurious medically to sing always at full voice, but that the greatest pleasure is given by those voices which seem to have a reserve of power, or, to put it another way, those voices in which the hearer never feels that the mechanism is going to fail. It is for this reason that, as a rule, although tenor and soprano voices elicit most admiration, it is the deeper voices that engender most sympathy.*

It is the musician's rather than the doctor's duty to point out how important a part the brain and heart must play in developing perfect singing. There must be ability to interpret sentiments as to express them, there must be conscience in study as well as talent, there must be power to recognise defects, and perseverance to overcome them. Without such qualifications, however marvellous the natural beauty of the organ, its possessor will be unable to prevent his hearers from feeling that there is '*vox et præterea nil*'

DISCUSSION.

The CHAIRMAN said he should be glad to know whether the case quoted from Dr Marcet referred to the retention of the speaking or of the singing voice, after the loss of the vocal cords. He could not conceive how the singing voice could exist under such circumstances.

Association with regard to the use of stimulants. By long experience I find it much better to do without them entirely. A glycerine lozenge is preferable, on very rare occasions a small quantity of claret and water may be necessary, but all alcoholic stimulants are detrimental. I formerly, and for many years, used beef tea, but that was too heavy. If one could limit oneself to a tablespoonful at a time, the latter might be the best, but a large draught clogs the throat, and produces more saliva than is necessary, and induces the desire to swallow often.'

* I regret to say that I have seen not a few instances of good baritone and mezzo soprano voices utterly ruined by the endeavours of masters to convert them into tenors and sopranos.

Mr. LENNOX BROWNE said he believed it was the speaking voice. He had never seen such a case himself

Mr SALAMAN said about thirty years since he knew a case of a lady who, in consequence of a sudden fright, had been deprived of her voice for nearly a year Galvanism was medically recommended as a means to recover it, but was not adopted It so happened that the lady required to have a decayed tooth stopped with metal. Almost immediately after its application to the cavity of the tooth the lady's voice returned It was at the time suggested that galvanism had been set up by the contact of the metal with the saliva, and the recovery of the voice was attributed to its action

Dr. VERRINDER said he should be very glad if Mr. Browne could throw some light on the way in which the falsetto and the natural voice blended. It was a matter of great difficulty to blend these two voices

The CHAIRMAN said he thought the great difficulty arose from the impossibility of seeing the parts in operation, as had been mentioned by Mr. Browne, and the slight changes in the position of the vocal apparatus during the two modes of production.

Professor MONK said he understood from Mr Browne that the pressure of the mirror of the laryngoscope against part of the throat prevented the production of the falsetto voice.

The CHAIRMAN said there were really three varieties of voice; there being one between what was commonly called the 'chest voice' and the 'falsetto' The French recognise this in speaking of the first, second, and third registers, not so much with reference to the compass as to the mode in which the notes were produced. Some identical notes might be produced in three different ways.

Mr. WILKINSON said he supposed the falsetto voice must be considered entirely unnatural.

Mr. COOPER asked if it were not possible that the falsetto was produced by the epiglottis falling, because there was so much less effort in producing a falsetto note.

The CHAIRMAN thought the falsetto was not always introduced with less effort than the other registers It might be in some cases; but in counter-tenor singers it was, to a great extent, the result of practice A counter-tenor, generally speaking, would be an indifferent bass who had cultivated the falsetto register almost exclusively.

Mr. WILKINSON said a treble voice might be practised at the time the voice broke and continue to retain the high notes, so as, in course of time, to produce an alto voice

The CHAIRMAN said he had known a boy who retained his treble voice up to G, or even A, and of good quality, until his virile voice was tolerably well formed. Thus he could sing down to the F below the bass stave, and up to A above the treble, though, of course, the notes varied very much in quality.

Mr. WILKINSON asked how it was that, when a boy's voice broke, sometimes in the course of two months he would develop

a tolerably good baritone voice, whereas, in another case, he might have to wait two years before his voice settled

Mr. Cooper suggested that this must be, to a great extent, a question of health and constitution

Mr. Wilkinson said he had known choir boys who had stepped immediately from the treble into the alto row when their voices broke, and remained there for the rest of their lives

Mr. Cooper said there were some counter-tenors who had high tenor voices.

The Chairman said this was another illustration of the defectiveness of our musical nomenclature. There ought to be a distinction drawn between what was really a high tenor, which was the voice for which Tallis and the old masters really wrote (in the alto clef) and the falsetto voice, which was totally different. The modern alto voice or counter-tenor was, he believed, never heard in England until after the Restoration.

Mr. Osborne said there were no such voices on the Continent, only high tenors.

The Chairman thought the modern English alto voice was an imitation of a class of voice which was now extinct—a voice artificially produced

Mr. Osborne asked if it would be possible for a singer exercising before a looking-glass to so observe the action of the parts employed in vocalisation as to improve his method.

The Chairman said he could only watch the action of the 'vocable cavity.'

Captain Hutton said, by keeping the larynx well down, by allowing the tongue to fall back whilst singing the scale, the voice was made fuller.

Mr. Salaman said, in the account given by Dr. Burney of the Handel Commemoration there was a list of voices in which there were very few contraltos mentioned, the altos were nearly all men. The contralto seemed to be comparatively a modern voice.

The Chairman said Handel wrote his alto parts for the voices he found in England, and they were mainly male counter-tenors.

Dr. Verrinder thought the introduction of the counter-tenor voice was owing to this: that in cathedrals ladies were not allowed to sing, because they could not be put into surplices, and therefore it was necessary to have artificial voices of the counter-tenor for the contralto part.

The Chairman said, up to the time of Orlando Gibbons what was now called the male counter-tenor was a voice utterly unknown. He should be very glad if anyone could produce a bar written before that time, written for such a voice. The highest part then written for male voices was a high tenor written on the alto stave, but at the Restoration, when Charles II came back, he wanted to hear the species of male voice he had been accustomed to on the Continent. As this could not be, the nearest imitation of this voice that was accessible was introduced at the Chapel Royal, and from that time dated those great solos

written for the male counter-tenor, going up to C, which were found in the anthems of Purcell, Blow, and the composers of that and later times.

Mr Cooper asked if it were likely that any of these singers were brought over by Charles II.

The Chairman thought not. There were falsetto counter-tenors in Spain in the sixteenth century, but not in England, and there was no cathedral music written for them. The female contralto was a sort of discovery—not even yet made all over the world. There were few German contraltos and fewer French; and thus it was there were no contralto parts in the French operas of Meyerbeer and his contemporaries. Certain parts in those operas had been sung by contraltos, but they had first been modified and adapted.

Mr Salaman asked in what country contraltos were discovered.

The Chairman said in Italy. Gluck wrote his Orpheus for a female contralto.

Mr Cooper said there must always have been contralto voices, whether used or not.

The Chairman said, Yes. One reason why women lost their voices so much sooner than men was because they would all sing soprano. The greatest difficulty was found in Training Colleges to keep students to their proper parts in that respect.

Professor Monk said Mr Salaman had referred to the absence of contralto voices from a chorus, but he thought he would be old enough to remember when even the contralto solos in Handel's oratorios had been sung by men.

Mr Osborne asked if there were any other instances, besides those already mentioned, of persons losing their voices by sudden fright.

Captain Hutton mentioned a case which he knew of.

Dr Stone also mentioned one in which a young lady many years ago had lost her voice, and although she regained it after a time, she was liable at any time to lose it for two or three days if she were slightly tapped between the shoulders.

The Chairman said he was very glad to hear Mr Browne's condemnation of all quack remedies for the voice.

Mr. A. J. Ellis, F.R.S., said he was not a singer, but sometimes had to speak for a couple of hours, and he found that drinking a glass of water, which some recommended, was a great snare. He found the best thing for keeping the voice moist was a little piece of Spanish juice held in the mouth.

Mr. Cooper asked if Mr. Browne could give any instructions for acquiring the *vibrato*, which was now so fashionable.

Mr Lennox Browne said simply to learn music by the French mode. The *vibrato* arose from a defective manner of breathing. He had already stated the difficulty there was in observing the physiological cause for the production of the falsetto. He could not say how it was produced, but thought *la voix de tête* was a

better term for it, the *falsetto* being, in his opinion, entirely a head note, and not, as Signor Garcia seemed to think, coming *between* the chest and head voice. The epiglottis did not go down in the falsetto; it was joined by certain folds to the cartilages, by which it was lifted according to the action of the vocal cords. In the production of high notes those folds were tightened, not relaxed, and therefore the epiglottis rose; in the lower notes they were relaxed. His experience was that the epiglottis went down with the low notes and rose with the high ones. With regard to nervous loss of voice, it was very frequent, and occurred from a number of causes, as from stage fright, for instance. He doubted whether, in the case mentioned by Mr. Salaman, the recovery was due to any galvanic action. In cases of nervous loss of voice, the effect of galvanism was to produce a shock on the nerves and so restore the action of the paralysed muscles acting on the vocal cords. With reference to holding anything in the mouth, several singers of his acquaintance were in the habit of singing continually with something in the mouth to stimulate moisture, holding it between teeth and cheeks like a sailor's quid of tobacco. He was glad to have heard what the Chairman said with regard to contralto and soprano voices, and he was thus emboldened to say how often he noticed that ladies wished to be sopranos, and the evil was intensified by the desire of teachers to produce sopranos.

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