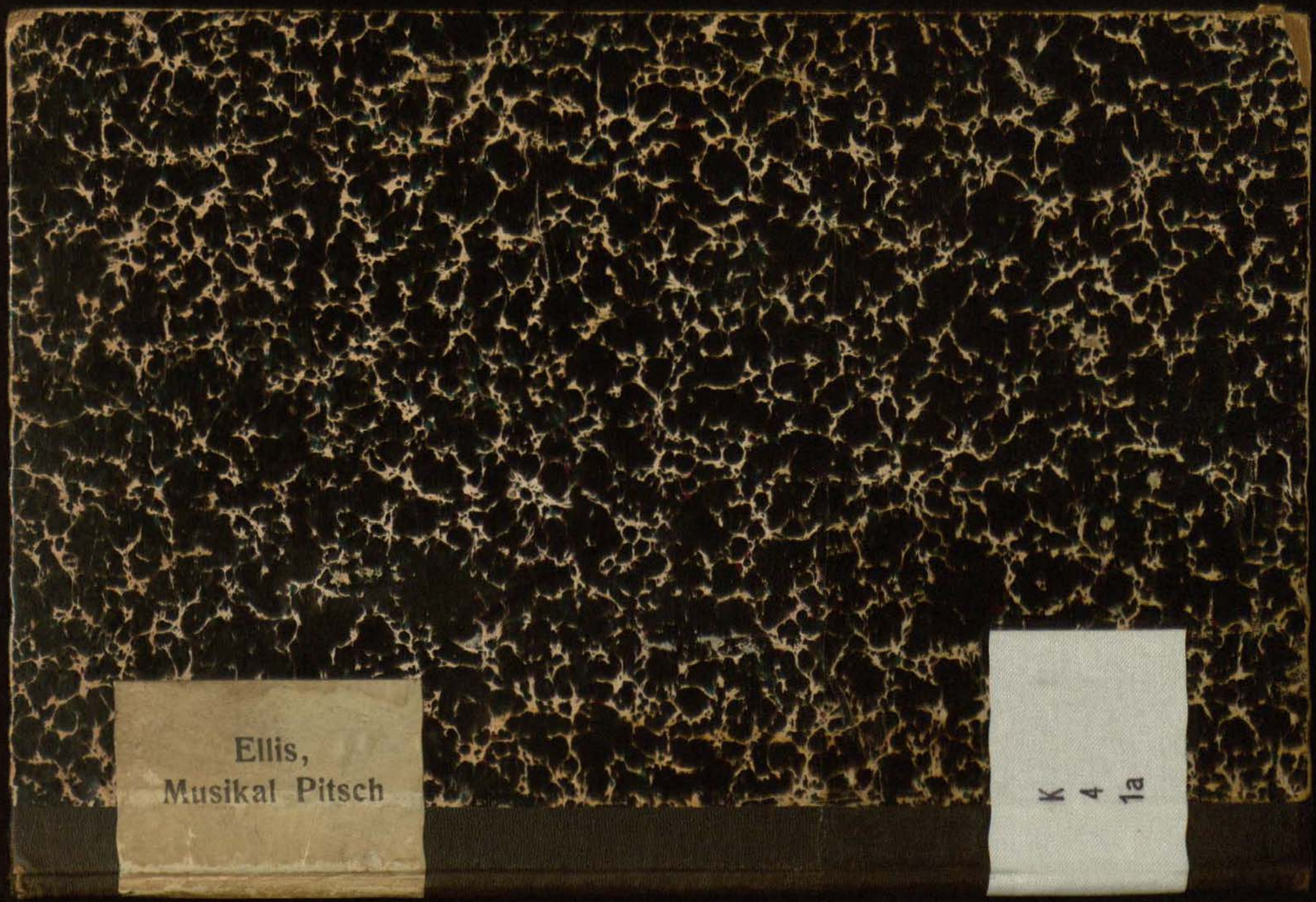
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VERWALTUNG
DER KÖNIGL. SAMMLUNG
ALTER MUSIKINSTRUMENTE.

Staatliches Institut für Musikforschung Berlin
1992.1053

JOURNAL OF THE SOCIETY OF ARTS,

FRIDAY MARCH 5, 1880.

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Institution of Naval Architects.—

The ANNUAL MEETINGS of the INSTITUTION of NAVAL ARCHITECTS will take place as follows in the Hall of the Society of Arts, by permission of the Council of that Society. President, Lord HAMPTON, G.C.B., will occupy the Chair.

WEDNESDAY, March 17th.
MORNING MEETING, at Twelve o'clock.
President's Address—Annual Report of Council.
Reading and Discussion of Papers.

THURSDAY, March 18th.
MORNING MEETING, at Twelve o'clock.
Reading and Discussion of Papers.
EVENING MEETING, at Seven p.m.
Reading and Discussion of Papers.

FRIDAY, March 19th.
MORNING MEETING, at Twelve o'clock.
Reading and Discussion of Papers.
EVENING MEETING, at Seven p.m.
Reading and Discussion of Papers.

Papers on the Principles of Naval Construction; on Practical Ship-building; on Steam Navigation; on the Equipment and Management of Ships for Merchandise and for War; on Marine Engines, and other Subjects connected with Naval Architecture and Marine Engineering, will be read at these Meetings.

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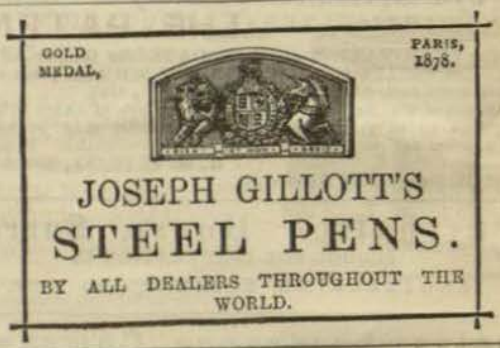

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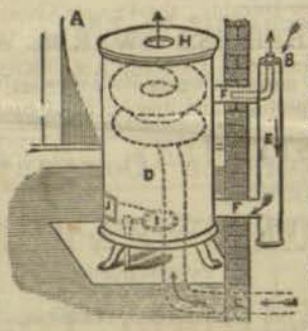

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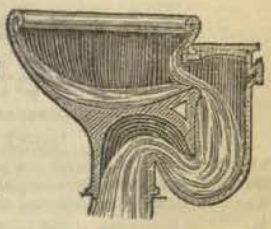

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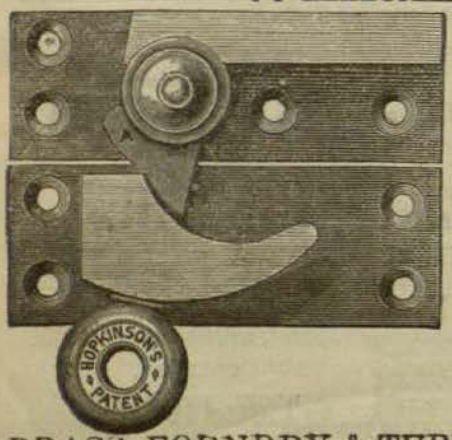

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JOURNAL OF THE SOCIETY OF ARTS.

No. 1,424. VOL. XXVIII.

FRIDAY, MARCH 5, 1880.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

The fifth lecture of the Second Course of Cantor Lectures, "On the Manufacture of India-rubber and Gutta-percha," was delivered by THOMAS BOLAS, F.C.S., on Monday, 1st instant. The Lecturer treated of ebonite or vulcanite, and substitutes for india-rubber. The next lecture, to be given on Monday next, the 8th inst., will be the last of the course, and will deal with gutta-percha. The Lectures will be printed in the *Journal* during the summer recess.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 3rd, 1880; WILLIAM POLE, Esq., Mus. D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Bell, Major William Morrison, 40, Pall-mall, S.W.
Pierce, Josiah, 12, Beaufort-gardens, S.W.
Ross, David, B.A., Church of England Training College, Glasgow.

The following candidates were balloted for and duly elected members of the Society:—

Baker, Chas., 60, Francis-road, Edgbaston, Birmingham.
Heaton, Charles W., F.C.S., Charing-cross Hospital, W.C.
Hoe, C., 44, Leadenhall-street, E.C.
Mole, Frederic M., Granville-street, Birmingham.
Moon, Ernest Robert, 2, Temple-gardens, E.C.
Parkes, Sir Harry Smith, K.C.B., H.B.M. Minister, Japan, and Athenæum Club, S.W.
Plant, George William, 145, Queen Victoria-street, E.C.
Underhill, Arthur, M.D., Great Bridge, Tipton.

The paper read was—

ON THE HISTORY OF MUSICAL PITCH.

By Alexander J. Ellis, B.A., F.R.S., F.S.A.

Art. 1. *Introduction.*—On 22nd May, 1877, I read a paper in this room on "The Measurement and Settlement of Musical Pitch," for which the Society of Arts honoured me with one of their silver medals. Subsequently, it was objected that the instrument which I used for measuring pitch (Appunn's tonometer, see Art. 19) gave results differing considerably from those obtained by other observers, and was, therefore, probably incorrect. It was also objected that I had not given a sufficient account of early musical pitch. I have been able to discover the cause of the error of Appunn's instrument and its correction, and I have been fortunate enough to obtain a large amount of new information respecting early musical pitch. To arrive at these results has been a work of time, labour, and expense, far beyond what I could have anticipated, and I should never have obtained them at all without the co-operation of numerous friends and assistants, to whom I beg hereby to tender my most hearty thanks.[1] This must be my apology for the length of time that has elapsed between the reading of my first paper and its present correction and supplement.

Art. 2. *Pitch.*—By the pitch of a musical note I shall always mean, as is usual in England, "the number of double or complete vibrations, back-

[1] *List of my Principal Helpers.*—The following is a list of the principal public bodies and persons to whom I am indebted for assistance. Those to whose names a star * is prefixed have helped me very much indeed, several of them to an extent for which I cannot sufficiently thank them.

Public Bodies.—The Lords of the Committee of Council on Education, Science and Art Department; the Society of Arts.

Professors.—W. G. Adams, of King's-college, London; Cornu, of Paris; F. Guthrie, of the Science Schools, London; *Herbert McLeod, of Cooper's-hill College, Staines; *Alfred Mayer, of Stevens Institute, Hoboken, New Jersey, U.S.; Sir Herbert Oakley, of Edinburgh; Rev. Sir F. Gore A. Ouseley, Bart., of Oxford; *F. Rossetti, of Padua; Sir R. Stewart, of Dublin; J. Tyndall, of the Royal Institution.

Private Gentlemen and Ladies.—Herr Amels, formerly of Crefeld; R. Drew, Esq., of Dublin; Rev. G. T. Driffield, rector of Bow; Mr. George Herbert; M. Philbert, when Consul at Amsterdam; Rev. H. R. Haweis; Dr. Huggins, F.R.S.; *Frau Näke, of Dresden; the family of Scheibler, in Crefeld; Dr. W. Spottiswoode, P.R.S.; Dr. W. H. Stone.

Organ-builders.—Bevington, Bros.; Bishop and Son; Bryceson Bros., and Ellis; *A. Cavaillé-Coll, of Paris; Forster and Andrews, of Hull; Gray and Davison; *Hill and Son; Jehmlich, of Dresden; H. Jones; T. C. Lewis and Co.; Herrman Smith; Telford and Telford, of Dublin; Ullmann, of Vienna; J. Walker and Sons; H. Willis.

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Horn-makers.—Blaikley, of Boosey's; V. Mahillon, of Brussels.

Instrument-makers.—G. Appunn, of Hanau; W. Ladds.

Tuning-fork-makers.—Valantine and Carr, of 76, Milton-street, Sheffield; Secretan, of Paris.

Bell-founders.—Cavedini, of Verona; Colbacchini, of Padua.

Musician.—*Moritz Fürstenau, librarian of the Dresden Opera.

Violin-makers.—Hart and Son, Wardour-street; Hill and Son, Wardour-street; E. Withers, Wardour-street.

Organists.—E. Adams, St. Lawrence Jewry; Dr. Armes, Durham Cathedral; W. Bensted, All Hallows, Lombard-street; H. R. Brinfield, St. Lawrence, Reading; J. T. Burrowes, St. James, Piccadilly; H. Byolin, St. Mary, Shrewsbury; T. L. Childerstone, St. John, Clerkenwell; E. Deane, St. Mary, Aldermary; *H. Degenhardt, St. Catherine, Hamburg; Dr. G. Dixon, Grantham; Sir G. Elvey, St. George's Chapel, Windsor; J. G. B. Elliott, St. Stephen, Haggerstone; C. J. Frost, St. Mary, Haggerstone; Mrs. Green, St. Katharine, Regent's-park; F. Grizelle, Fulham; W. G. Hammond, St. Botolph, Aldgate; *E. J. Hopkins, Temple Church; A. W. Hume, Barking, Essex; J. Howlett, Trinity, Gosport; W. J. James, Shadwell; H. Jimmerthal, St. Marie Cathedral, Lübeck; W. C. Lock, St. Dunstan, Stepney; C. Marshall, St. Alban, Wood-street; Miss Nottingham, St. Mary, Rotherhithe; C. W. Pearce, St. Luke, Old-street; J. Ridgway, Holyrood Church, Southampton; *H. Schmahl, St. Jacobi, Hamburg; *Dr. Sellé, Hampton-court Palace; C. Severn, St. Mary, Islington; Dr. Stainer, St. Paul's; Mrs. Stirling, St. Andrew Undershaft; H. Stonex, Parish Church, Yarmouth; H. Streatfield, Maidstone; E. H. Thorne, St. Michael, Cornhill; Th. Sunbridge, St. George's Chapel, Great Yarmouth; J. Turle, Westminster-abbey; F. Weber, German Chapel Royal, St. James's; B. Yñiguez, Cathedral, Seville.——N. W. B. Collyer, Mercers'-hall Chapel; W. J. Ions, St. Nicholas, Newcastle-upon-Tyne; C. S. Jekyll, Chapel Royal, St. James's; R. Massey, late of Chapel Royal, Whitehall; F. I. Yeatman, All Hallows the Great and Less, Upper Thames-street.

Choir Conductors and 542 *Members of their Choirs.*—Henry Leslie, W. G. McNaught, J. Proudman, Ebenezer Prout, G. I. Venables, L. C. Venables.

wards and forwards, made in each second by a particle of air, while the note is heard." The words in inverted commas are briefly represented by the letter V. Thus, by V 256 is meant a musical sound due to 256 vibrations in a second. On the Continent, they usually reckon by *single* or half vibrations, as in counting a pendulum, written SV. Thus SV 512 means the same pitch as V 256. By V 256·3 is meant 2,563 double vibrations in 10 seconds, and so on for other decimals.

Art. 3. *Musical Pitch* is the pitch, or V of any named musical note, which determines the pitch of all the other notes in a particular system of tuning, and gives the pitch of the instrument producing it. For the sake of comparison, the same note A is here always selected, and, when it was necessary to determine the pitch by measuring the V of some other note, the V of A has been always calculated. By A 444 is meant the note called A, which makes V 444.

Art. 4. *Systems of Tuning, or Temperaments.*—For perfect harmony, the Fifths and major Thirds, in the treble at least, should produce no perceptible beats or roughness. This effect could not be obtained without many more than 12 notes to the Octave, the largest number used on ordinary organs, harmoniums, and pianos. Hence arose various contrivances, known as tunings, or temperaments (from the Italian *temperare*, to tune). In the history of pitch it is necessary to distinguish the following:—

1) *Just Intonation*, where all the Fifths and Thirds are perfect, used only by singers and theorists.

2) *Pythagorean Temperament*, in which the Fifths of the series, E *flat*, B *fl.*, F, C, G, D, A, E, B, F *sharp*, C *sh.*, G *sh.* only, are perfect, and the major Thirds E *fl.* G, B *fl.* D, FA, CE, GB, DF *sh.*, AC *sh.*, EG *sh.* only, are a comma, or V 1 in V 80 too sharp.

3) *Meantone Temperament*, in which all the major Thirds specified in (2) are perfect, but the Fifths specified in (2) are a quarter of a comma, or V 1 in V 322 too flat.

4) *Equal Temperament*, in which every Fifth, without exception, is one-eleventh of a comma, or V 1 in V 885 too flat, and every major Third, without exception, is seven-elevenths of a comma, or V 1 in V 126, too sharp.

These temperament will be distinguished by prefixing J for just, P for Pythagorean, M for meantone, and E for equal, to the name of the note calculated. The tuning note, which is measured, might be in any system, and hence is not distinguished. Thus, A 444 being measured, gives JC 532·8, PC 526·2, MC 531·2, and EC 528. In Table I., at the end of this paper, the JC, MC, and EC are calculated, corresponding to any A or other note that was measured, and the JA, MA, and EA corresponding to any C or other note that was measured.[2]

Just intonation is due to Ptolemy, the astronomer, A.D. 136. Meantone temperament was perfected by Salinas, A.D. 1577. Equal temperament is said to have been proposed by Aristoxenus, a pupil of Aristotle, and to have been in use in China for centuries earlier. It seems to have been used, in intention, in North Germany, as early as 1690, and to have remained on many organs. (See A 489·2 in Table I.) It was recommended by E. Bach, and is believed to have been used by J. S. Bach. But, throughout Europe generally, meantone temperament was used till about 50 years ago. It is still retained generally on Spanish organs, and in England on Green's organs, at St. George's Chapel, Windsor; St. Katharine's, Regent's-park; and Kew

[2] *Calculation of Temperaments.*—It is absolutely necessary, for all investigations on historical musical pitches, to be able to calculate A from C, and C from A, and sometimes from other notes, and often to find the V to all the notes in any system of temperament when the V of one is known.

To find C from A.

1) In Just Intonation, increase the V of A by one-fifth. Thus, to A 440, add one-fifth, or 88, to find JC 528.

2) In Meantone Temperament, first find JA, and then subtract 3 in 1,000 and 1 in 10,000, working to two places of decimals, and finally retaining one. Thus, from A 440, find JC 528, and then subtract 1·58 or 3 in 1,000, and also ·05 or 1 in 10,000; that is, 1·63 on the whole, giving 526·37, whence MC 526·4.

3) In Equal Temperament, first find JA, and then subtract 1 in 111. Thus, for A 440, we find JC 528, which, divided by 111, gives 4·76, and substracting this we obtain 523·24, whence EC 523·2.

To find A from C.

1) In Just Intonation, subtract one-sixth. Thus, one-sixth of JC 528 is 88, which, subtracted, gives JA 440.

2) In Meantone Temperament, find JA, and increase the result by 3 in 1,000 and 1 in 10,000. Thus, one-sixth of MC 526·4 is 87·73, which, subtracted, leaves 438·67, and this increased by 1·31, or 3 in 1,000, and ·04 or 1 in 10,000 gives 440·02, whence MA 440.

3) In Equal Temperament, find JA, and increase the result by 1 in 110. Thus, from C 523·24 we find JA 436·03, and, adding the 110th part, or 3·97, the result is EA 440.

A justly Intoned scale can be formed by adding one-eighth for the major Tones C to D, F to G, and A to B; one-ninth for the minor Tones D to E, and G to A; and one-fifteenth for the diatonic semitones E to F, and B to C.

A Pythagorean scale can be made from a series of Fifths up, adding one-half for each Fifth, and dividing by 2 when necessary to keep within the Octave; or a series of Fifths down, subtracting one-third for each Fifth, and doubling the result where necessary to keep within the Octave. Work up to G *sharp* and down to E *flat*, beginning anywhere.

A Meantone scale can be formed by taking the perfect Fifths, as in the last case, and then diminishing each upward and increasing each downward Fifth, as it is calculated, by 31 in 10,000. Thus, the perfect Fifth above C 256 is found by adding one-half, or 128, to be JG 384; taking 3 in 1,000, and 1 in 10,000, we have 1·19, which being subtracted, gives MG 382·81; and the perfect Fourth below C 256 is found, by subtracting one-third, or 85·33, to be JF 170·67, double which is 341·34; and then, taking 3 in 1,000 and 1 in 10,000, we have 1·06, adding which we have MF = 342·40. Begin anywhere, and work up to G *sharp* and down to E *flat*. Make two places of decimals and keep one.

A scale in Equal Temperament can be made by first forming a series of equal Tones by continually adding 12½ per cent., the proof being that the Sixth Tone thus found is scarcely more than double the first; then, the semitones may be found by adding 6 per cent., and subtracting 1 in 2,000 to each of the Tones. The result ought not to be wrong by one-tenth of a vibration anywhere.

The above are chiefly close approximations, very convenient for those who can use decimal fractions but do not understand logarithms. For those who do, the following table will be much more convenient.

To the logarithms given below, add the logarithm of the V of C, and the result is the logarithms of all the corresponding notes. When the V of any other note is given (as of E), subtract the logarithm opposite that note (as E) in the table from the logarithm of the V of the given note (as E.) The result is the logarithm of the corresponding V of C, having found which proceed as before. Find numbers corresponding to the logarithms to one place of decimals only.

Table of the Logarithms of Tempered Notes.

Note.	Just.	Meantone.	Equal	Pythagorean.
C	·0	·0	·0	.0
C *sharp.*		·01908	·02500	·02852
D	·05115	·04846	·05017	·05115
E *flat.*		·07783	·07526	·07379
E	·09691	·09691	·10034	·10231
F	·12494	·12629	·12543	·12494
F *sharp.*		·14537	·15051	·15376
G	·17609	·17474	·17560	·17609
G *sharp.*		·19382	·20069	·20461
A	·22185	·22320	·22577	·22724
B *flat.*		·25258	·25086	·24988
B	·27300	·27165	·27594	·27840
C *octave.*	·30103	·30103	·30103	·30103

Parish Church, and on a few other organs; but equal temperament is now generally aimed at, though seldom really attained.[3] Messrs. Broadwood did not use it on any of their pianos till 1840, and it was generally introduced in their works, under the superintendence of Mr. Hipkins, from 1844 to 1846. The organ of St. Nicholas, Newcastle-upon-Tyne, was tuned in equal temperament in 1842, on the occasion of a great musical festival (see A 428·7 in Table I.). In the Great Exhibition of 1851, no English organ was tuned in equal temperament. In July, 1852, while making alterations in the Exeter-hall organ, Messrs. J. W. Walker and Sons put it into equal temperament, and it was first used in that tuning in November, 1869. In the meantime, in September, 1852, Mr. George Herbert, a barrister and amateur, then in charge of the organ at the Roman Catholic Church in Farm-street, Berkeley-square, had that organ tuned equally by Hill, its builder. Though much opposed, it was visited and approved by many, and, among others, by Mr. Cooper, who had the organ in the hall of Christ's Hospital tuned equally in 1853. The first organ built and tuned originally in equal temperament, by Messrs. Gray and Davison, was for Dr. Fraser's Congregational Chapel at Blackburn, in 1854 (since burned). Messrs. Walker and Mr. Willis also sent out their first equally tempered organs in 1854. Hence, in England, equal temperament is barely 40 years old.

Before, and, indeed, after 1577, many unequal temperaments were used, and the meantone temperament itself is commonly called *unequal*, whereas, when expressed on 12 notes, it is merely defective, because it requires 27 notes to the Octave for its full development, as is shown in ordinary musical notation. The law followed in these unequal temperaments is generally so unknown that the exact values of the notes cannot be calculated. There was, however—at least, on the old bonded or fretted clavichord—a semi-meantone temperament, in which the natural notes C, D, E, F, G, A, B were tuned in meantone temperament, and the chromatics were interpolated at intervals of half a meantone. This was very like equal temperament in most keys. But, in the calculations of this paper, none but the Just, Meantone, and Equal systems of tuning will be regarded, and all the unequal temperaments, which were slight variations of the meantone system, will be treated as belonging to that species of tuning.

Art. 5. *Equal Semitones as a Measure of Relative Pitch.*—If we supposed that, between each pair of adjacent notes, forming an equal semitone as a piano is now intended to be toned, 99 other notes were interposed, making exactly an equal interval with each other, we should divide the octave into 1,200 equal hundredths of an equal semitone, or *cents* as they may be briefly called. We generally estimate intervals in music by the number of semitones they contain; thus, the minor Third has 3, the major Third 4, the Fourth 5, the Fifth 7 semitones, and so on. In the same way, very small intervals, less than a semitone, may be estimated in cents. Thus, S 3·56 means an interval of 3 semitones and 56 cents. In this way, in Table I. the interval formed by the initial value of A in each entry with A 370 is given.[4] The interval between any two such values of A is the difference of the corresponding S. Thus, the interval between A 455·3, S 3·59, and A 422·5, S 2·30, is S 1·29, which is the interval between Handel's and Erard's concert pitch.

Art. 6. *Notation of the Great Musical Scale.*—As the name of the note is the same in the different octaves, it is necessary to mark the Octave. I shall here adopt the organ-makers' names, by which an Octave is referred to a certain number of feet, and give it a practical notation. These names neither indicate the exact length of pipe nor the exact pitch of the note, but merely show its position on the musical staff.

32 C, lowest note of very large organs, 32 D, 32 E, 32 F, 32 G, 32 A (usual lowest note of the largest pianos), 32 B, comprising the 32-foot Octave, beginning 2 octaves below the lowest note of the violoncello.

16 C (lowest note of the double bass in Beethoven's Pastoral Symphony), 16 D, 16 E (lowest note of the German four-stringed double bass mentioned by Helmholtz, my translation, p. 267, as the lowest really musical note), 16 F (lowest note of English four-stringed double bass), 16 G (lowest note of Italian three-stringed double bass),

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[3] *How to Tune Equally.*—In my translation of Helmholtz, p. 785, I gave a rule for tuning sensibly in equal temperament, and I put it into a thoroughly practical form in the *Musical Times* for 1st October, 1879, pp. 520—521. It may be epitomised thus. Tune the bearings in the one-foot Octave of an organ or harmonium in the order C, G, D, A, E, B, F*sh*, C*sh*., D*sh*., A*sh*., E*sh*. Make all the Fifths too close, and all the Fourths too wide, so as to beat the Fifths "up," CG, DA, EB, C*sh*. G*sh*., D*sh*. A*sh*., *twice* in a second, and the Fourths "down," GD, AE, BF*sh*., F*sh*. C*sh*., G*sh*. D*sh*., A*sh*. E*sh*., three times in a second. The Fourth CF is not tuned. The pitch is unimportant. The beats hardly last long enough to be available for the piano, which should be tuned to an harmonium.

[4] *To Calculate the Cents in any Interval.*—1) For intervals less than an equal semitone—that is, when the larger V is not more than 6 per cent. larger than the smaller V: Divide 100 times the difference of the V by 6 per cent. (less 1 per 2,000) of the smaller V to the nearest whole number. Thus, to find the interval between A 422·5 and A 440: 100 times the difference is 1,750, and 6 per cent. of 422·5 is 25·3, and this, less ·2 (or 1 per 2,000 in 422·5), is 25·1; then, dividing 1,750 by 25·1, we obtain 70 cents.

2) If the interval is more than an equal semitone, we can continually form equal Tones and semitones, above the lowest, by adding 12½ per cent. for a Tone, and 6 per cent. (less 1 per 2,000) for a semitone, till we obtain a V which is less than an equal semitone from the larger number. Then, we find the cents in this smaller interval by the last rule, and add 100 for each equal semitone added on to the lower V. Thus, for A 422·5 and A 455·3, we form an equal semitone above 422·5 by adding 25·1 (or 6 per cent., giving 25·3; less 1 per 2,000, that is, ·2, giving 447·6). Next, we find the cents in the interval V 447·6 to V 455·3 to be 29, as in the last case, and we have 129 cents. for the whole interval.

3) For intervals less than a just major Third—that is, when 8 times the larger V is not greater than 10 times the smaller V—multiply 3,477 by the difference of the V's, and divide by their sum. If the result lies between 150 and 300, subtract 1 from the quotient; the result is exact. Thus, for the last example, 3,477, multiplied by the difference 32·8, gives 114,045·6; and this, divided by the sum 877·8, gives 129 cents., as before. It is evident that this may be applied to any interval by continually reducing it by a just major Third till it is less than a major Third. This is effected by continually subtracting 10 times the smaller from 8 times the larger V, and adding 386⅓ cents. to the result, for every such reduction. When the interval exceeds an Octave, divide the larger V continually by 2 till it is less than double the smaller; then proceed as before, and add 1,200 to the result for each division by 2.

4) For any interval, by logarithms (by far the most convenient method for those who can use them), multiply the difference of the logarithms of the two V's by 4,000 (which will be enough for intervals under a semitone); correct by subtracting 1 in 300 and 1 in 1,000 from the former product. The result will be correct to one-tenth of a cent. Thus, log. 455·3 = 2·65830, log. 422·5 = 2·62583; difference = ·03247, which, multiplied by 4,000, gives 129·88. Subtract 1 in 300, or ·43, and 1 in 10,000, or ·01 (sum ·44), and the result is 129·44 cents, or 129 to the nearest cent. When many cases have to be calculated, it is best to form a little table of the multiples of 39·86314, and, by its means, multiply the difference of the logarithms by that number. This was the method pursued for Table I.

16 A (lowest note of English three-stringed double bass), 16 B, comprising the 16-foot Octave.

8 C (lowest note of the violoncello, written on the second leger line below the bass staff), 8 D, 8 E, 8 F, 8 G (third open string of violoncello), 8 A, 8 B, comprising the 8-foot Octave.

4 C (tenor C, the lowest note of the viola, written on the second space of the bass staff), 4 D (second open string of violoncello), 4 E, 4 F, 4 G (lowest note of the violin and of the English concertina), 4 A (first, or highest, open string of violoncello), 4 B, comprising the 4-foot octave.

2 C (middle C, written on the leger line between the bass and treble staves), 2 D (third open string of the violin), 2 E, 2 F, 2 G, 2 A (second open string of the violin, the *tuning note* for orchestras, and the note to which all pitch is referred in Table I.), 2 B, comprising the 2-foot Octave.

1 C (Treble C, a very usual tuning note for pianos, and pitching note for singers), 1 D, 1 E (first, or highest, open string of the violin), 1 F, 1 G, 1 A, 1 B, comprising the 1-foot Octave.

½ C, ½ D, ½ E, ½ F, ½ G (usual highest note of flute), ½ A, ½ B (highest note of the English concertina), comprising the ½-foot or 6-inch Octave.

¼ C, ¼ D, ¼ E (highest note on the violin, the double Octave harmonic of its highest string), ¼ F, ¼ G, ¼ A (usual highest note of large pianos), ¼ B, comprising the ¼-foot or 3-inch Octave. And so on for higher Octaves, used only on certain stops of organs.

Art. 7. *Carriers of Pitch.*—As very few persons are able to reproduce a pitch at will after the lapse of a short time, it is necessary to have instruments by which a given pitch-note may be sounded at any moment. The oldest of these contrivances are the metal cylindrical open flue *organ-pipe*, and the stopped *pitch-pipe*. In later times, the *tuning-fork* and the *free reed* have been used. In orchestras, the *oboe*, a reed pipe, is generally sounded for the other instruments to tune to.

Art. 8. *The Organ Pipe.*—The pitch rises with heat, and falls with cold, often making a semitone between its winter and summer pitches. When the V at any given temperature is known, the V at any other temperature may be found with sufficient exactness by increasing the first V by 4 per cent., dividing by 1,000 to 2 places of decimals, multiplying the result by the number of degrees Fahrenheit by which the observed differs from the required temperature, and adding or subtracting according as we reduce to a higher or a lower temperature. In this way all the organ pitches in table I., which I have myself observed, have been reduced to the pitch they would have at 59° F.= 15° C.= 12° R. Thus, A 528, at 59° F., gives what at 73° F.? To 528 add 4 per cent., or 21·12, which gives 549·12, and this, divided by 1,000 to 2 places of decimals, gives ·55, which, multiplied by 14 (the difference of 73° and 59°), gives 7·70, and, as the required temperature is greater, we have to add this 7·70 to 528, producing A 535·7 at 73° F. (See A 441·7 and A 443·1 in Table I.) As the wind used is often of a lower temperature to the air about the organ, and as the expansion of the air effects the temperature, the rule is not always perfectly accurate, but I have found it sufficiently so for the purposes of this paper. After touching an organ-pipe, or blowing it with the mouth, it should be left to cool before its pitch is taken. For the same temperature, the pitch is mainly influenced by the length of the pipe, measured from the line where it is soldered on to the foot, up to the open end, and by the internal diameter. If these dimensions are taken in inches, the pitch or V of the pipe is very nearly 20,080, divided by the sum of 3 times the length added to 5 times the diameter, according to M. Cavaillé-Coll (adapted from *Comptes Rendus*, 1860, p. 176), and in the two-foot Octave I have seldom found the result so much in error as a comma, or V 1 in V 80. If we actually find the V of a similar pipe, and multiply it by the sum of three times the length added to five times the diameter (expressed in inches), and use this product in place of 20,080, we may find the pitch of another pipe of the same kind, differing slightly in length and diameter, by dividing this product by the sum of three times the new length added to five times the new diameter, both taken in inches. I have had to use this device frequently when the actual dimensions of pipes made for me differed from their intended dimensions, in order, from the pitch of the actual pipe, to deduce that of the intended pipe. (See Table I., A 373·7, 376·6, 396·4, 424·4, 434·7, 446·0, 445·8, 504·2, 505·8[4])

The strength of the wind used is important. The above rule supposes this pressure to be capable of supporting a column of water about 3¼ inches high. From experiments made by M. Cavaillé-Coll, as pressure varies from 2¾ to 3¼ inches, V increases by about 1 in 300, but, as pressure varies from 3¼ to 4 inches, V increases only by about 1 in 440; the whole increase of pressure from 2¾ to 4 inches increases V by about 1 in 180. Hence the pitch of A may vary by from V 1 to V 2½ from this cause only. (See actual observations in Table I., under the pitches last cited.)

The quantity of wind, regulated by the size of the wind-slit and the orifice at the foot, is another source of variation. The shape of the mouth, and especially the shading of the mouth or extremity, greatly influences pitch. Hence a solitary pipe removed from the organ where it was shaded by adjacent pipes, is often sharper. Cleaning an organ sharpens it. Even removing a pipe and replacing it will often alter the pitch. An organ-pipe is slightly flattened by pressing in, and slightly sharpened by pressing out, the edges of its open end, as by the "tuning cone;" but considerable changes require the pipe to be lengthened or shortened.

It is clear, therefore, that, when the V of a pipe is not measured as it stands in the organ itself, the pitch given may be several vibrations in error.

[4] *M. Cavaillé-Coll's Rule.*—This rule requires to be a little changed for stopped and square pipes. For the square modern pipes the agreement is not quite so good as for the open metal cylindrical pipes, and a device similar to that in the text must always be employed for them. (See Table I. A 424·2.) In square pipes, the depth is from the mouth to the back, internal measure.

Complete Rule.—Pressure of wind about 3¼ inches or 8 centimetres. Divide 20,080 when the dimensions are in inches, and 510,000 when the dimensions are in millimetres, by—

(1) Three times the length added to five times the diameter for *cylindrical open* pipes.

(2) Six times the length added to ten times the diameter for *cylindrical stopped* pipes;

(3) Three times the length added to six times the *depth* for *square open* pipes; and

(4) Six times the length added to twelve times the *depth* for *square stopped* pipes.

The rule is always sufficient for cutting organ pipes to their approximate length, and piercing them to bring out the Octave harmonic.

And even where we are fortunate enough to find an organ with pipes that have remained unaltered for 200 or 300 years, which is seldom the case, we cannot be sure that it stands exactly at its original pitch. This must, of course, be borne in mind for all the cases of organ-pitch given in Table I. But the extreme amount of error will seldom be 1 per cent., which, for present purposes, is insignificant. In point of fact, the exact pitch of an organ cannot be ascertained, for it is so large that various parts of it are constantly at variable temperatures, and hence are constantly liable to be at different pitches, or out of tune with each other. Hence, in measuring the pitch of an organ, I always select the 2 A or 1 C of the open metal diapason, and, if possible, on the great organ, and consider that to be the pitch for which the organ was constructed.

Art. 9. *The Pitch-pipe* (of which I am able, through the kindness of the Bellfoundry Colbacchini, at Padua, to show you two very curious Italian examples of 150 and 100 years old, described under A 425·2 in Table I. below) is subject to all the errors of an organ-pipe, and being blown by the warm breath at very different pressures cannot be depended on for accuracy. But its portability, and the easy production of one or two Octaves of tone by sliding the piston in and out, formerly rendered it indispensable to singers who had no instrument to guide them. The same is true of pitch derived from flutes, clarinets, and oboes. (See remarks in Table I., under A 395·2, 410·0, 413·3, (2) A 418·0, 422·0, 425·2, 424·5.)

Art. 10. *The Tuning-fork*, originally called the *Pitch-fork*, was invented by John Shore, Royal Trumpeter, in 1711, Sergeant-Trumpeter at the entry of George I. in 1714, and Lutist to the Chapel Royal in 1715. He died deranged in 1753. Hence the tuning-fork is probably not more than 150 years old. It was very rude at first, as in this example, which was dug up at Brixton in 1878 (see A 454·2, in Table I.), but has, in late years, become a beautiful philosophical instrument, as in the larger forks before you. It is very permanent. I have reason to believe that Scheibler's forks have not varied by one vibration in ten seconds, since his death in 1837. It varies very slightly for temperature, being (contrariwise to the organ-pipe) flattened by heat and sharpened by cold to the amount of about V 1 in V 21,000 for each degree Fahrenheit. When, therefore, careful experiments have to be made, a tuning-fork should never be touched by the hand at all (wood or paper being interposed), or carried in the pocket, or struck hard or often (every blow heats, and, therefore, flattens it very slightly); but, for ordinary purposes, this is immaterial. As forks are tuned by filing, which not only heats them, but unsettles their molecular arrangements—at least, in part—it is necessary to let them cool and rest for several days, sometimes for weeks, before their pitch can be depended on for scientific accuracy. They will often rise by several vibrations in ten seconds in the course of cooling. Hence copies are always apt to be too sharp, and should, if possible, be re-compared. This has often caused me much difficulty, and, in several cases, a doubt will necessarily remain on such copies which have been sent to me. The difficulty of tuning a fork in exact unison with another is also extremely great. Hence, in Table I., such pitches may be too sharp by half a vibration in a second, or even more. We seldom find a batch of tuning-forks at the same pitch. (See A 435·4 in Table I.) On the whole, however, no more accurate means of preserving pitch exist. Two great sources of permanent injury to a fork are wrenching or twisting the prongs (as by a fall, or screwing the forks in and out of resonance-boxes, when the prongs ought never to be touched; or fixing both prongs in a vice to file) and rust. To preserve from rust, never stroke the prongs with the fingers (as musicians have a habit of doing), do not speak over the forks, keep them carefully from the damp (the large forks on resonance-boxes in chamois leather stalls, the smaller ones in cases, or folded in paper) and oil them occasionally with a film of limpid gun-lock oil (to be obtained from any gunsmith). If rust forms, prevent it spreading by applying oil, but be careful not to use sand-paper, as that will certainly injure the pitch still more. As most old forks are more or less rusty, it is important to have some notion of the amount of injury inflicted. Actual cases are investigated in Table I., under A 441·1, 441·8, and 443·2. But I found it advisable to try the following experiments:—Three ordinary forks, having been carefully measured, were immersed in water, one halfway from the end of the prongs, another halfway from the stem end, and a third totally. First experiment: they were left 48 hours in water, and then taken out without wiping and allowed to dry during 24 hours, they were then wiped and tried. Second experiment: afterwards, they were repeatedly immersed for a day or two, and taken out, being left to dry by themselves; this produced a large quantity of rust, which was rubbed off with soft paper, and then the forks were well oiled. The following were the results:—

Forks.	Original Pitches.	Pitches after immersion.	Alteration in V.	Alteration per cent. of V.
First Experiment—				
Prongs immersed	518·77	518·79	·0	·0
Bend immersed	528·20	527·90	— ·3	—·0568
Totally immersed	258·77	258·63	— ·14	—·0541
Second Experiment—				
Prongs immersed	518·77	518·44	— ·33	—·06
Bend immersed	528·20	526·30	—1·90	—·36
Totally immersed	258·77	257·72	—1·05	—·41

These experiments show that a slight amount of rust is imperceptible, and that with a very large amount, such as could not occur without the greatest carelessness, as in the old fork, described under A 454·2 in Table I., the error is never likely to exceed 4 in 1,000. For measuring pitch this would be fatal, but for merely conveying the history of a pitch it is perfectly unimportant. Observe that rust towards the extremity of the prongs is of slight importance, and, in case of complete rusting, almost the whole effect is due to rust at the bend. In all cases, the effect is to flatten the fork.

Art. 11. *The Reed.*—Harmonium reeds, placed in little tubes and blown by the mouth, may be classed with the pitch-pipes, convenient, but untrustworthy. The reed itself is apt to vary, and the pitch also depends greatly on the force of the wind. (See A 442·5 and A 488·0 in Table I.)

Art. 12. *Measurers of Pitch.*—The following are the principal methods for determining the V of any note heard:—1. By a string. 2. By the siren. 3. By Professor McLeod's optical method. 4. By Professor Mayer's electrographic method. 5. By beats.

Art. 13. *The String.*—A string, stretched by a constant weight, may be stopped at different places, and each sounding length will determine a different note, as on the violin. If the string were perfectly elastic and uniform, the V of these notes would be inversely proportional to the length of the string.

Assuming this to be always the case, Mersenne (1648) took a string long enough to allow its vibrations to be seen and counted, and then shortened it till it was in unison with a given note, and, after multiplying the observed V by the first length, divided it by the second (each expressed in the same unit), to find the V of the given note. He was, of course, very wrong, making an organ-pipe four French feet in length, speak, at one time, V 84, and at another, V 96, whereas, it probably spoke V 112. (See A 373·7, and A 376·6 in Table I.).

J. H. Griesbach (1860) greatly improved on this method, by tuning a string, one-fifth of an inch (more accurately 5½ mm.) thick, till one-quarter of its length was in unison with a given note, and then counting the vibrations of the full length of the string (which was kept in action by a continuous bow) by making the string, as it reached its upper position, mark a strip of paper passed over it, on which seconds were also marked as they elapsed. The instrument itself is in Room Q of the Scientific Collection at the South Kensington Museum, with a description from the *Journal of the Society of Arts* for 6th April, 1860, p. 353. The extreme care with which Mr. Griesbach, worked, and, at the same time, the untrustworthiness of the arrangement, which is crowded with sources of error, is shown by some of his his results; thus, his V 416, V 521·6, and V 528, are shown, by remeasurement of the forks to be V 422·5, V 524·8, and V 534·46.

Euler and Bernouilli worked out the problem of the string mathematically,[6] but the difficulties of determining the unison, measuring the lengths, finding the weight, and obtaining uniformity in the string, together with those arising from its thickness, are so great, that the method cannot be relied upon for any great accuracy. We are, however, indebted to it for some important measurements by Euler, Dr. Robert Smith, Marpurg, Fischer, and De Prony. (See Table I., under A 392·2, 414·4, (2) 424·2, 427·6, (1) 431·7, 437·3, 438·2, (1) 441·7, (1) 444·5.)

[6] *Formula for finding pitch* from a heavy weighted suspended string. Let

L = the vibrating length of the string from the suspending point to the movable bridge, expressed very accurately in English inches.

l = the same in French millimètres.

W = the stretching weight of the string, including the weight of non-vibrating part of the string, expressed in any unit.

w = the weight of the vibrating length of the string in the same unit. These weights of the string are best obtained by stretching a similar string by the same weight and leaving it for some days till the stretching is complete, then cutting off a known length of it, weighing it, and dividing the whole weight of the string by the whole length to determine the weight of an inch or a millimètre of it. The weights are then found by measurement.

V = the number of double vibrations in a second. Then

$$2 \log V = 1{\cdot}98485 + \log W - (\log w + \log L)$$
$$= 3{\cdot}38968 + \log W - (\log w + \log l)$$

Delezenne, of Lille, made the best use of the stretched string. Having proved that only the finest wire which would bear the strain would give satisfactory results, he stretched 700 millimètres of such a wire on a violoncello body, tuned it to Marloye's fork of V 128 (which was, probably, very accurate, as Marloye's V 256 was so), and then, by a movable bridge, cut off the length, which gave a unison with a given fork. Measuring this length in millimètres, he divided 128 × 700 = 89,600 by it, to find the V. For organ-pipes, he first tuned a fork with sliders in unison with the pipe, and then measured the fork so tuned by his sonometer. (See Table I., under A 450·5.) I am indebted to Delezenne for numerous important pitches, which he believed to be correct within three-tenths of a comma, or about V 37 in V 10,000, and they are, very probably, still more accurate. He estimates that those who use Euler's formula may be wrong by a comma, or V 1 in V 80, or V 125 in V 10,000, owing to the mere thickness of the string necessary to support the stretching weight.

Art. 14. *The Siren* of Baron Cagnard de la Tour consists of a perforated disc, which is driven round by a stream of air, and, allowing puffs to pass through the oblique holes, makes a musical sound, of which the V is the number of such puffs in a second counted by an appended mechanism. M. Cavaillé-Coll added a bellows, giving a constant pressure of wind, and, by its assistance, he tells me that Lissajous determined the pitch of the French Diapason Normal. M. Cavaillé-Coll also improved the counting apparatus, by which he has been able to obtain even more accurate results. The ordinary siren of commerce is very untrustworthy; for example, Mr. Hullah's forks, thus measured, and intended to make V 512, really made V 524·8 to V 525 (See Table I., under A 441·3.) Even at the best, it is a difficult instrument to manipulate. Probably all the determinations of pitch made for the French Commission in 1859 were made by Lissajous and Despretz with this instrument, as well as those cited by de la Fage as made by Lissajous. These and other pitches determined by the ingenious inventor himself are all cited in Table I.

Art. 15. *The Optical Method*, invented by Prof. Herbert McLeod and Lieut. R. G. Clarke, R.E., and described in the "Proceedings of the Royal Society," for January, 1879 (vol. 28, p. 291), consists in viewing white lines, on a rotating cylinder, through the shadow of a constantly vibrating fork. The result is apparently, a dark wave, which remains stationary when the V of the fork is the same as the number of white lines which pass before the eye in a second. For effecting this, and counting the lines that pass, there are elaborate contrivances. The machine is very difficult to manipulate, but, probably, extremely accurate in result. It will be seen that I am greatly indebted to it for several measures of vital importance to my investigations.

Art 16. *The Electrographic Method* was invented by Professor A. Mayer, of Stevens Institute, Hoboken, New Jersey, U.S., who is preparing for publishing it in all its details. In this method, a camphor-smoked paper on a metallic rotating cylinder is inscribed with a wave-curve by an aluminium point fastened to one prong of a large

fork, through which a powerful induction coil, actuated by a seconds' pendulum, throws a spark, which burns a single hole in the paper precisely every two seconds. By counting the sinuosities in the wave-curve between these holes the V is determined. The difference of pressure of the aluminium point makes no difference in the rate of vibration. The flattening caused by the point is ascertained by beats. This instrument is, of course, expensive, and difficult to adjust, and is applicable only to large tuning-forks, the V of which it determines with great exactness. As will be seen, I have been greatly indebted to Professor Mayer for several measures of pitch taken by this instrument, but they could not be completed till 1st March, and hence must be communicated hereafter.

Art 17. *Musical Beats.*—When two musical notes of very nearly the same pitch are sounded together they produce beats, or loudnesses separated by silences, which, under ordinary circumstances, occur exactly as many times in a second as the V of one note exceeds the V of the other. The number of beats in a second can be counted easily when it lies between 2 and 5. Beyond 5 beats in a second there is considerable difficulty, arising from the rapidity of the loudnesses, and, after 6 beats in a second, the result cannot be depended on. Below 2 beats in a second there is also a difficulty, arising from the length of time occupied by each loudness. After 1 beat in a second the result can seldom be depended on. If, then, we know the exact interval between two notes, we can, by interposing forks and counting the beats, determine the exact V of each note. In particular, if the notes form an Octave, the beats in a second between them is the V of the lower note.[1]

Sauveur, 1713, used beats of organ-pipes (see A 406·6 in Table I.), and his experiments were successfully repeated by M. Cavaillé-Coll (Association Scientifique de France, Bulletin Heb., No. 81, 16 Aug., 1868, p. 126), but they were difficult and uncertain; and the organ-pipe varies too much with temperature to make it useful for measuring the pitches of other notes. Sarty (see A 436 in Table I.) complicated the matter more by using a monochord in addition, and his result is very uncertain. About 1865, Mr. Henry Willis, the well-known organ builder, also made a number of very careful experiments with organ-pipes, tuned by a slide on a slot, and actuated by bellows of constant pressure, of his own construction, with a view of determining difference of pitch by beats.

Art. 18. *Tuning-fork Tonometer.*—If two tuning-forks, making an Octave with each other, very nearly, but not exactly, be held over a resonance jar, tuned to the higher by pouring in water, beats are heard, and may be counted for from 10 to 20 seconds, between the precise Octave of the lower fork, and its approximate Octave, while the low note itself is practically inaudible. If, then, a number of tuning-forks be interposed between the two, beating roughly four times in a second, two and two, and, after having rested sufficiently for their pitches to become permanent, are accurately counted, the V of the lower fork, and hence that of all the intermediate forks, can be determined. For verification, it is best to carry the series to at least a dozen forks beyond the Octave. The forks should be good, beating at least 45 seconds audibly with each other, and furnished with wooden handles, but not screwed on to a resonance box. The difficulty is in counting with sufficient accuracy, for if the lower fork be about V 256, there will be 64 sets of beats to an Octave, and an error of ·01 beat per second, would make the serious error of V 0·64 in determining the pitch of the lower note.

The invention of this tonometer is due to Johann Heinrich Scheibler (born 11th November, 1777, died 20th November 1837), a silk manufacturer, of Crefeld, in Germany. His account of his method and mode of measurement, and the details of his tonometer of 52 forks, from A 219⅔ to A 439⅓, at 69° F., is given in his pamphlet, "The Physical and Musical Tonometer" (*Der Physikalische und Musikalische Tonmesser*, Essen bei Bädeker, 1834, pp. 80, and plates). His method was much more laborious than that here suggested, but his counting seems to have been wonderfully perfect. These 52 forks have disappeared since Scheibler's death, and all efforts I have made to discover them, with the help of Herr Amels and Scheibler's existing descendants (to whom I am much indebted) have hitherto failed. But a tonometer of 56 forks, which belonged, at least, to Scheibler, if it was not made by him, still exists, only there are no records of its having been counted by Scheibler. It was inherited by Scheibler's daughter, Madame M. E. L. de Greiff (died 4th September, 1854), and then by her son, Herr Aurel de Greiff, who gave it on a long loan to Herr Jean Amels, then of Crefeld, and now of 78, Newgate-street, London, silk merchant and musician, none of Scheibler's family caring for music. Herr Amels has kindly allowed me to have the use of this tonometer since 10th May, 1879, to the present time, and I am able to show it you this evening.

It was believed that this tonometer proceeded by 4 beats in a second, from 4 A 220 to 2 A 440. A very careful count showed me that only 32 out of the 55 sets of beats were 4 in a second, and that the others varied from 38 to 42 beats in 10 seconds. The best sum of all the beats that I could obtain was 219·27 in a second, which should, therefore, be the V in the lowest fork at 69° Fahr., the mean temperature used by Scheibler. It struck me then, as possible, that the extreme forks were really of the same pitch as those of the 52-fork tonometer, namely V 219·6⅔ and 439·3⅓. On that supposition, I had made the trifling error of V 0·4 in counting, and I distributed this among 20 of the 23 sets of beats, which were not exactly 4 in a second. Then I reduced the whole to 59° Fahr., and obtained the following result:—

[1] *Determining Pitch by Beats.*—Let the V of two notes be M and N, where M is greater than N, and let the ratio M and N be known, so that $n\,M = m\,N$. Let the sum of the beats in a second made by the interposed forks with the extreme notes and each other be b. Then $M - N = b$. These two equations give $(m - n)\,N = nb$, and $(m - n)\,M = mb$. If M is the Octave of N, then $m = 2$ and $n = 1$, and hence $N = b$. Suppose that we do not know the ratio $M : N$ exactly, but know that it is nearly that of $m : n$, and also whether M is too sharp or too flat, and have observed that the sum of the beats in a second of the forks interposed between M and N is c; then 1) if M is too sharp, we have $n\,M - m\,N = c$, and $M - N = b$, whence $(m - n)\,N = nb - c$, $(m - n)\,M = mb - c$; and 2) if M is too flat we have $m\,N - n\,M = c$ and $M - N = b$, whence $(m - n)\,M = mb + c$, $(m - n)\,N = nb + c$. The easiest and most important case is when M is nearly the Octave of N, and hence $m = 2$, $n = 1$. Then in the first case $M = 2\,b - c$, $N = b - c$, and in the second case $M = 2\,b + c$, $N = b + c$.

Scheibler's 56 Fork Tonometer at 59° Fahr.

No. of Fork.	Formerly presumed pitch.	Ellis's count.	Octaves of Ellis's.	No. of Fork.	Formerly presumed pitch.	Ellis's count.	Octaves of Ellis's.
1	440	439·54	879·08	29	328	327·62	655·24
2	436	435·74	871·48	30	324	323·61	647·22
3	432	431·84	863·68	31	320	319·54	639·08
4	428	427·96	855·92	32	316	315·54	631·08
5	424	423·96	847·92	33	312	311·54	623·08
6	420	419·96	839·92	34	308	307·54	615·08
7	416	415·74	831·48	35	304	303·61	607·22
8	412	411·74	823·48	36	300	299·39	598·78
9	408	407·74	815·48	37	296	295·57	591·14
10	404	403·77	807·54	38	292	291·70	583·40
11	400	399·76	799·52	39	288	287·70	575·40
12	396	395·79	791·58	40	284	283·70	567·40
13	392	391·67	783·34	41	280	279·69	559·38
14	388	387·57	775·14	42	276	275·69	551·38
15	384	383·57	767·14	43	272	271·69	543·38
16	380	379·60	759·20	44	268	267·77	535·54
17	376	375·60	751·20	45	264	263·82	527·64
18	372	371·68	743·76	46	260	259·81	519·62
19	368	367·56	735·12	47	256	255·64	511·28
20	364	363·63	727·26	48	252	251·67	503·34
21	360	359·63	719·26	49	248	247·67	495·34
22	356	355·63	711·26	50	244	243·67	487·34
23	352	351·63	703·26	51	240	239·66	479·32
24	348	347·63	695·26	52	236	235·69	471·38
25	344	343·62	687·24	53	232	231·69	463·38
26	340	339·62	679·24	54	228	227·77	455·54
27	336	335·62	671·24	55	224	223·77	447·54
28	332	331·62	663·24	56	220	219·77	439·54

The difficulty was now to verify my count, which had been made with great care with the help of a ship chronometer, each set of beats having been counted repeatedly for 40 seconds. But, then, I could not feel sure of being right in my count within V 0·05 or V 0·025 at most, and this left the distributed error of V 0·02 imperceptible. From this difficulty I was relieved by the kindness, first, of Prof. Herbert McLeod, and subsequently, of Prof. Alfred Mayer. Both counted for me by their instruments already described, five large French forks which I had had made, and Prof. McLeod also lent me four of Koenig's forks, which he had carefully measured. On measuring these by Scheibler's forks, using the values given in the preceding Table, I obtained results practically identical with those of Prof. McLeod, as shown in the following Table, in which all the V are reduced to 59° Fahr. The final results by Prof. Mayer have not reached me in time enough to insert in this place, but will be subsequently communicated to the Society.

Name of Fork.	Ellis.	McLeod.
1812, Conservatoire A.....	439·54	439·55
1820, Tuileries A.....	434·25	434·33
1818, Feydeau A.....	423·09	423·02
1789, Versailles A.....	395·79	395·83
Nominally.		
Marloye Ut_3 256.....	255·96	255·98
Koenig Ut_3 256.....	256·30	256·31
,, Mi_3 320.....	320·30	320·37
,, Sol_3 384.....	384·43	384·44
,, Ut_4 512.....	512·55	512·55

The extreme closeness of these results gave me perfect confidence in using this 56-fork tonometer of Scheibler for all the measurements made for this paper. My rule has been to determine the beats several times (generally 5, often 10) with each of two forks, and to take the mean of all the results. It is, therefore, probable that measures of forks which I could count for 10 seconds, are not so much as V 0·1 in error.

Other tuning-fork tonometers have been made by Wölffel and Koenig, both of Paris, but I have had no opportunity of examining and comparing them. Koenig is reported to have lately invented a new and exceedingly accurate counting instrument, but I have seen no description of it as yet. The great difficulty in verifying is one of the disadvantages of the tuning-fork tonometer. I have found it impossible to verify by imperfect Fifths, as their beats last too short a time to be counted with any approach to sufficient accuracy.

By furnishing Messrs. Valantine and Carr, of 76, Milton-street, Sheffield, extensive tuning-fork makers to the music trade, with standards counted by means of this Scheibler's tonometer, as thus valued, I have enabled the public to obtain small forks, such as are usually employed for giving pitch, at moderate prices, and of great accuracy, that is, seldom or ever showing half a vibration in a second different from the number impressed on them. For those who wish to know the pitch of instruments or orchestras within the usual limits, I recommend pocket-boxes of 12 forks, either V 412 to V 456 for A or V 500 to V 544 for C. Such boxes, properly fitted, would cost, complete, about two guineas. Single forks above V 412 can be made for 3s., and below to V 256 for 4s. 6d. each. Larger forks are more expensive, 6-inch prongs costing 15s. It would be quite impossible to obtain such cheap forks elsewhere with anything like the same accuracy of pitch, and I consider it one of the principal results of my long and laborious countings that I am able to show investigators where they can obtain the tools they need. Messrs. Valantine and Carr also make complete Octaves of 65 forks at similar reasonable prices, and then the operator can count for himself; they have already made two such sets.

Art. 19. *Reed Tonometer.*—To remedy the deficient power of verification in the tuning-fork tonometer, and to accomplish many other desirable objects, Herr Georg Appum, of Hanau, invented his tonometers of 65, 33, and 57 reeds, of which copies may be seen in the South Kensington Museum, and of the two first at the Museum of King's College, London. Lord Rayleigh has also a copy of the first. I have carefully examined all of these copies. I was so pleased with the first, after long work upon it without discovering error, that I used it in my former paper for measuring pitch, notwithstanding that it differed considerably in its indications from other measurements. The cause of error could not be discovered by long work and counting with a single instrument. It was not till the Lords of the Committee of Council on Education permitted me to remove the 65 and 33-reed tonometers to King's College Museum, that I discovered the curious fact on which it depended. The decisive observations were of this kind. Suppose L, M, N are three consecutive reeds on one instrument, and P, Q, R three reeds of the same pitch on another. (In point of fact, the instruments, which had been

made independently, were not exactly in unison, and this was the first shock that my belief in their accuracy sustained.) Then I beat L with M, and M with N, and adding the observed beats, I obtained what I term the "internal beats" of L with N, that is, such as take place inside the box containing the reeds. Next, I beat L with Q, and Q with N, and adding them, I obtained the "external beats" of L with N, that is, the beats made outside the box containing the reeds, in the free surrounding air. Now, the internal were always more than the external beats. My first experiment showed that the internal exceeded the internal beats by about 1 per cent. Continuing the experiments for many weeks, till all the beats were thus counted, and varying the experiment occasionally by sounding L and B at different ends of the Museum, at least 50 feet apart, while I stood midway to count, I found, as a mean of all my observations, that the number of internal beats must be reduced by 7½ per 1,000 to produce the external beats, and that, consequently, the values obtained for the reeds, by counting internal beats, must be reduced in the same proportion. The internal beats were counted on the King's College copy. Last autumn I varied this experiment, by taking the pitch of each reed of all three tonometers in the South Kensington Museum, by beats with Scheibler's forks as counted above. The result was, that in order to reduce Appunn's numbers on the 65-reed tonometer (nominally V 256 to V 512) to Scheibler's, it was necessary, as a mean, to deduct 76 in 10,000, precisely confirming the former result (showing that the instrument went actually from V 254 to V 508). For the first Octave of the 57-reed tonometer (nominally V 64 to V 128), the same reductions was obtained (showing that instrument went really from V 63½ to V 127). For the 33-reed tonometer (nominally V 128 to V 256), the reduction was 83 in 10,000 (showing that the instrument went really from V 127 to V 253¾); but, then, almost every reed of this tonometer (which had been sent from Germany afterwards, and without comparison) was flatter than its corresponding Octave in the 65-reed tonometer, and the Octave was not quite perfect.

What the cause of this "drawing" of the beats may be, has not yet been investigated. Its direction and amount was, I believe, entirely unknown previously, and hence Herr Appunn can hardly be blamed for overlooking it. Nor does it in any way detract from the use of the instrument. When the beats have been exactly counted, and hence the values of the reeds determined, we have only to reduce these values by 76 in 10,000, with the help of a little table (like that of Scheibler's forks given above), and the instrument is as useful as ever to determine pitch and make experiments. Thus Koenig's forks, when I take the numbers from Appunn given in my former paper, and reduce them properly, are very near what we may suppose Koenig's to have really been, as calculated from his Ut_3 = V 256·28, and supposed to be absolutely correct harmonics. Of course there were slight errors in my former measurements, which were early attempts, and frought with difficulty, and, possibly, either slight errors in Koenig's own excellent workmanship, or slight subsequent changes due to rough usage.

No. of Harmonic.	Marked values in simple Vibrations.	Calculated values in double Vibrations.	Measured by Appunn's Tonometer.	Reduced by substracting 76 per 10,000.	Difference from calculated values.	Harmonics of 64·105.
1	...	64·07	...	...		64·105
4	Ut_2 512	256·28	258·4	256·42	+ ·14	256·420
5	M_2 640	320·30	323·1	320·64	+ ·34	320·525
6	Sol_2 768	384·42	387·6	384·64	+ ·22	384·63
8	Ut_3 1024	512·56	516·7	512·75	+ ·19	512·84
10	M_3 1280	640·70	646·0	641·07	+ ·37	641·05
14	7. 1792	896·98	905·0	898·10	+ 1·12	897·47
16	Ut_4 2048	1025·12	1032·6	1024·7	− ·42	1024·68
18	Re_4 2304	1153·26	1163·3	1154·4	+ 1·14	1153·49
20	Mi_4 2560	1281·40	1292·0	1282·1	+ ·70	1282·1

By examining the harmonics in the last column, deduced from a quarter of 256·42, it will be seen that they agree closely with the reduced numbers in the fifth column except in two cases (those in which the apparent error in the sixth column exceeds 1), and this seems to point to a small error in measurement in these two cases. All the four last pitches had to be counted by high partial tones of the reeds, and hence mistakes were very probable. But this crucial test shows that the errors made neither arose from grossly erroneous counting, nor from careless manufacture of the reed tonometer, but must have proceeded, as my other observations establish, from an acoustical phenomenon affecting all the nominal values of the reeds in the same ratio. And this is my answer to the first objection raised against my former paper. At the same time, I feel that I owe an apology to Herr Koenig, for my having been unfortunately misled by the unknown error of Appunn's instrument to attribute that error to him, and I make this apology most sincerely, for no one deserves more thanks from acousticians than Herr Koenig, both for the excellence of his workmanship, and the ingenuity of his contrivances.

Besides this accoustical acceleration of the beats, there remain two other drawbacks to Appunn's tonometers: first, they do not retain their pitch with accuracy, and, secondly, their variation with temperature is unknown. Hence they are not, as I had hoped, instruments of scientific precision, though admirable for all purposes of lecture illustrations.

Art 20. *Practical Importance of Musical Pitch and its History.*—If two instruments, tuned to the same system, are not at the same pitch, they cannot be played together. Some instruments can be slightly altered to agree with others, but none to any great extent, and all instruments would be more or less injured in effect on being altered by a semitone, although this is the practice in Spain when instruments play with the organ. (See (2) A 419·6 in Table I.) All instruments have a limited compass, that is, they cannot produce any musical sound at all above or below a certain pitch, hence their power of transposition by a semitone or more is limited. This is most seriously felt by the human voice. If, for example, a piece of music, written for a very high pitch, is sung to a very low pitch, the lower notes will indicate depths which the voice cannot reach; this occurs in singing Orlando Gibbons's church music, which was written for a much higher pitch than we now use, and, consequently, has to be transposed to make it suit the present values which we give to the notes. (See

the conclusion of the remarks on A 567·3 in Table I.) More frequently, however, works written for a low pitch (such as Handel's A 422·5, or Mozart's A 421·6) have to be sung to a modern orchestral pitch, rather more than an equal semitone (actually S 1·27) higher. The voice of the singer, therefore, becomes distressed in reaching its upper limits, or has to give up the attempt altogether.

Now, it so happens, that a great deal of the best music was written to comparatively low pitches. This is not generally known. The notes bear no traces of it. It could only be surmised from them, as in the case of Handel, and then not with certainty. It becomes, then, of practical importance to know precisely for what pitch the principal musical composers wrote, and of antiquarian importance to trace the formation of that pitch, and its subsequent abandonment. This is what I endeavour to do in the following history.

Art 21. *Compass of the Human Voice.* — From the remarks just made, it will be readily seen that the importance of musical pitch consists in the nice adjustment of the work required from the voice to the work it is capable of performing. Hence, the first requisite to understanding the variations of pitch, or the value of any pitch proposed, is to know, in numbers of vibrations, the average limits of each kind of voice for which composers write, and on which instruments, by accompanying, impose an interpretation. It is clearly essential that no instrument should make a composer expect an impossible performance. Now, I was unable to find any satisfactory solution of this problem. The ranges of the several voices are given by Mr. Alberto Randegger, in his Primer on "Singing" (Novello, 1879), expressed in notes, which, as he kindly informed me, referred to Broadwood's medium pitch A 446·2, so that they can be immediately translated, assuming equal temperament, into numbers of vibrations. But, proceeding only by equal semitones, the intervals were too large, and although, doubtless, due to great experience, they did not seem to be founded on a sufficiently extensive observation of chorus singers; hence, I felt compelled to undertake the investigation myself. I am indebted to the great kindness and liberality of the choir conductors, Messrs. Henry Leslie, W. G. McNaught, J. Proudman, Ebenezer Prout, L. C. and G. I. Venables, and 542 members of the choirs they conduct, for having been able to try it upon a sufficiently large number of voices, to furnish a trustworthy mean. The Table in next column gives the numbers of each kind of voice examined, rejecting duplicates.

These numbers by no means represent the full numbers of the members of these choirs, but only the few who happened to be present on the practising nights that I attended, during very unfavourable weather. Thus, I attended Mr. Henry Leslie's choir during the dense fog of 27th January, when the room itself was full of fog, and the attendance was, consequently, extremely limited.

The method adopted was as follows:—I procured four forks, tuned to V 507, 522·5, 528, and 540·7, of which the three first represent the *just* C, corresponding to Handel's A 422·5, French Normal A 435·4, and Scheibler's A 440, and the last is Mr. Hipkins's fork, representing the highest Philharmonic pitch in 1874, giving EA 454·7, but JA 450·6. The first and last forks are a diatonic

Choirs in Order of Examination.	S	A	T	B	Totals.
1. Bow and Bromley Institute Choir; conductor, Mr. W. G. McNaught	22	20	23	29	94
2. Mr. Proudman's Voice-training Class, at the Tonic Sol-fa College Winter Classes	8	1	10	2	21
3. South London Choral Association, Advanced Choir; conductor, Mr. L. C. Venables	40	25	26	33	124
4. Tonic Sol-fa Choral Association, Select Choir; conductor, Mr. Joseph Proudman	20	11	10	12	53
5. South London Choral Association, Intermediate Choir; conductor, Mr. G. I. Venables	30	13	11	23	77
6. Borough of Hackney Choral Association, conductor, Mr. Ebenezer Prout	38	25	19	24	106
7. Mr. Henry Leslie's Choir; conductor, Mr. Henry Leslie	18	13	18	18	67
Total independent voices	176	108	117	141	542

semitone apart; the two middle ones are a little less than half that from each extreme. I had printed four descending scales marked *do, si, la, sol, fa, mi, re, do, si*$_1$, &c., in words or letters, and four ascending scales marked *do, re, mi, fa, sol, la, si, do*^{1}, in the same way. Then I asked the conductor to pitch the voices of the choir to *do* from the first fork, and the choir to sing the scale down twice, the first time marking, by scratching out, the lowest note to which each voice (after noting its own name) could sing *easily*, and the *extreme* lowest note it could sing at all, and at the second singing to revise its marks. Next, the voices took an ascending scale to the same pitch, and marked the highest *easy* note (male voices avoiding *falsetto*), and highest *extreme* note (admitting *falsetto*). The three other pitches were treated in the same way. As unaccompanied singers (especially the Tonic Sol-faists) naturally sing in just intonation, it was easy to calculate almost exactly the number of vibrations in each of the limiting notes. Then taking from the paper of each voice its easy and extreme limits, certainly found within a quarter of a tone, I was able, by adding the vibrations, and dividing by the number of voices, to get the average compass of each kind of voice, expressed in vibrations, and to compare them with Mr. Randegger's, expressed in the same way. The following Tables express the results obtained:—

The first Table gives the more important *easy*, lower and higher limiting notes of the compass of each kind of voice. The column headed *mean* gives, in name and number of vibrations, the mean note reached by the voices in the first column. The column headed *actual* gives the highest and lowest note actually sung, of all the notes from which the mean was calculated. In this column the letters H, F, S, P, refer to the pitches derived from Handel's, the French, Scheibler's, and the Philharmonic forks, all calculated in just intonation. The second Table gives the extreme limits in the same way, but these are not of so much importance, and in particular, the extreme higher limits of the bass and tenor, which include falsetto, are rather curiosities than otherwise. The third Table gives Randegger's regular and exceptional limits of the same voices, but, for comparison, the soprano and mezzo soprano are placed together, and the

tenor and barytone, instead of, as is more usual and natural, the mezzo soprano with the alto, and the barytone with the bass.

On the chart I exhibit, the whole results are written out in musical notation, in Broadwood's medium pitch, tailed white notes representing the means, and black notes with the tails turned different ways, the highest and lowest. In doing so, the notes were taken as named, except those marked H, which were taken half a tone flatter, thus HA is represented by A *flat*. On a piano, in concert pitch, no note will be then more than a quarter of a tone in error, and the table can easily be played. In the present paper, musical notation had to be avoided, for typographical reasons.

A strict comparison with Randegger will show great differences, for which probably good reasons can be given; and it should be borne in mind that Randegger's "exceptional," does not exactly correspond to my "extreme." The limits of this paper do not allow of a full discussion of these results, but reference will have to be made to them under A 503·7 and A 567·3, in Table I. below, for which the observations were mainly undertaken. In the meantime, observe that music for choruses should *not* be written for the average or mean limits, as probably one half the chorus could not reach those limits easily, and those that could would be distressed by them if they occurred frequently. But it is always safe to write from the actual highest form of the lower limit to the actual lowest form of the upper limit. Thus, it would not be safe to write for soprano choristers from the mean 4 F 180·2 to the mean 1 B 993·2, but it would be quite safe to write from the higher actual form of the lower limit, 4 PB 253·4, to the lower actual form of the upper limit, 1 SG 704. But even then, long frequent sustained and forte passages involving these notes would distress. Taken in the last-named form, the limits will be found to agree better with Randegger's.

Art 22. *Materials.*—Having learned how to measure pitch with tolerable ease and certainty, I began by collecting all forks with a name and a

MEAN AND ACTUAL COMPASS OF THE HUMAN VOICE.

Voices observed.	Easy Lower Limit.	
	Mean.	Actual.
149 Sopranos	4 F 180·2	4 PB 253·4 to 4 PC 135·2
91 Altos	4 E *flat* 161·3	4 HA 211·3 to 4 SC 132
107 Tenors	8 G 98·2	4 FE 163·3 to 8 PD 76
125 Basses	8 E 81·2	8 HA 105·6 to 8 SC 66

Voices observed.	Easy Higher Limit.	
	Mean.	Actual.
145 Sopranos	1 B 993·2	½ SF 1406 to 1 SG 704
83 Altos	1 G *sharp* 835·7	½ PD 1216·4 to 1 PE 675·8
114 Tenors	1 C 520·8	1 PD 608·2 to 2 HE 316·9
120 Basses	2 F *sharp* 375·2	1 PC 540·7 to 2 FD 293·9

Voices observed.	Extreme Lower Limit.	
	Mean.	Actual.
173 Sopranos	4 E *flat* 161·9	4 PG 202·8 to 4 FC 130
108 Altos	4 D 147·1	4 SG 198 to 8 SB 123·8
114 Tenors	8 E 84·7	8 PB 126·7 to 8 SC 66
140 Basses	8 C *sharp* 71·6	8 PF 90·1 to 16 PA 56·3

Voices observed.	Extreme Higher Limit.	
	Mean.	Actual.
173 Sopranos	½ C *sharp* 1124·4	½ HA 1690 to 1 PG 811
105 Altos	1 B *flat* 951·6	½ SG 1584 to 1 PF 721
112 Tenors	1 D 616·9	1 PG 811 to 2 SG 396
139 Basses	2 B *flat* 482·9	½ PC 1081·4 to 2 SE 330

RANDEGGER'S STATEMENT OF LIMITING TONES EXPRESSED IN NUMBER OF VIBRATIONS.

REGULAR.

Voice.	Lower Limit.	Upper Limit.
Soprano	4 B *flat* 236·4	½ C 1061·2
Mezzo soprano	4 G 198·8	1 B *flat* 945·4
Alto	4 E 167·2	1 F 708·4
Tenor	4 C 132·6	2 B *flat* 472·7
Barytone	8 A *flat* 105·0	2 F 354·2
Bass	8 F 88·6	2 E *flat* 315·5

EXCEPTIONAL.

Voice.	Lower Limit.	Upper Limit.
Soprano	4 B *flat* 236·4	½ F 1416·8
Mezzo soprano	4 G 198·8	½ C 1061·2
Alto	4 E 167·2	1 G 795·0
Tenor	4 C 132·6	1 C *sharp* 562·2
Barytone	4 F 88·6	2 G 397·5
Bass	8 D 74·5	2 F 354·2

date to them, and others which, though impossible to fix to a certain place or date, yet represented a known note, and had, undoubtedly, considerable antiquity. The Society of Arts put their foreign forks at my disposal. Mr. Hipkins was most kind in allowing me to measure extremely valuable forks, and in procuring others for me. The Rev. G. T. Driffield allowed me to copy his Handel's fork. Frau Näke, of Dresden, sent over some very curious forks collected by her late husband. Prof. Rossetti, of Padua, procured me exact copies of interesting forks from Padua and Verona. Mr. Blaikley, of Boosey's, lent me a set of forks, formerly belonging to Prof. Faraday. Dr. W. H. Stone lent me others which had been tuned for him. I also procured copies of forks preserved in the Conservatoire at Paris, and had others tuned at known temperatures to remarkable organs in Vienna, Dresden, and Hamburg. These forks form the nucleus of my materials. But forks, as already mentioned, are only about a century and a half old, and it was necessary to go much further back than that, to meet the second objection raised against my former paper. Hence, I measured the pitch of numerous organs, which seemed to be untouched, and when organs failed, I was indebted to the kindness of organ builders for letting me measure the pitch of solitary pipes which they had preserved from organs they had rebuilt. Even these, however, often failed, and then I had recourse to measures of organ-pipes recorded in old books, as Schlick, 1511; Praetorius, 1619; Mersenne, 1636; Tomkins, 1668; Bédos, 1766, and others;[8] and from these and other measures Mr. Thomas Hill, of Messrs. Hill and Sons, kindly constructed pipes, which he not only allowed me to measure on his voicing machine, but most liberally presented to me. When even these failed, I had to trust to the memory of organ builders and organists as to certain organs being "flat" or "sharp," to which rather vague terms my researches enabled me to give a somewhat definite shape. This forms my own personal collection of materials. For the rest I had to trust to others, but I always endeavoured, at least, to trace their statements to the original source, and see how they obtained the pitch they give. In the first rank of these stands Scheibler himself, with about a dozen pitches, and the late Herr Näke, of Dresden, who used Scheibler's forks, and whose measures, where I could repeat them, were found very correct. Next comes Delezenne, whose method has been already explained, and whose work was excellent. Lissajous's results, believed to have been obtained with the siren and constant pressure bellows, stand, perhaps, next, but many of these are given only on the authority of de la Fage and others, and some are, perhaps, concealed in the report of the French Commission. The older determinations of Dr. Robert Smith (of Trinity College, Cambridge), Fischer (of Berlin), Euler, Marpurg, and Sauveur, were also examined.

From all these sources I have formed the large collection of pitches given in Table I., with every necessary particular respecting each, arranged by order of the pitch of A, and afterwards in Table II., by countries and places.

These two Tables, in fact, form my "history of musical pitch," but they require a little previous explanation to show their import and relations. Whenever, in future, I cite a pitch as A 505·8, reference should be made to that number in Table I., where all particulars respecting it will be found. This will save many repetitions. Table II. forms an index to Table I., as the pitch of A can be found by referring to the country, or place where it was used, and then by consulting Table I., all the other information I can furnish will be found.

The following condensation of these two Tables,

[8] *Titles of Old Books used as Authorities.—Schlick.* "Spiegel der Orgelmacher und Organisten, allen Stiften und Kirchen so Orgel halten oder machen lassen hochnützlich, durch den hochberümpten und künstreichen Meyster Arnolt Schlicken Pfalzgrauischen Organisten artlich verfasst." (Mirror of Organ-builders and Organists, very useful to all foundations and churches which possess or order organs, excellently composed by Master *Arnold Schlick*, Organist to the County Palatine.) Reprinted from the only known copy (belonging to Herr Wilh. Bethge, junior, and printed, apparently, by Peter Schöffer, in Mainz) in the "Monatshefte für Musik-Geschichte herausgegeben von der Gesellschaft für Musikforschung" (Monthly Journal for Musical History, edited by the Association for Musical Investigation.) First year, 1869, edited by Rob. Eitner, Berlin, pp. 78—114, with a *fac-simile* of the title, containing an engraving of an organist playing on the organ, with the bellows-blower behind it; in front, a performer on a rude clarinet, and two men and three boys singing from musical notes. There is no date to the book, but the Imperial Privilege to print is dated 3rd April, 1511. The second chapter "speaks of the dimensions of pipes, a good church measure, convenient to sing to, and for the organist to play," and the eighth chapter tells "how, and at what time, the organ should be tuned." This very interesting book, which was of great use in showing the relation between very high and very low church pitch, and the method of tuning before the invention of the mean-tone temperament, was lent to me by Mr. A. J. Hipkins.

Praetorius. "Syntagmatis Musici, Michaelis Praetorii C. Tomus Secundus de Organographia." (Second volume of the Musical Work of *Michael Praetorius C.*, concerning Organ description.) "Wherein" (translating the title) "the Nomenclature, Intonation, and Properties of all Musical Instruments, old and new, not only foreign, barbarian, rude, and unknown, but also domestic, artistic, lovely, and known instruments, together with an exact Figure and proper Counterfeit of the same; and also an exact description of Old and New Organs, Manual and Pedal Keyboards, bellows, specification and Stops, and also how to tune perfectly and easily the Regale and Clavicymbalum, and what has to be attended to in delivering over an organ, together with an appended copious index; not only very useful and necessary to Organists, Instrumentalists, Organ-builders, and Instrument-makers, and all who are devoted to music, but also very entertaining and elegant reading for Philosophers, Philologists, and Historians. To which is added a complete Index. Printed at Wolfenbüttel, at the house of Elias Holwein, printer and type-founder to the Prince of Brunswick. Published by the Author. Anno Christi, M.DC.XIX." Three small quarto volumes of this very rare and curious book exist, of which the above is the title of the second. Extracts from this book were first sent me by Herr Schmahl, Organist of St. James's Church (St. Jacobikirche), Hamburg, to whom I am much indebted for kind assistance. A complete copy (with the exception of one leaf of engravings), the only one, so far as I am aware, in the United Kingdom, exists in the Reid Music Library, attached to the Chair of Music in Edinburgh, and for six months' loan of this work, which has proved to be most essential to my investigations, I am indebted to the great kindness of the Professor of Music at Edinburgh, Sir Herbert Oakley.

Mersenne. "Harmonie Universelle, par Marin Mersenne, de l'Ordre des Minimes." Paris, 1636. Folio. In the British Museum.

Mersenne. Harmonicorum Libri xii., in quibus agitur de sonorum natura causis et effectibus: de Consonantiis, Dissonantiis, Rationibus, Generibus, Modis, Cantibus, Compositione, orbisque totius Harmonicis Instrumentis, authore F. M. Mersenno Minimo. 1648. In the British Museum and Library of the Royal Society. This is a Latin abridgment of the French book, from which it varies in part.

Tomkins. For the account of this book see under A 474·1 in Table I.

Bedos. "L'Art du Facteur d'Orgues, par Dom François Bédos de Celles, Bénédictin de la Congrégation de Saint Maur, dans l'Abbaye de Saint Denys, en France, de l'Académie." 1766. The finest and most complete work existing on the construction of the organ, of which J. G. Töpfer's work is principally an abridgment, with borrowed plates. In the Reading-room of the British Museum.

For temperament, also, I have had to consult—

Zarlino. "Le istitutioni harmoniche, del reverendo M. Gioseffe Zarlino di Chioggia." Venice, 1562. In the British Museum and Library of the Royal Society.

Salinas. Francisci Salinae Burgensis, abbatis Sancti Pancratii de Rocca Scalegna, in regno Napolitano et in Academia Salmanticensi Musicae Professoris, de Musica, libri septem. Salamanca, 1577. In the British Museum.

The titles of many other works which I have consulted are given sufficiently where they are cited.

in which the arrangement is by equal semitones, and tenths of equal semitones, from a lowest ideal pitch to the highest found, and also by the nearest whole number of the vibrations made by the single note A in one second, for a few of the principal and most characteristic pitches, with the designation of the classes into which I distribute them, will probably make it more easy to follow the remarks I have to make, while the filling up of details by Tables I. and II. themselves will give that feeling of confidence which can only arise from a most extensive induction.

OUTLINE HISTORY OF MUSICAL PITCH.

S	A		
0·0	370	Ideal lowest, or zero-point.	Church Pitch lowest.
0·2	374	Hospice Comtesse, 1700.	
0·3	377	Schlick low, 1511; Bedos, 1766.	
1·0	392	Euler's Clavichord, 1739.	Church Pitch low.
1·1	395	R. Smith, 1759; Roman pitch pipes, 1720.	
1·2	396	De Caus, 1615; Versailles Chapelle, 1789.	
1·4	403	Mersenne Spinet, 1648.	Chamber Pitch low.
1·6	407	Sauveur, 1713.	
1·7	408	Mattheson, Hamburg, 1762.	
1·7	409	Pascal Taskin, court tuner, 1783.	
2·0	415	Dresden chained fork, 1722.	European Mean Pitch for two centuries.
2·2	420	Freiberg, 1714; Seville, 1785.	
2·3	422	Mozart, 1780.	
2·3	423	Handel, 1751.	
2·4	424	Praetorius's suitable pitch, 1619; original Philharmonic, 1813.	
2·5	428	R. Harris, 1696; Opéra Comique, 1823.	
2·7	433	Sir George Smart's fork, 1820-26.	Compromise Pitch.
2·8	435	French Diapason Normal, 1859.	
3·0	440	Scheibler's Stuttgart Standard, 1834.	Modern Orchestral Pitch, and *Ancient Medium Church Pitch.
3·1	442	*Bernhardt Schmidt, low, 1690.	
3·2	445	Madrid, 1858; San Carlo, Naples, 1857.	
3·2	446	Broadwood's Medium, 1849; French Opera, 1856; Griesbach's A, 1880.	
3·4	449	=C 534; Griesbach's C 528, 1860.	
3·5	451	Lille Opera, 1848; British and Belgian Army, 1879.	
3·5	453	Mean Philharmonic, 1846-54.	
3·6	455	Highest Philharmonic, 1874; Broadwood, Erard, and (English) Steinway, 1879.	
3·6	456	Vienna, high, 1859.	
3·7	457	(American) Steinway, 1879.	
3·8	458	Great Franciscan Organ, Vienna, 1640.	Church Pitch high.
4·0	466		
4·3	474	Tomkins, 1668; B. Schmidt, high, 1683.	
4·5	481	St. Catherine's, Hamburg, 1543.	
4·8	489	St. James's, Hamburg, 1688.	
5·0	494	St. James's, Hamburg, 1879.	Church Pitch highest.
5·1	496	Rendsburg, 1638.	
5·3	501	Schlick, high, 1511; Mersenne, ton de chapelle, 1636.	
5·4	506	Halberstadt Cathedral, 1361.	
6·0	523		
7·0	554		Chamber Pitch highest.
7·3	563	Mersenne, ton de chambre, 1636.	
7·4	567	Praetorius, North German, very old.	

Art. 23. *Early Church Pitch* (*Ton de Chapelle, Chorton*).—No doubt, the earliest musical instrument was the human voice, and the old lyres and flutes were merely arranged to steady it, and to give it such a pitch that its strains should not run beyond its compass. We have a notable instance of the latter use in the flute-player of Tiberius Gracchus, who always stood near him to give him the proper pitch of his voice. (Cicero de Oratore, lib. iii., §§ 225-228.) But with these ancient times I have nothing to do. I take up music at a point where the Pythagorean or Ptolemaic scale, or some of the numerous unequal temperaments, had been applied to church music for many years, and the pitches used can be compared with those now prevalent, because there was a practical agreement of notation and relative intonation. Also with those old instruments which were not intended to be played with any others, and which were consequently intoned simply in the way which was thought to bring out their quality of tone best, as Praetorius tells us, I have nothing to do.[9]

The pitch-pipe was the most natural instrument for starting the voice, and I have the impression that those primitive little organs, of which Prætorious speaks (*ib.*, vol. 2, p. 94), which were hung up against a column in the church, "like swallows' nests," as he says, and contained only the notes B *natural*, C, D, E, F, G, A B *natural*, C, D, E, F, or else the notes C, D, E, F, G, A, B *flat*, C, D, E, F, G, A, which have the appearance of a series of pitch-pipes, set to the proper notes, were really so, that is, were as much the development of the pitch-pipe, as the clavichord is well known to have been the development of the monochord. But to the pitch of these little instruments I have no clue.

I begin with the great organ of the cathedral of Halberstadt (29 miles S.W. of Magdeburg, in Prussian Saxony), finished on 23rd February, 1361 by Nicholas Faber, and restored, 1495, by Gregory Kleng, which was still existing, though no longer used, in the days of Praetorius, 1619, who has described and partly figured it. Praetorius gives the dimensions and name (B *natural*) of the largest pipe, from which I had a model constructed to a scale of one-sixteenth, which speaks four Octaves higher, and gives 4 B 284·5, whence J A 505·8, which sounds more like 1 C than 2 A. This is the sharpest pitch which I have measured, but not the sharpest which I have met with. It is nearly a whole tone sharper than the sharpest pitch now used in London. Practically belonging to nearly the same period, although, possibly, one or two centuries later, is the C of an ancient organ at L'Hospice Comtesse, near Lille, measured by Delezenne, and giving 4 C 112·7, whence A 374·2.

Now, these two pitches, A 374·2 and A 505·8, are S 5·22, or a comma more than an equal Fourth apart, and it requires considerable faith to believe that sounds so extremely different could ever have been conceived and written as the same note A. But a key to the mystery is furnished by Arnold Schlick, 1511, who says (chap. 2):—"The organ is to be suited to the choir [or church *chor*], and properly tuned for singing, for where this is not considered, persons are often forced to sing too high or too low, and the organist has to play the chromatics, which is, however, not convenient for

[9] *Ancient Pitch of Solo Instruments.*—"In the first place, it must be known that the pitch, both of organs and other musical instruments, varies greatly. Since the ancients were not accustomed to play in concert with all kinds of instruments at the same time, wind instruments were very differently made and intoned by instrument makers, some high and some low. For the higher an instrument is intoned in its own kind and manner, as trumpets, shawms, and treble viols, the more freshly they sound and resound. On the contrary, the deeper trombones, bassoons, bassanelli, bombards, and bass viols are tuned, the more majestic and magnificent is their stately march. Hence when the organs, positives, clavicymbals, and other wind instruments do not stand in the same pitch with each other, the musician is much plagued."—Praetorius, "Syntagma," vol. 2, p. 14.

everyone. But what is the proper length of the pipes for this purpose, and convenient to the choir to sing to, cannot be exactly defined, because people sing higher or lower in one place than in another, according as they have small or great voices. However, if the longest pipe, the F below the Gamma-ut in the pedal [that is 8 F below 8 G, the Gamma-ut being the name given by Guido Aretino to 8 G, the note on the last line of the bass staff], has its body down to the [beginning of the] foot, sixteen times the length of the annexed line [which the editors say is 4 and 7-8 Rhenish inches = 127·5 mm. long, so that the full pipe is 6½ Rhenish feet, or 2,040 mm. long], I think it will be a suitable length for the choir. But if you build an organ a Fifth larger, then you must make C in the pedal [that is, 8 C, the lowest note of the violoncello], of this length. . . . The reason is that a greater part of church music ends in *grambus* [a word which puzzles Schlick's editor, who says, however, that it can only mean the transposition of the *tonus primus* by a Fourth], than in the first tone." And he proceeds to show its advantage, and especially the advantage of the first pitch (with 6½ Rhenish feet to 8 F) in other ecclesiastical tones. Assuming that when Schlick's pipe was taken two Octaves higher, its diameter would be one-thirteenth of its length, which is not improbable, although, perhaps, it is rather narrow, I had such a pipe made, and then measured it, and found its pitch to be V 301·6. If we assume this as 2 F, and, taking 2 A a perfect major Third above (and Schlick's directions for turning made this major Third very nearly perfect), we obtain as the pitch A 377, which is practically the same low pitch as Delezenne's Hospice Comtesse A 374·2. But if, as in Schlick's greater organ, we assume the 6½ Rhenish feet for 8 C, we obtain A 504·2, which is practically identical with the Halberstadt A 505·8, and is parallelled by the actually existing organ of St. James's Church (*S. Jacobikirche*), at Hamburg, A 494·5, as now tuned, but formerly A 489·2. Hence, we have both the very sharp and the very flat pitch recommended by the same writer, at the same date, and on the same grounds, namely, the accommodation of the singer and the organist in playing the old ecclesiastical tones.

This gives the first three principles which seem to have determined early pitch, namely (1) ecclesiastical music, (2) ease of fingering it, (3) the compass of the human voice. To this we must add a fourth, and very important principle, which seems to have had great influence in practical construction, namely (4) the foot-rule of the country. It is clear that organ builders would naturally choose for their chief standard pipe some easy multiple or sub-multiple of the foot-rule with which they worked, as they could not well make their men attend to any other. The old organ builders divided the pipes into Octaves of so many feet each. I have adopted this division as the most generally received nomenclature of the great scale, for it is found, not only all over England, but also all over Germany, France, and Italy, despite the variety in the length of their feet. Although it has long ceased to be anything but a name, and does not at all signify the real dimensions of the pipes, being as much a survival as our own English spelling, it must, like that spelling, have had an original foundation in fact; and in Dom Bédos's great work on the organ, 1766, we find this division a reality, the 4 foot C being really a pipe of 4 old French feet in length, and so on. Now, for the same "scale" (that is, the same ratio between the diameter and length of the pipe), the pitch varies inversely as the length of the pipe, and much of the older diversity of pitch seems to me referable to the old diversity of measures. The following are the principal foot measures which have to be considered, expressed in millimètres to the nearest unit (25·4 mm., being one English inch):—

	m m.
Long old French foot, or *pied de roi*	325
Long German, or Rhenish foot	314
Long Austrian foot	316
English foot	305
Old Nurnberg foot	304
Old Roman foot (medieval).....	295
Old Augsburg foot	296
Bavarian foot.....	292
Short Saxon foot	283
Short Brunswick and Frankfort foot....	285
Short Hamburg and Danish foot	286
Very short old Brabant foot of 11 inches	278
13 Rhenish inches	340
13 Saxon inches.....	307
12 old Brabant inches	303

Now, a difference of 12 per cent. in the lengths of two pipes will, for the same scale, make a difference of nearly a whole meantone in their pitch. Thus the short Saxon foot was a meantone sharper than the long Austrian or Rhenish foot.

Again, 6 per cent. corresponds to an equal semitone, 3 per cent. to an equal quartertone, 5¾ per cent. to a semi-meantone, 4½ per cent. to a small, and 7 per cent. to a great, meantone semitone. Thus we see that the English foot is nearly a great semitone sharper than the French foot, and the Rhenish foot is about a small semitone sharper than the French, and the English about an equal quarter of a tone sharper than the Rhenish. Throughout Germany, there was a great variety of small feet, quite sufficient to account for a great variety of organ pitch.

The flat pitch took the most root in France. Dom Bédos says that chapel pitch was constant, and he draws and describes his pipes, proceeding by French feet, giving A 376·6, which is 2½ equal semitones flatter than the French diapason normal of 1859. The Rev. Sir F. A. Gore Ouseley, who has examined a large number of the continental organs, informs me that "most of the old *untouched* organs in the French cathedrals are of this low pitch" (see A 376·6). The English foot is a semitone sharper than the French, and the only English example of an organ in which C is 1, 2, 4, &c. feet, is that furnished by Trinity College organ in 1759, A 395·2, which is nearly three-quarters of an equal semitone sharper than Dom Bédos's A 376·6. In Germany, the low pitches I have found are few, Schlick's A 377, already noticed, and Solomon de Caus's A 394·4, which is sharper than the French, because the Rhenish foot itself is a quarter of a tone sharper.

On the other hand, the sharp organs are principally German, the Halberstadt A 505·8, Schlick's high A 504·2, and the existing pitches of the organ in the cathedral at Lübeck A 484·1, and the Hamburg churches of St. Catherine A 480·8, and

St. Jacobi A 494·5. In England, we had Tomkins's high pitch A 474·1, realised in Bernhardt Schmidt's old Durham organ, 1683, arising from placing the pipe, of one English foot in length, on A, which evidently belongs to this series. In France, Mersenne places the French four-foot pipe on 8 G for the *ton de chapelle*, giving A 503·7, agreeing with the Halberstadt. In Italy I found, preserved at the University of Padua, a 1 G made for Prof. Stratico, which would imply A 483·7, but whether it represented a pitch really used I do not know. The above high and low pitches seem to me to belong to this earliest period of church pitch; the other low and high pitches appear to have been influenced by other considerations, after the tradition of the older pitch had died out.

Art. 24. *Early Chamber-pitch* (*Ton de Chambre, Cammerton*).—Music was by no means all ecclesiastical. When choirs were formed for the church, and musical instruments were introduced to play with the organ, forming the German *Kapelle* (properly "chapel," but afterwards merely "band"), both choir and instruments were used by the king or prince to perform in his "chamber," that is, his private apartments, for his private gratification. But the music they wanted to play and sing far exceeded church requirements, and hence the old church pitch hampered them; it was generally either too high or too low. But as one set of instruments was wanted both in the church and the chamber—I have only heard of one place, Dresden, in which two sets of instruments were used (see A 424·0, and 437·8)—it was necessary that the chamber pitch should bear a definite relation to the church pitch; in other words, that it should differ from it by an interval of the scale. For this reason, apparently, chamber pitch differed from church pitch by a semitone, a Tone, or a minor Third, or even a Fourth, according to the pleasure of the performers. Dom Bédos says (Art. 1,140), that church pitch in France was fixed, but that the opera pitch (an advance on the chamber pitch) is not fixed, but ascends, or descends, a quarter of a Tone, or even more, according to the compass of voice. This, as well as the instruments which happened to exist in any place, had doubtless much to do with the great variety and confusion of the chamber pitch. It seems that, as a rule, this pitch tended towards a certain mean, by being a tone higher than the low pitches, and a minor Third, or even a Fourth lower, than the very high pitches. This, however, was not always the case. Mersenne's high church pitch is capped by his still higher chamber pitch, A 563·1, produced by putting the 4 (French) foot pipe on to 8 F. To modern ears, it would amount to transposing the bass by a Fifth, to allow it to be sung by a tenor, but it was evidently not so considered by Mersenne. We find, probably, as high a pitch called chamber pitch, by Praetorius. (See A 567·3.) Of course, we have very few direct traces of ancient chamber pitch. But the fact that St. Jacobi organ at Hamburg (formerly A 489·2 now 494·5), had for many years one stop, which was a minor Third flatter than the rest of the organ, that is, a little lower than the old pitch of the Dresden organ, A 415, and that this stop (long since replaced as useless) was said to be in chamber pitch, serves to show an indirect action of chamber upon church pitch. This stop evidently enabled the organist to play with the instruments occasionally without transposition. At present the organists of St. Jacobi and St. Catherine, at Hamburg, have always to transpose a tone or a semitone at sight, a state of things that certainly was not contemplated when their church pitch was settled.

Art 25. *Influence of Chamber-pitch on Church-pitch*.—The direct effect of chamber on church pitch was evidently the building of organs in chamber pitch, or the returning of old organs in that sense. This came to placing the standard lengths of pipe upon different notes, or shifting the existing pipes into different holes, so as to be actuated by keys a Tone or a Semitone different from those by which they were before evoked, and then supplying the required extra pipes, and trimming the old pipes for temperament. We have some conspicuous examples of this shifting, which is a very common device of organ builders at the present day. Thus the pitch of Trinity College organ was altered from A 441·7 to A 395·7, by shifting in such a way that the C pipe was made to speak to a D finger-key. The organs of the Temple and St. Paul's were altered from A 441·7 by shifting a semitone and then piecing when required to bring them probably to Sir George Smart's pitch A 433·2, which is practically identical with the modern French pitch. But, the flattening of St. Paul's proving disagreeable, after some years the pipes were shifted back again and retrimmed, so that the original pitch was restored. The present organ is new, by Willis, but is almost exactly in the first pitch (see A 444·7). The pitch of Durham Cathedral and St. James's Chapel Royal organs were altered in the same way (see A 474·1). It is evident that in such changes the traditions of church pitch were set at naught.

The changes of course differed in different countries. In France, to give the one foot French pipe to B *natural* produced A 395·8, which we find in the chapel of Versailles, and which is practically identical with putting the one foot pipe upon C at Trinity College, where B *flat* became C, producing A 395·2. I have no other certain indications of such a proceeding in France, because all the organs which Delezenne examined, except that of the Hospice Comtesse, which was in the oldest flat pitch, A 374·2, had been more or less repaired. The St. Sauveur, Lille, A 384·6, looks merely to be the old pitch with the pipes cleaned and "trimmed;" La Madeleine, Lille, A 398·7, seems, however, to be a similar alteration of an organ with the French foot on B. Mersenne's spinet, A 402·9, had its lowest note, 8 B, tuned to the 4-foot pipe. The V 7·1 difference between this and the Versailles A 395·8, may be merely a matter of temperature or scale. Let us briefly class these organs as French C foot and French B foot organs.

In England, we have this formation very marked. The old English A foot organ, A 474·1, belonged to the old sharpest organs, such as Tomkins's and Bernhardt Schmidt's high pitch at Durham, and at the old Chapel Royal, St. James's. The B *flat* foot organ, a great semitone lower, gave Bernhardt Schmidt's low pitch A 441·7, which, with a change of temperament, seems to be the favourite church-pitch among London organ-builders at this day. (See Gray and Davison's

A 440, Walker's 440·2, Bevington's A 440·5, Lewis' A 441, Hill's 441·7, Bryceson's 443·4, Willis's church-pitch, A 445·2.) The B foot organ, which, for 200 years, found the most favour in England, had two distinct forms: the *wide scale*, deduced immediately from Bernhard Schmidt's, and giving Green's A 422·6 or A 423·2; and the *narrow scale*, used by Renatus Harris, giving A 427·7 or 427·2, 434·7, or even A 419, according to pressure, &c. The C foot organ never seems to have found favour with us, although it is possible that Bernhardt Schmidt built some chamber organs at that pitch. (See A 395·2.) The alteration of the Trinity College organ to this pitch is attributed, by Dr. R. Smith, to the influence of Roman pitch. I have not been able to find a Roman pitch so low. The lowest Italian pitch, A 403·9, derived from an old Paduan fork, is, however, only S 0·38, or about one-sixth of a tone sharper. Euler's clavichord or spinet, A 392·2, seems to have been a Russian C foot instrument (the Russian foot agreeing with the English). But from this may have been derived Euler's organ, A 418, a semitone higher; that is, as nearly as I can judge from Euler's rather vague description. Again, in England, if from a B foot organ, giving A 424·6, we form an organ a whole great semitone sharper—that is, having its A on the B *flat* of the other organ, or its B on the C of that organ—we shall get A 454·2, a pitch which I found on a very old fork accidentally dug up at Brixton. This seems, also, to be the meaning of A 457·6, the pitch of the existing large organ in the Franciscan Church at Vienna. The natural alteration of an organ was by a great semitone, B *natural* to C; the small semitone, B *flat* to B, would only arise from shifting the pipes. It must be remembered that B *flat* was the only chromatic which formed part of the original musical scale. For a table of the relations of these organs, see the end of the remarks on A 474·1.

Art. 26. *The Mean Pitch.*—The result of all these different endeavours to reconcile the requirements of the church with those of the chamber seems to have been the institution of a mean pitch, which, within very narrow limits, prevailed for a very long time over most of Europe. This was, in fact, the chamber pitch, formed by taking the D of the old flat church pitch as C, and the A (or occasionally the G) of the high church pitch also as C. It was, therefore, a whole Tone above the flattest, and a minor Third (or occasionally a Fourth) below the highest pitches. This, at least, appears to me the origin of a pitch which certainly bears these relations to the older pitches, and was very widely used. In my list of Historical pitches, in Table I., 63 pitches lie between A 415, and A 430, the mean of which, A 422·5, is the exact pitch of Handel's fork, now in the possession of the Rev. G. T. Driffield, the Rector of Bow. This pitch I regard as the mean pitch of Europe during the 17th, 18th, and the early part of the 19th centuries, so important for musical art. The earliest recommendation of this pitch I find in Praetorius, 1619, in an N.B. at the end of his second volume, p. 231, where he says:

"In this second volume I have often had to speak of the true Church pitch (*des rechten Chor-Tons*). I have found that, in many places, even in large and important cities, and on their splendid organs, the proper Church pitch, by which both human voices and instruments must be regulated, was not used, but their pitch was either too high or too low, forming one of the principal defects of the organs. This has made me think of all kinds of ways and means to remedy this defect, and make the proper pitch known to both organ-builders and organists, so that the organ-builder may intone new organs, and renovate and correct old organs, by this means. For this purpose, I give a correct drawing of the proper measure for Church pitch, for the Octave beginning with what the organ-builders call the half-foot C, from which small pipes can be constructed through a whole Octave with great correctness, and used for tuning purposes by organists." Then follows a drawing, the particulars of which will be found under (1) A 424·2; the pitch I have deduced from it by having a 1 C pipe constructed from its corrected dimensions. Several little points remain in doubt, as Praetorius neglected to give the size of the mouth and the force of the wind; but the pitch measured must sufficiently represent the actual mean pitch which he finally adopted. It corresponded to the English B foot organ, and had as variations, owing to scale and pressure, from A 415 to A 428·7, besides the variations due to the original length of foot. Some of the earliest organs in this pitch are Gottfried Silbermann's celebrated Roman Catholic Church organ, at Dresden, built 1754, originally A 415, and now A 418·1; his St. Sophie, at Dresden (built 1740), A 415·5; and his organ of the Saxon Cathedal at Freiberg (built 1714), A 419·5, which, as A 419·6, is still used as the church pitch all over Spain. Singularly enough, these Saxon pitches have been regarded as remnants of the high Church pitch, and Näke assumes the existence of a chamber pitch A 375·2, a whole tone below the Freiberg Cathedral A 419·5, and belonging, really, to the early lowest church pitches. The English organ-builders, Renatus Harris, Christian Smith, Glyn and Parker, Schnetzler; Byfield, Jordan and Bridge; Byfield and Green; and Green, all, at least occasionally, used this pitch. Almost any untouched English organ in country places is a B foot organ. And when the London Philharmonic Society was founded, in 1813, and down to 1828, the pitch used was A 423·7. But the wide Continental diffusion of this pitch is most important. Marpurg's A 414·4, at Breslau in 1776, was, no doubt, really one of these pitches; probably giving A 420 when corrected. Näke cites a flute by Floth, in 1760-70, of A 418, and a D-clarinet of Grenser, in 1783, of A 422. The fork of Franz Anton von Weber (father of the celebrated composer, Carl Maria von Weber) who lived 1740 to 1812, shows A 424·1; and, at the time that C. M. von Weber himself was Kapellmeister at Dresden, 1815-21, the fork of the orchestra gave A 423·2. The pitch for which Stein, the predecessor of Streicher, constructed the pianos used by Mozart in 1780, was A 421·6, and the fork of the Saxon organ-builder Schulz (predecessor of the celebrated Schulze, of Pauluscelle) who lived in Vienna in 1780, was A 421·3. The two old pitch-pipes lent me by the bell foundry Colbacchini, at Padua, the first of about 1730, and the second of about 1770 show a mean of A 425·2 (which see). The higher F fork of the same house is equivalent to A 422·6; the lower F fork of the same first is equivalent to A 403·9, and belongs to another series. The old forks of the

bell foundry of Cavedini, at Verona, of which I was obligingly allowed to have accurate copies, belonging to about 1780, give A 422·3.[10] And, as late as 1839, the best piano-tuner at Bologna used a fork A 425·8. In France, the old fork of François, of Lille, assigned to 1754 by Delezenne, gave A 422·6, and that of Cohen, of the same place, about 1800, gave A 428·7. In 1810, Drouet assigns A 423 to the Grand Opera, in Paris; and Scheibler, in 1811, assigns A 427·0 to the same. In 1824, the pitch of this opera was lowered for a special singer (Madame Branchu) to A 425·8, evidently the pitch to which she was accustomed. In 1823, Fischer assigns A 424·2 to the Italian Opera in Paris. Dauprat's fork, preserved at the Conservatoire at Paris, gives A 423 to the comic opera there in 1820, and Fischer, in 1823, gave A 427·6 to the same.

Now, from 1670 to 1820, during which this mean pitch was in full vigour, we have the following composers:—

Belgium and France.—Lulli, Rameau, Monsigny, Gossec, Gretry, Dalayrac, Leseur, Mehul, Boildieu (operas).

Italy.—Stradella, Corelli, Lotti, A. and D. Scarlatti, Porpora, Geminiani, Vinci, Leo, Durante, Pergolesi, Galuppi, Jomelli, Marcello, Guglielmi, Piccinni, Tartini, Sarti, Sacchini, Farinelli, Boccherini, Cimarosa, Paesiello, and earlier periods of Clementi, Zingarelli, Cherubini, Rossini (all his operas), Donizetti, Bellini.

Germany and Austria.—Zachau, Keiser, Handel, Graun, Gluck, Hasse, Stamitz, J. Sebastian Bach, C. P. Em. Bach, Haydn, Mozart, Beethoven, C. M. von Weber, and earlier careers of Hummel, Spohr, Meyerbeer, Moscheles, Pleyel, Mendelssohn.

England.—Purcell, Croft, Green, Arne, Boyce, Burney, Hawkins, Webbe, Battishill, Shield, Stevens, Wesley, Calcott, and earlier careers of Horsley, Crotch, Bishop.

That is to say, the heroes of music, the founders and perfecters of modern musical art, all used this mean pitch, all thought out their music, and arranged their voice-parts to be played and sung in this pitch. This is, therefore, emphatically the classical pitch of music.

It was during this period that the great Cremona violins were made. Savart considered that the resonance power of the cavity of a violin, shown by the fork which utters the loudest tone when held before one of the *f* holes, was likely to be the pitch of the time, and on his authority, C 256 was the resonance of the violins of Stradivarius, and hence this maker was credited with adapting his instruments to that pitch, which was, therefore, assumed to be the pitch of their time. By the kindness of Dr. Huggins, F.R.S., and Rev. H. R. Haweis, together with the violin-makers, Messrs. Hart, Hill, and Withers, all of Wardour-street, I have been able to examine the resonance of several fine instruments of this period, by Duiffprugcar (Swiss Tyrol, Bologna and Lyons, 1510-1538), Amati (Cremona, 1596-1684), Ruggieri (Cremona, 1668-1720), Stradivari (Cremona, 1644-1737), Giuseppe Guarneri (known as "Joseph," Cremona, 1683-1745), Lupot (France, 1750-1820), &c.

It was often difficult to decide what fork gave the maximum resonance, as the difference between two adjacent forks was often slight. And as my forks proceeded by four vibrations each, the resonance could not be determined within less than two vibrations in a second of the pitch named, either sharper or flatter. The method adopted was to hold a fork over the widest part of the *f* hole on the "bar" side of the violin, and, therefore, most remote from the "post." By far the strongest resonance lay between V 268 and V 272; but one early Stradivari, 1696, had a fine resonance at V 264. Then there was a secondary, but decidedly weaker maximum resonance about V 252. The V 256 was generally decidedly inferior. We may, then, take V 270 as the general resonance, and about 252—say 252·4—as a secondary resonance. Now, taking the doubles of these as 1 C, we obtain C 540 and C 504·8, which would give MA 451 and MA 421·9. Now, the latter represents the mean pitch of the period very closely. (Compare Cavedini's Verona A 422·3.) And the other is a great semitone above it, which is a regular difference. (Compare notes on A 454·2 and 437·6, both of which belong to this period.) These may be mere coincidences, and may have really had nothing to do with any attempt to adjust the resonance to the prevalent pitch. This is certainly the case in the making of more modern violins on the same model and with the same resonance as the old. But, if coincidences, they are, at any rate, remarkable. And the higher resonance, corresponding to modern English orchestral pitch, may account for the possibility of playing these violins with effect at our present concerts. As the resonance is not bad, although inferior, between V 252 and V 268, it is evident that these violins will also sound well with an intermediate pitch, such as the French.

With the establishment and reception of mean pitch, the history of earlier musical pitch closes; and the extent to which I have been able to work it out, with the proofs in Table I., will, I hope, be accepted as an answer to the second objection raised against my former paper. It is necessary, however, to show the gradual passage of a universally accepted mean pitch into the lamentable conflict and confusion of pitches which now exist, and this my recent researches enable me to do more completely than before.

Art. 27. *Orchestral Pitch.*—During the latter part of the reign of mean pitch, a new power was showing itself in music—the orchestra, including the opera. Both church and chamber pitch were founded on the capabilities of the human voice alone, and the instruments were accessory. But the formation of large orchestras, for which especial music was written, gave an excessive

[10] *Ancient Variability of Italian Pitch.*—Carlo Gervasoni, of Milan, in his "La Scuola della Musica," Piacenza, 1800, p. 126, footnote says, "The tone, commonly called Pitch [*Corista*, a word also used for a pitch-pipe and a tuning-fork, although *diapason* is now also employed for the latter] is not the same in all cities, but in some it is higher or lower than in others. The pitch of Rome is, in fact, much lower than that of Milan, Pavia, Parma, Piacenza, and all the other cities of Lombardy, and the pitch of Paris is not only sharper than that of Rome, but much sharper than that of Lombardy. A mean pitch (*un corista di mezzo*), which is more generally accepted, is, nevertheless, that of Lombardy, and with this agree, more or less, the pitches of various provinces." The Lombardy pitch, then, may be taken as A 422·6, and the lower Roman as A 403·9 or A 395·2. As to the pitch of Paris, about 1800, the nearest I have are, for the Grand Opera in 1810, A 423; in 1811, A 427; in 1819, A 434; and for the Conservatoire in 1812, A 439·5, and Lemoine's fork 1810c, A 430—it would seem that the nearer we get to 1800 the nearer we are to the Lombard pitch. Nike, however, makes the Lombard pitch flatter (see A 415·5 and A 419·5 in Table I.). Still it would appear to have been within the limits of the mean pitch.

power to the instruments, which could develop their powers independently of the voice, and then, when joined with the voice in operas, could often exercise—have certainly, often cruelly exercised—a tyrannical power over the voice.

Down to 1816 in Austria, and later in most other places, mean pitch held undisputed sway. The most serious outbreaks against it I can find are: the French Conservatoire, which in 1812, according to a fork preserved at the Conservatoire itself, used A 439·5 (nearly three-quarters of a semitone sharper than mean pitch), and two very doubtful pitches, not precisely specified, measured in 1815 by De Prony, as A 438·2 and A 444·5. The former I look upon as an individual freak, for which I find no contemporary corroboration so that I presume the pitch was confined to the Conservatoire, and may have been only a temporary trial. The other two are laboratory experiments, and, from all the circumstances under which they were made, I cannot attach much historical value to them. It was not till after 1816 that any general rise took place and slowly spread.

According to Schindler ("Niederrheinische Musik-zeitung," 1855, Nos. 8 and 9), as quoted by Näke ("Ueber Orchesterstimmung," 1862, p. 26)—and the same story is given in the Report of the French Commission, as sent to it in a letter by M. Kittl, director of the Prague Conservatoire—the rise began at the Congress of Vienna, when the Emperor Alexander of Russia, who was colonel of an Austrian regiment, presented it with a new set of musical instruments, made by Stephan Koch, which were sharper than the mean pitch; and, under the direction of Hieronymus Payer, this band became very noted for the brilliancy of its tones. But, when its assistance was required in performing an oratorio for the return of the Emperor Francis, it was found impossible to make use of it, and much talk thence arose. In 1820, the band of another regiment (Hoch- und Deutschmeister-Infanterie) received new instruments, which were even sharper than the other. The Vienna theatres were in great trouble; for, whereas it was usual to call in the assistance of the military bands for great operas, two out of three of the regiments quartered in Vienna were no longer available, so that only one extra band remained for the theatres. The result naturally was that the theatres had ultimately to raise their pitch also. In 1823, Näke puts down Weber's "Euryanthe" as having been performed to A 437·5, and in 1834, Kreutzer's "Nachtlager" to A 440, both in Vienna; and notes (from his own hearing, apparently) A 466 as the actual pitch of the Vienna opera in 1861, during performance, which would be sharper than that officially recognised. Thus, the fork in possession of the great pianoforte-maker, Streicher, of which a copy was kindly sent to me, was only A 456·1 before 1859. The transitional pitches, A 433·9 to A 445·1—which last was regarded as a monstrosity—are noted by Scheibler before 1834. Once set the ball in motion and instrument-makers keep it well up. Yet, heightening the pitch of wind instruments does not generally improve their quality of tone; they lose richness and roundness, and incline to scream; and it is continually the wind instruments which force the pitch up.

The Vienna sharpening took some time to spread to Dresden, but Herr Näke, a Dresdener, says that in 1821 the celebrated flutist there, Herr Fürstenau, obtained a sharp flute from Koch, in Vienna. These flutes, with additional keys, were much in vogue, but they drove the orchestra up. However, Dresden did not emulate Vienna; for, as late as 1826, the fork of Kapellmeister Reissiger was only A 435; and, although Näke reports A 446 in 1861, the officials (especially Herr Moritz Fürstenau, the librarian, who has been very kind in helping me) declare that they are all perfectly unaware of such a pitch. They profess to use A 440, but the forks I have measured are one or two vibrations lower, as A 438·9, 439·4, and 437·8. It is, however, often the case that the orchestra, by heating up, plays sharper during performance, as I have just noted. See, for an excellent example, A 449·7, generated from A 445·6 at Covent-garden opera in 1879. This is a good reason for using a comparatively low pitch, for the singer's voice does not sharpen in the same way, but has rather a tendency to flatten as it becomes weary with much singing.

The Austrian influence was, of course, greatly felt in Italy, and in 1845 we find the Italian pitches at Florence, A 436·7; Turin, A 439·9; and at Milan, A 446·6, where it increased in 1856-7 to A 450·3 and A 451·7. In 1869, the information officially communicated to the Society of Arts, gave Vienna pitch (meaning, possibly, A 456·1) to Florence, Venice, and Naples. Bologna, which sent a fork, was flatter, showing only A 443·1. There was, in fact, complete want of agreement.

Although the elevation of pitch took some time to accomplish in Dresden—where it, after all, remained tolerably low—it seems to have proceeded much further and faster in Leipzig, where the celebrated Gewandhaus concerts were held, and where, in 1859, I find A 448·8, and, in 1869, nearly the same, A 448·2. A fork, sent officially from the late Kapellmeister Rietz, from Dresden, to the Society of Arts, in 1869, as the Dresden pitch, A 449·4, seems to have been a Leipzig fork sent by mistake. In Berlin, it was some time before the sharpening influence was felt. In 1806-14, Wieprecht reports A 430·5 possibly an error in calculating an equally tempered A from C 512, instead of MA 428, which would belong to the mean pitch; but I have not been able to see the original statement. Fischer, in 1822, found A 437·3; in 1830, Berlin reached A 440; and, in 1834, according to Scheibler, A 441·6. After this, progress was rapid, and in 1858, A 450·8; in 1859, A 451·8 was reached.

The whole of the German and Italian pitches were thrown back in 1859 by the introduction of the French Normal A 435·4, of which I shall have to speak in the next article.

In France, the pitch rose gradually at first. The Grand Opera was A 434 in 1819, and only A 431·7 in 1822. In 1824, however, a singer, whose voice was failing (Madame Branchu), insisted on restoring the old pitch, A 425·8, and it was five years before the opera returned, in 1829 to A 434. According to de la Fage ("De l'Unité Tonique," 1859, additional notes, p. 7), this recovery of pitch was undesigned. A single horn-player, Jean Mengal, without consulting any one, shortened his horn, and his companions either returned to their old sharper instruments or cut down their new ones. It was another case of sharpening due to a wind instrument. Of course, it is the duty of the conductor to prevent such

freaks, but conductors seem to prefer avoiding squabbles with instrumentalists; and not to care if the singers' voices are strained, and rapidly ruined. A curious thing occurred at this time at the Grand Opera in Paris. The pianos used for rehearsals had been lowered when the pitch of the opera was lowered in 1824, and were not raised when the pitch of the opera was raised; thus, in 1829, we find the pianos at A 425·5, and the orchestra at A 440, both pitches being taken from forks verified by the tuner, Monneron for de la Fage. Finally, in 1856, the Grand Opera was at A 445·8, or A 446·2, and, in 1858, at A 448. The Italian and the Comic Opera had nearly reached the same figure, and the Conservatoire also, A 446·2, according to de la Fage. The provincial French operas were generally high—as Lille, A 450·5, or 452; and Marseilles, A 447—and Pleyel's pianos were at A 446. This pitch began to frighten French musicians, and the French Commission was issued in 1859, of which I shall speak presently. Since that time, French pitch has been, nominally, A 435; what the actual pitch of the opera is, during performance, I have not been able to ascertain, but probably a little higher.

Belgium, which, in 1859, had the sharpest pitch known to the French Commission—namely, A 455·5, which it seems to have used only for military bands; and their director advocated a lower pitch for operas, as (3) A 442·5. The pitch of the Belgian Army bands is now nominally A 451, (the fork actually sent to Dr. W. H. Stone by M. Victor Mahillon was A 451·7, practically identical with Dr. Stone's British Army Regulations A 451·9).

In London, the progress has not been so rapid, and it has been once or twice checked. In 1813, the Philharmonic Concert, opened with A 423·7—that is, in mean pitch—and retained it till 1828. It is supposed to have been fixed by the conductor, Sir George Smart, after a consultation with singers. But, about 1820 to 1826, he altered his fork to A 433·2, which, as he used meantone temperament, gave MC 518·2, or almost exactly the modern French EC 517·8. This became the pitch commonly known as "Philharmonic," and was generally represented by forks sold in music-shops from 1840 to 1846. It was one of these forks (C Philharmonic 518), that Mr. Hopkins used when he examined the pitch of the Lübeck, Hamburg, and Strasburg organs, as I have ascertained by measuring the fork itself (see "The Organ," edition 1870, p. 189, in the chapter on "Pitch;" for the two first, see A 484·1 and A 489·2; I have vainly endeavoured to discover the third, but see under A 376·6.) But, from 1846 to 1854, Sir Michael Costa was conductor at the Philharmonic, and the average pitch then used, as determined from observations by Mr. Hipkins, was A 452·5. In 1874, it reached its highest point, A 454·7, since used as Broadwood's highest piano pitch. But the highest English concert pitch which I have recorded is that at the Wagner festival in the Albert-hall, measured by Mr. Hipkins as A 455·1. Pianofortes have even gone higher; thus, the Erard's fork that I measured is A 455·3; one used by Chappell's tuners, A 455·9; and, though Steinway in England uses Broadwood's and Erard's pitch, in New York he has run up to A 457·2.

The London opera fared differently. In 1857, Bettini's fork, sent to the French Society of Pianoforte-makers, is said by de la Fage to have been measured by Lissajous as A 456·1, which is higher than any modern English pitch now known; so that I think there must be some mistake. Two forks, copied from others used by Sir M. Costa when conducting at Covent-garden Opera, show A 453·4 and A 454·7. A little before 1878, the pitch had been reduced to French at both Italian operas, on the urgent solicitations (and rather more) of Mesdames Nilson and A. Patti. But, in 1878, the fork for tuning the opera at Covent-garden gave A 441·2, and Mr. Hipkins found the harmonium of the opera in that year at A 447·5, and, during actual performance of the band, he measured A 449·9. In 1879, the organ was sharpened to A 445·6. I inquired of Mr. Pitman, the organist, why the pitch had been sharpened; he said that it had been settled at the end of the season of 1878, because the oboe, bassoon, and flute could not be got to play properly to a lower pitch. Moreover, he declared that the singers themselves objected to a low pitch, averring that they could not sing in tune to it. That singers accustomed to high pitch should prefer singing in that pitch is probable, provided that the notes they have to produce do not come too near the extremities of their compass. But, if they were obliged to sing music written for the mean pitch in this high pitch, they would soon cry for transposition in the other direction. The fact remains, that here again orchestral pitch has been raised solely by the obstinacy of players of wind instruments, and without the least regard to the powers of the singers, whom they dragged after them. During actual performance at Covent-garden, in 1879, the organist held A on the organ for half an hour for the instruments to tune to. But, though the organ was tuned to A 445·6, the heat of the house raised it, according to Mr. Hipkins's measurement (made by beats), to A 449·7, which was, therefore, the real pitch of the Covent-garden Opera last season. But, according to the *Athenæum* for 8th November, 1879, the pitch is to be again reduced to the French pitch, A 435·4, on the instance of Madame Patti—"whose voice has deepened considerably of recent years at the expense of her upper register"—a reduction comparable to that of the French opera under Madame Branchu's influence. "M. Lassalle, the eminent baritone," continues the *Athenæum*, "is also said to find the difference of pitch between the Paris Grand Opera and Covent-garden very embarrassing." The management has certainly procured a fork from Paris, which I have measured and found to be in correct French pitch. So the singers have again reduced the pitch!

Of her Majesty's Theatre I cannot speak with the same detail. In 1878, the fork for tuning the organ was A 436·1; but it was, probably, at least A 440 during performance. In the winter season of October, 1879, Mr. Hipkins measured the pitch at A 445·5 during performance, and, in January, 1880, he measured the theatre fork itself at A 444·9.

Modern organs, since mean pitch was thrown overboard, have been nowhere. Most organ-builders, during the transition, put the old flat organs into Sir George Smart's pitch, A 433·2; so

that organs which have not had their pitch adjusted for thirty to fifty years seem to have French pitch, as St. Mary's, Shrewsbury, A 433·6, Fulham Parish Church, A 430·4, and, perhaps, Green's restored organ at Trinity College, Dublin, A 436·8. Most modern organ-builders will build to any pitch. The favourite is about B. Schmidt's low pitch A 441·7, but many build to French pitch for churches, and "band pitch," or about A 450, for public halls and performances, and sometimes even for churches, as Bryceson's organ at St. Michael's, Cornhill. Of course, when the church gets warmed up, the pitch rises still more, and the singers are distressed, as the organist of the last-named church complains. In fact, when we put organs into this pitch, we have, unconsciously, reverted to one of the high church pitches, as A 457·6, the great Franciscan organ at Vienna, and A 454·2, the old Brixton fork. But the music which we wish to perform is not adapted for that high pitch. Except in the last few years, it was written for the mean pitch; so that, properly, all music composed before 1820 should, on such organs, be transposed a semitone down, which would be unnecessarily inconvenient to the organist.

It is, therefore, impossible to say that there is any organ pitch or any orchestral pitch in England at the present moment, Many old organs are at mean pitch; several of them were raised about 30 to 40 years ago to French pitch, as it has been subsequently termed. Some recent organs have been originally so tuned. A few of Bernhardt Schmidt's B *flat* foot organs remain, and many new organs are tuned to this favourite pitch of modern organ builders, but not a few organs, especially those used for concert purposes—as at the Crystal Palace, St. James's and Albert-halls, Alexandra Palace and Royal Academy of Music—are at the highest pitch, A 450·6 to A 455·1. Exeter-hall is a little flatter, A 447·3. The Philharmonic concerts remain at the extremely high pitch. In smaller concerts, much depends on the piano used. Broadwood, Erard, Steinway, all use the sharp pitch for concerts, but Broadwood has a second medium A 446·2, for private, instrumental performance, and keeps French pitch for pianos to accompany private singers. Brinsmead uses the same three pitches. Other piano makers and tuners also use French pitch, as well as the high pitch, and others a so-called Society of Arts Pitch, which should have been A 444, but rises to A 445·7, 448·4, 449·4, 450·3; that is, gradually becomes the High Pitch. The military bands have quite gone over to high pitch, A 451·9, 452·9. The only standard that I know of which preserves mean pitch is that of the Tonic Sol-fa College, formerly A 427·5, but since reduced to A 422·5 or thereabouts, which is the true mean. All the Tonic Sol-fa teachers, however, do not employ this standard, and some use a much sharper pitch.

Such is the very undignified and unscientific position occupied by our own country with regard to musical pitch—a position into which we have drifted without due consideration, and which is the occasion of much practical inconvenience. It is entirely an orchestral or instrumental pitch, due to the makers, especially, of wind instruments, and maintains its ground on account of the expense of changing the instruments—£1,000 is mentioned in the probable cost of the contemplated reduction of pitch at Covent-garden—as if the price of whole orchestras of instruments bore an appreciable ratio to the loss caused by the premature ruin of one great singer's voice!

Art. 28. *The Compromise Pitch.*—The gradual increase of pitch in France—though its highest, A 452 at Lille, was less than our highest, A 455·1 to A 455·9, or Steinway's American A 457·2—alarmed French musicians, and on 17th July, 1858, a Commission was appointed by the then Government, "to investigate the means of establishing, in France, a uniform musical pitch," alleging the increase of pitch to be a great drawback to musical art, from which composers, performers, and instrument-makers all suffered, and the difference of pitch to be a constant source of embarrassment to concerted music and commercial transactions. The Commission consisted of four officials, two physicists, one orchestral composer, and five operatic composers (one of whom, M. Halévy, drew up the report), but no singer, or musical performer or musical instrument-maker of any kind. A translation of the Report, dated 1st February, 1859 (to which I am much indebted, as the original cannot be purchased), is given in the *Journal of the Society of Arts* for 3rd June, 1859. The Commission did not seem to be aware of the former general acceptance of mean pitch. They all agreed that the pitch must be lowered; one wanted to reduce by one-eighth of a Tone, several inclined to a semitone, which would have brought about mean pitch, but the majority were in favour of a compromise, and advocated the reduction of a quarter of a Tone. The actual pitch desired was A 435, and Messrs. Despretz and Lissajous, the physicist members of the Commission, were entrusted with making it. It seems that they really produced A 435·4, which must be considered a very great success. Then, on 16th February, 1859, a decree was issued for its use after 1st July, 1859, in Paris, and after 1st December, 1859, in the departments, for all places receiving Government aid, and the same decree provided for preserving the original fork and issuing stamped copies. This last arrangement has been dropped. How inefficient it was to secure perfectly accurate copies will be seen in Table I., under A 435·4. Whether the use of this pitch is still imperative I do not know, but there is, at least, one standard of music pitch, preserved in the original fork at the Conservatoire, in a form which bids fair to endure. This is one excellent result. Of course, there was a revolution in the construction of French musical instruments, and, at present, French pitch is the easiest one to find instruments for, except in London.

In Germany this compromise pitch met with great favour, and it was adopted at court theatres and some others, but by no means universally. The only place in Europe which had two distinct sets of instruments—independently of the new French—was, perhaps, Dresden. The lower was in mean pitch A 418·1 to A 424, and the higher, intentionally in Stuttgart pitch A 440, but really rather lower, A 438·9, and this the direction of the theatre thought too near to the French to warrant the expense (about £900) of a new set of orchestral instruments. In 1861 and 1862, the direction had three operas—Mozart's "Magic Flute" and "Idomeneus," and Marschner's

"Templar and Jewess"—performed in mean pitch. In consequence of the success of these performances, and partly owing to the exertions of Herr Näke (who, as a teacher of singing, was very anxious to restore mean pitch, the full historical value of which he duly appreciated), a conference was appointed, and invitations were sent out on 5th August, 1862, to the principal German and other theatres, to witness performances in both pitches, and discuss the result. This conference met in September, 1862, and witnessed the performance of Gluck's "Iphigenia in Aulis" and Mozart's "Idomeneus," both in mean pitch, and of Rossini's "William Tell" and Weber's "Euryanthe" in the usual pitch of the Dresden Theatre, and a series of private morning performances in the rehearsal-room of the theatre, consisting of Weber's overture to "Oberon," Mozart's "O cara imagine," from the "Magic Flute;" the *Scena* of Bois Guilbert, in Marschner's "Templar and Jewess;" the trio of the three ladies, "Oh, stelle! soccorso;" and "Vinto è già il mostro," from Mozart's "Magic Flute;" and "Durch die Wälder," from Weber's "Der Freischütz;" all in both pitches, in immediate apposition; and "Che pur aspero," from Mozart's "Seraglio," and the Polacca "Son Vergin Vezzosa," from Bellini's "Puritani," both in the Dresden Theatre pitch only. On 1st October, 1862, several of the gentleman invited met in the theatre, add, after a conference, the following resolution was adopted, with only one dissentient (Herr Näke).

"That a lowering of pitch to the new Paris standard appears equally desirable and satisfactory for singers and for orchestra. That quality of tone would gain, the brilliancy of the band would not be lost, and the power of the singers would not be so severely taxed or strained. That, on the other hand, it was probable that, especially in recent operas and in instrumental music, a further reduction down to Mozart's pitch, as it was called [A 421·5 that is, mean pitch], would injure the brilliancy and effect of the music under the present entirely altered conditions, and, consequently, such a reduction must be rejected as unpractical. That *uniformity*, especially in the orchestral pitch which is to govern the future, must be looked upon as the principal object and chief gain, and consequently, under present circumstances, it was desirable that the Paris orchestral pitch [the compromise pitch, or diapason normal, A 435·4] should be generally adopted in Germany; a course which would be certainly welcome to singers, and be gratefully accepted."

Herr Näke contended that *uniformity* was not the principal point, but suitability and beauty. The principal object to be considered was the singer, and the preservation of his voice. That is, his standard was vocal, not orchestral; which is the reverse of that propounded in the resolution.

The report of this meeting was drawn up by Dr. Julius Pabst, and was signed by Von Koenneritz, general director of the Dresden Theatre; Franz Abt, composer, and Kapellmeister of Hanover; Bernhardt Scholz, Kapellmeister of Hanover; Gerold, director of military music, Hanover; Carl Reiss, Kapellmeister of Cassel; Edward Thiele, Kapellmeister of Dessau; Professor Loewe; Karl Naeke, singing master, of Dresden; Friedrich Kaufmann, acoustician, of Dresden; Lendel, instrument-maker, of Dresden; C. Krebs, Kapellmeister of Dresden (Rietz being too ill to attend); and Franz Schubert and J. Lauterbach, concert masters, of Dresden. Kapellmeister Taubert, of Berlin, was not present at the conference, but expressed his adhesion to the resolution, as did Kapellmeister Ernst Lampert, of Gotha.

The above account is taken from the official lithographed report furnished to musicians present, a copy of which I obtained from the direction of the Dresden Theatre, through the kindness of the librarian, Herr Moritz Fürstenau, and I wish to draw attention to the great importance of the opinion of practical musicians who had had such a remarkable opportunity of forming a judgment. To this list I should like to add the name of Mr. Turle, the venerable organist of Westminster Abbey, whose organ, built by Schreider and Jordans, originally, perhaps, an A foot organ (see A 474·1), had been reduced to mean pitch long before Mr. Turle's time, but, at the coronation of George IV., 19th July, 1821, was "slightly raised by Greatorex," Mr. Turle's predecessor; that is, was put into Sir George Smart's pitch, which was, as we have seen, identical with the French pitch of to-day. At this pitch the organ remained till 1848, when it was renovated and retuned to his own pitch, A 441·7, by Hill. After this long experience of French pitch, and high (not highest) pitch, Mr. Turle adds, "The French pitch is, in my humble opinion, a most sensible one."

It is quite hopeless to suppose that the mean pitch will be again adopted, as, although suitable to classical music, it is not suitable to modern music. It is impossible to transpose a semitone lower in an orchestra, for the violins and wind instruments would be quickly out of their depth, and our stringed instrument players are not likely to slacken their strings a semitone, as the organist of Seville Cathedral assures me that they do there, when playing with the organ. Hence it seems necessary to choose a pitch which, like the French, stands exactly halfway between the two; so that while it exactly suits neither, will do the least violence to either. It is a compromise, and, on the whole, it is always unfortunate to have to resort to compromises. But a compromise is often all that is possible. In the present case, musical compositions written for mean pitch and high pitch must both remain to be used. Instruments for playing in the compromise pitch exist. It was, also, a pitch which was for many years prevalent in England, and there must be plenty of instruments, of 30 or 40 years old suitable to it. It was a pitch used by one of our favourite conductors, Sir George Smart, and has many opinions in its favour. Not that it has remained in Germany, where it seemed to meet with so favourable a reception. None of the Governments of that country really enforced it. When the Society of Arts endeavoured to collect information through the Foreign-office, in 1869, they found it in Munich officially, in Stuttgart unofficially, and, although the older high pitch was much used, in the Court Theatres and Imperial Band, but not in other places in Vienna (and, in 1878, I found A 446·8 even at Vienna, not far from the old sharp pitch A 456·1); in the Duchy of Baden (where even the regimental bands used it); in a few theatres at Berlin (where most bands used a higher pitch), and in the Concert Society of Cologne. In other places, and even in the towns

and countries above mentioned, except in the places specified, the French A 435·4 was not in general use. Beyond France and Germany it seems to have found no favour till it was the other day (18th March, 1879) adopted officially in Madrid, and has been chosen for the coming opera season in Covent-garden.

Immediately after the French Commission had reported, the Society of Arts appointed an influential commitee of 50 members, on 3rd June, 1859, which published a report drawn up by Mr. Hullah. The committee do not seem to have closely investigated the History of Musical Pitch, and its leanings toward C 512 and C 528—which it finally recommended—seem to have arisen rather from arithmetical than from musical feeling. Indeed, in the subsequent debate, Sir John Herschel especially took the arithmetical view of C 512. It is enough to say that there were then no means of tuning C 512 and C 528 exactly, and that even now it is difficult, if not impossible, to meet with forks giving these precise pitches. But, if perfect exactness be not attained, the whole arithmetical charm is broken. Curiously enough, C 512 was approximately attained by Renatus Harris by putting the one-foot pipe with a narrow scale (one-twelfth) on B *natural*, and using meantone temperament; and C 528 was very closely reached by Bernhardt Schmidt by placing the same one-foot pipe with a wide scale (one-tenth) on B *flat*, and also employing the meantone temperament. Harris and Schmidt, and, quite recently, Willis, reached these results much more closely than Mr. Hullah, whose C 512 fork turned out to be C 524·8, or than Mr. Griesbach for the Society of Arts, whose C 528 fork is C 534·46. Such forks can be produced now with much greater exactness, but absolute exactness is Utopian. Every alteration of temperature by 10° F. would destroy it sensibly, even if attained at one mean temperature. Then, again, the arithmetical value of C 528, owing to its representation of the natural intervals of the scale by whole numbers, depends solely upon using Ptolemaic, or Just Intonation, for the major scale of C and no other. Mr. Hullah, who advances this argument in his Report of the Committee to the Society of Arts, is one of the stoutest defenders of equal temperament, to which it has no sort of application. Indeed, by neglecting temperament in the whole of this report, some curious errors have been unintentionally committed. Thus, the Committee, intending to adopt the German A 440, made it identical with C 528; whereas, on equal temperament, A 440 requires EC 523·25; so that, if their A was right, their C was much too sharp; whereas C 528 required EA 444. This involuntary sharpening was enhanced by Mr. Griesbach's errors of A 445·7 and C 534·46; so that the Society of Arts pitch, which was supposed to be but little sharper than the French, actually became one of our very sharp pitches. There is, however, no room for two compromises. The Dresden Theatre, having about A 440, did not require A 435. It would have been impossible to keep a set of instruments in the intended Society of Arts pitch distinct from French instruments. Perhaps, for this reason, the attempt has never been made. The Society of Arts pitch has been absorbed into our high pitch, and the only recognised compromise is the French Diapason Normal.

Art. 29. *Conclusion.*—I have thus endeavoured to sketch the History of Musical Pitch from 1361 to 1880. I distinguish, first, the Early Church Pitch, which was, at the same time, excessively low and excessively high, for the same reason, the exigences of ecclesiastical music, as interpreted by the human voice and the foot-rule of the country. Secondly, the Early Chamber Pitch, where the exigences of secular music made themselves felt, and the pitch was taken at intervals of the scale above and below church pitch, to allow of the instruments and organ playing together. Thirdly, the Influence of Chamber upon Church Pitch made itself felt by the construction of organs in chamber pitch. Fourthly, the construction of organs in chamber pitch led to the proposal and very general adoption of Mean Pitch for both church and chamber. To Herr Näke is due the merit of pointing out the great importance of this pitch, as having been used by the classical writers of music; and to his labours and collections (through the kindness of his widow) I am under great obligations. But he had not gone back to a period earlier than 1714, and hence had been unable to see how Mean Pitch arose; so that I consider the establishment of this pitch, and its relation to earlier usage, one of the chief results of my own investigations. Fifthly, the predominance of instruments over voices, brought about the gradual abandonment of mean pitch, and the introduction of Orchestral Pitch, which, since 1876, has led to all the modern confusion of pitch; due, not to any preconcerted arrangement, but often to accidental circumstances, such as the presentation of new instruments to a regiment, the acquisition of a new flute, the cutting down of a horn, the persistence of oboes and bassoons in playing sharp, and the expense of acquiring flatter instruments, but in all cases to the elevation of instruments above voices, that is, to orchestral motives. These alterations I trace in England to the present day, and abroad till 1859, when we arrived, sixthly, at the Compromise Pitch of the French Commission, which proposed, and in France actually carried out, a pitch which lay halfway between the Classical Mean Pitch and the modern high pitch; and I trace, in some degree, the consequences of this introduction, and endeavour to show, by the results of the Dresden Conference, that it is the only available pitch in which both modern and classical music can be executed.

But this history consists merely of my own inferences on the large series of facts which I have partly collected from others, and partly for the first time myself discovered and published. Having shown the bases on which all these pitches have been calculated, I do not think that subsequent investigation will discover any practical error—say, any error amounting to one vibration in two seconds—in the measurements themselves. The only doubt attaches to the scale, force of wind, voicing, temperature, and crowding of certain organ-pipes, as already pointed out. These facts, then, must, I believe, form the bases of all subsequent examinations on the subject. I wish they were more complete, but the difficulty of getting information is, sometimes, exceedingly great, and the time spent over obtaining a single pitch has often been so long that I

should despair of living for years enough to render my investigations really complete. A personal examination of all existing old organs throughout Europe, with visits to all great organ-builders for isolated pipes, to makers of musical instruments, to physical cabinets, and amateurs who have inherited forks, would be necessary to complete the history. I could only accomplish a small portion of this work, but the collections I have made, and present in the following tables, will enable any successors to insert their own observations by the aid of the forks which I have made purchasable, and, after my death, of my own forks, which I shall take care to make available for their use at some public institution, warned by the great loss the world has sustained by the disappearance of Scheibler's own fifty-two fork tonometer.

The two following Tables, containing the record of these facts and their authentication, really constitute my paper, and I hope they will be accepted as a sufficient reply to the objection which was very reasonably urged against the extremely insufficient account of early musical pitch in my former essay.

It is rather important that a modern should be able to realise some of the principal effects of these great changes of pitch. As regards the very gradual transition from the lowest mean to the highest orchestral pitch, which is nearly a Tone, working by very small degrees, the only feasible plan seems to be to use the human voice, pitched to different standards by properly prepared tuning-forks, as those which I used for determining the compass of the voice. But the general effect of the main difference between old and new pitch may be well illustrated by a piano tuned to Broadwood's medium pitch and in equal temperament, which is indispensible for accurate transposition, such as I have here. This is almost precisely an equal semitone sharper than Handel's pitch. Mr. Hipkins will now kindly play a very well-known air by Handel, "See the Conquering Hero comes," originally written in G, in the pitch at which Handel heard it; that is, by transposing it to G *flat* on this instrument. This is, therefore, the classical pitch. Now, descending a tone—that is, transposing to E natural—we have the same air in Schlick's low pitch, which was also the old French; that is, the lowest church pitch. Ascending by a fourth—that is, by five equal semitones, and hence playing in A natural—we have the same air in Schlick's high pitch, and as it would have sounded on the Halberstadt organ, or in Mersenne's *ton de chapelle*; while, by giving a tone higher or, playing in B, we reach Mersenne's *ton de chambre* and Prætorius's high pitch, which may, possibly, have been the pitch for which Orlando Gibbons wrote (see A 567·3). Reverting, for a few bars, to Handel's own pitch, or G *flat*, on the instrument, just to refresh our ears, we sink a semitone, to play in F at the pitch of the organ at Trinity College, Cambridge, when Dr. Robert Smith was master. Then, ascending a Tone, or playing in G, we have very nearly the effect of the same organ as Bernhard Schmidt built it, in his low pitch, before the pipes were shifted; and this is the natural pitch of the present piano. One semitone higher, or playing in A flat, gives us Tomkins's and Bernhardt Schmidt's high church pitch, as in the oldest form of the Durham organ. Now, you have listened to these seven varieties, feeling them to be, as they were played, mere transpositions. But you must recollect that they would have been all written by the same notes, and played with the same finger-keys on the organs of these different times. They are not an air transposed. They are the different sounds attributed at different times to the same symbols, just as the different nations of Europe now utter different sounds to represent the same Arabic numerals.

In the two following Tables, you will find many pitches which differ by only one or two tenths of a vibration, and others by only one or two vibrations in a second. Such pitches are practically identical. It is scarcely possible to keep apart pitches which differ even by a comma, or V 1 in V 80. But twice that amount is very perceptible indeed. And, when examining a long series, if two pitches which differed so slightly were confounded, considerable mistakes of grouping might have been committed. I have, therefore, given every pitch as accurately as I found it described, or could determine it myself, up to V 0·1 and S 0·01, both of which limits are beyond the power of the human ear to appreciate when two notes are struck in melodic succession, although they can be readily rendered perceptible mechanically. And I have throughout purposely relied only on mechanical evaluation, to the exclusion of mere estimation of ear, which I could not have trusted at all in my own case, and which I have not unfrequently, but quite unexpectedly, found decidedly defective, even in persons of undeniable fineness of perception; more especially in the estimation of the extent of musical intervals and the recollection of musical pitch. And I trust that the great length of my Tables will be excused on the ground of the musical importance of the facts which I have been enabled for the first time to bring together and appreciate.

TABLE I.

Historical Musical Pitches, proceeding from Lowest to Highest.

ARRANGEMENT.

Tuning A.—The pitches are arranged according to the value of 2 A; where possible, this 2 A has been measured direct; where some other note only could be measured, the 2 A has been calculated according to the (M) meantone, (E) equal, or (J) just intonations. All three are always calculated, but that one is placed first which is considered to have been most probably in use at the time, and the rest are added in square brackets. The corresponding 1 C, when not measured direct, is also given in all three intonations. In every case, the note measured direct is annexed, with its name alone, as A, C, F, &c., without any qualification but the mark of its Octave MA, MC; EA, EC; JA, JC; therefore, without the mark of the Octave, are always calculated tones.

Pitch.—After the letters giving the names of the notes follow the numbers of double vibrations in a second, to the nearest tenth, or one place of decimals (the number of tenths, therefore, follows the inverted period, and the number of double vibrations precedes it). For continental measures, all these numbers must be doubled to give single vibrations; thus, A 435 is called *La* 870 v.s. in Paris. When several pitches are identical, they are placed in order of date, and marked (1), (2), &c. It must be particularly observed that all pitches, especially of organs, have been reduced, as far as lay in my power, to 59° F. = 15° C. = 12° R. Unfortunately, other observers seldom indicate the temperature, but pitches of organs are generally supposed to be taken at spring and autumn mean temperatures.

Intervals between Pitches.—After the pitches follow S (meaning equal semitones) and a number, showing by how many equal semitones (preceding the inverted period) and hundredths *of* a semitone (following the inverted period) the A at the commencement is sharper than the zero or lowest A 370. Thus, A 444·7, S 3·18, shows that the pitch for which A makes 444 double vibrations and seven-tenths of a double vibration in a second is three equal semitones and 18-hundredths of an equal semitone sharper than the zero pitch A 370. By subtracting the S of one pitch from that of another, we find how much sharper one pitch is than the other. Thus, A 435·4, S 2·82, is (S 3·18 less S 2·82, or S 0·36, that is), 36-hundredths of an equal semitone, flatter than A 444·7, S 3·18. The rule for finding S from the number of vibrations is given in

footnote 4 to Art. 5 of the paper. As the tenth of a vibration is often less than the hundredth of a semitone, several pitches will often have the same S.

OBSERVERS.

The name in a parenthesis immediately following S is that of the observer who measured the pitch of the note in question. When only one pitch is due to a given observer, he is sufficiently described in the note on that pitch.

Cagnard de la Tour (Charles), baron, French Physicist, b. 31st March, 1777, d. 5th July, 1859, inventor of the Siren, employed his instrument to measure several pitches, here given on the authority of others, who are always named. The siren was first described by him in the "Annales de Chimie," vol. xii., 1819, pp 167-171, and was much improved by M. Aristide Cavaillé-Coll.

Cavaillé-Coll (Aristide), born at Montpelier, Department of Hérault, 4th Feb., 1811, established at Paris 1833, where he still resides, and has been long celebrated for the extreme perfection of his organ work. He determines pitch by means of copies of Scheibler's forks. I have been greatly indebted to him for assistance in every way. His little work, "De la Détermination du Ton Normal," 1859, and his "Etudes Expérimentales sur les Tuyaux d'Orgues," Comptes Rendus, 1860, p. 176, have been very useful to me.

de la Fage (Adrien), a musical writer and critic, author of "De l'Unité Tonique," 1859, intended to influence the decision of the French Commission but published too late, with additional notes, and an excellent table of pitches, which has been of great service to me.

Delezenne, died at Lille, August 20th, 1866, meteorologist and acoustician, author of numerous papers on the acoustics of music in the "Mémoires de la Société des Sciences à Lille," 1826 to 1857, of which the most important in relation to pitch is his memoir "Sur le Ton des Orchestres et des Orgues," second series, 1854, p. 1, to which I have been greatly indebted. M. Delezenne worked with a peculiar bowed monochord tuned to Marloye's V 128, and obtained pitches of organs by tuning forks with sliders, measuring the forks afterwards by this monochord (see Art. 13 above). I have great confidence in his results.

De Prony (G. C. F. M. Riche), baron, French engineer and mathematician, b. 1755, d. 1839, proposer of the system of reckoning intervals by equal semitones and fractions (which is identical with my S, but I have not been able to see his work on acoustic logarithms). He gives two pitches in his "Mécanique Analytique," Part II., 1815, p. 495, obtained by means of Euler's formula.

Drouet, Kapellmeister to the Grand Duke of Saxe Coburg-Gotha, cited by the French Commission, is stated to have sent them three tuning-forks, but the measurements were probably taken in Paris. I have not seen any memoirs by him. His pitches are cited from the French Commission.

Ellis, the author of this paper. Where my name is affixed, it means that I am responsible for the measurement, unless otherwise stated.

Euler (Leonhardt), the celebrated Swiss mathematician and physicist, b. 1707, d. 1783, gives two pitches, incidentally discussed below, A 418 and A 392·2; but I attach no great value to them.

Fischer (Ernst Gottfried), physicist, measured four pitches with great care by a weighted monochord. Berlin; Abhandl. 1822-23, pp. 187-216.

French Commission.—This is the Commission of 1858-9, which settled the Diapason Normal. The anonymous measurements given at the end of their report are probably due to MM. Despretz and Lissajous, and were possibly made with the siren, assisted by M. Cavaillé-Coll's bellows of precision. I was unable to find any of these forks in Paris (except those sent by Messrs. Broadwood), so that they had been, probably, all returned, and it was impossible to verify the pitch. But, in the case of the three forks of Broadwood, some mistakes were certainly committed.

Hill (Thomas), of the firm of Messrs. Hill and Sons, the eminent London organ-builders. Mr. T. Hill has been of great assistance to me in many ways, by allowing me to measure on his bellows old organ-pipes which he had preserved from organs he had altered, by informing me of the sharpness or flatness of several organs he has restored of which no pipes existed, and by kindly making and presenting to me ten pipes of which the measurements had been furnished by old writers. Great part of my success has been due to this valuable assistance.

Hipkins (A. J.), of Messrs. J. Broadwood and Sons, a musician, and a writer on musical instruments, who introduced equal temperament into Broadwood's in 1844-6, and who has constantly been engaged in noting, and recording on forks, important varieties of English pitch. To him I owe the loan of many important forks belonging to himself and others, which I have measured myself, and also several pitches which he took by beats with other forks that I had measured. In every possible way throughout my work, Mr. Hipkins has lent his valuable assistance to me with the utmost kindness and readiness.

Lissajous (Jules Antoine), born 1822, the eminent French physicist, inventor of the optical method of examining musical intervals, a member of the French Commission, and especially commissioned, with M. Despretz, to superintend the construction of the Diapason Normal. The pitches attributed to him are, if possible, cited from his original memoirs, or from the Report of the French Commission, but many of them are given solely on the authority of de la Fage.

McLeod (Herbert), Professor of Physics at Cooper's-hill College, joint inventor (with Lieut. Clarke) of the optical process for measuring tuning-forks, as described in Art. 15 above. I am greatly indebted to him for his verification of Scheibler's tonometer by re-measuring sundry forks for me.

Marpurg (F. W.), German musician, b. 1718, d. 1795, determined some pitches by the weighted monochord, one of which I have found in his works, and the other I have to give on the authority of the French Commission.

Naeke (Carl), Professor of Singing at Dresden, author of a pamphlet, "Ueber Orchesterstimmung," privately printed for the Dresden Conference in 1862, and presented to me by his widow, who also kindly sent me several of the valuable forks which he had collected; so that I was able to verify his measurements, which I found extremely accurate. I am greatly indebted to Herr Näke's work.

Sauveur (Joseph), b. 1653, d. 1716, an eminent French acoustician, who has left us some doubtful pitches, discussed under A 406·6.

Scheibler (Johann Heinrich), born 11th Nov., 1777, died 20th Nov., 1837, to whom we owe the conception and execution of the Tuning-fork Tonometer described in Art. 18 above, left a record in his "Tonmesser," 1834, of several valuable pitches measured by himself, all of which have been used, and are, probably, perfectly accurate.

Schmahl (H.), organist of St. Jacobi Kirche, Hamburg, who has copies of Scheibler's forks for tuning in equal temperament to A 440 and A 445, together with his A 420 and A 430 for determining pitch. By the help of these and other forks, he determined numerous pitches for me. To Herr Schmahl I am also indebted for many references to older German writers on music, especially Praetorius, with which he is well acquainted. His assistance has been very valuable to me.

Smith (Robert), D.D., mathematician, born 1689, elected master of Trinity College, Cambridge, 1742, died 1768, author of a work on "Harmonics," 1749 (second edition, 1759; and postscript, 1762), discovered the law of beats of disturbed consonances, and used a weighted monochord to measure the pitch of his organ. (See A 441·7 and A 395·2.)

Wieprecht, —, cited by the French Commission, must, I suppose, be the director of military music in Prussia of that name, who, as the Commission states, sent them a masterly letter on the subject. I have been unable to find any memoirs by him.

Wölfel, —, mentioned by M. Cavaillé-Coll as having constructed a tuning-fork tonometer on the model of Scheibler's, without any other assistance but Scheibler's pamphlet, and quite as accurate as Scheibler's. It took him two years to construct it.

DATE.

This gives the date of the fork, or of the instrument measured, as nearly as can be ascertained, when it is probable that the pitch has not been changed. Organs have been frequently altered in pitch. Old forks can often only be conjecturally assigned to their date. The date of altered organs is either that of their last change, or of the time of measurement. The letters *a*, *c*, *p* after a date mean—*ante*, before; *circa*, about; *post*, after. Thus, 1800*a* means before 1800, how much before unknown; 1800*c* means about 1800, before or after; 1800*p* means after 1800, how much after unknown. But *a* sometimes means before and up to, and *p* sometimes means from and after.

PLACE.

The town, and, if possible, the peculiar institution (opera, conservatoire, &c.) or instrument measured are next given.

PARTICULARS.

Then follows as good an account as can be succinctly given of the means of determining or inferring the pitch employed, so that the reader may judge of its trustworthiness.

HISTORICAL PITCHES.

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1. *Church Pitch, Lowest.*

A 370, MC 442·6 [JC 443·9, EC 440·0], S 0·0. (Ellis.) Ideal pitch, lower than any found in practice; used, therefore, as a zero point from which to measure the intervals of all other pitches in hundredths of an equal semitone. Considered as equally tempered, it gives EC 440, which shows that it is almost precisely an equally tempered minor third below A 440·2 in that temperament; that is, below Scheibler's pitch adopted by the Stuttgart Conference.

MA 373·1 [EA 375·4, JA 372], C 446·4, S 0·15. (Delezenne.) Mean of 11 attempts to measure the pitch of an open wooden pipe 1·3 metres long; height of mouth, 16 mm.; section, 86 mm. by 72 mm.; constructed by Delezenne to determine the pitch of a pipe of 4 pieds de roi. The mean of 11 measures gave 111·594 as the pitch of the pipe. Delezenne does not say what was the temperature, or on which side the mouth was placed. Compare A 373·7, 374·2, 376·6.

MA 373·7 [JA 372·5, EA 375·9], C 447, S 0·17; pressure, 3¼ in. (Ellis.) 1648, Paris. Mersenne ("Harmonicorum," lib. I., prop. xxi.) gives, as the dimensions of the "lowest pipe of an organ which he had at hand," 11½ Fr. inches (= 318·07 mm.) in length, and 1½ Fr. in. (= 40·61 mm.) in diameter, and stopped. If Mersenne, as is probable, took only the outside measures, we must

allow 1 mm. for the thickness of the cap, and 2 mm. for the double thickness of the tube. This would make the real dimensions 317·07 mm. in length and 38·61 mm. for the diameter. I had an open pipe constructed, 318 mm. long, and 38 mm. in diam., which would, of course, give the octave above a stopped pipe of the same dimensions, and it spoke V 446·26, 447·1, 448·1 under pressures of 2½, 3½, and 4 inches respectively. Multiplying these numbers by 1144 (= 3 × 318 + 5 × 38) and dividing by 1157·26 (= 3 × 318·07 + 5 × 40·61), or 1144·26 (= 3 × 317·07 + 5 × 38·61), we can find what the pipes of the other dimensions would speak. (See rule, Art. 8, and footnote 5) We get, then, for the outside measures, V 441·1, 442, 443; and, for the inside measures, V 446·2, 447, 448 at the three pressures respectively. Considering that Mersenne, who was very inaccurate, measured outside, so that the reduced inside measures are more correct, and that the pressure was more likely 3½ inches, I assume V 447 as most likely to be the pitch of the pipe. This so nearly agrees with Bédos's A 376·6 that there can be no doubt that Mersenne's stopped pipe was intended to be in unison with an open organ-pipe of two French feet. But what note did it represent? It might be 4 F, 4 G, 4 B, or 2 C, as the two-foot pipe was used in all these senses in France. Here I have assumed 1 C 447, that is, the four-foot pipe, as V 111·75, which agrees very closely with my measures of Bédos (see A 376·6) and with Delezenne's measurements (see MA 373·1). In the other cases (see A 402·9,503·7, 563·1), I assume Bédos's measure as being probably more accurate. To show Mersenne's inaccuracy, I may mention that, in the very place where he gives the dimensions of this pipe, he says that it is of the same pitch as a brass wire ½ French line (= ·45 mm.) in diam., 9 Fr. inches (= 243·62 mm.) in length, weighing very nearly *(proximè)* 8 French grains, and stretched by a weight of 6½ Fr. pounds, each containing 9,216 Fr. grains. Then, by the rule Art. 13, note 6, we find V 276·8 in place of V 223·3. Again, from this string, Mersenne's own calculations should give V 200; but he immediately writes 150 in place of it, and continues to use the latter number. Again, in his "Harmonie Universelle" (livre iii., "Des Mouvements et du Son des Chordes," p. 169), he gives V 84 to the 4 Fr. feet pipe; but, in another place *(ibid.*, livre iii., "Des Instruments à Chordes," p. 143), he gives V 96, which he employs in his general table, p. 142 (where there are many misprints), and then, in a corollary to the first proposition, he notices the discrepancy (which amounts to more than a Tone), and says it is of no consequence, for people should repeat his experiment, and take what number suits them. The numbers in his table, p. 142, should be increased by at least 17 per cent.

MA 374·2 [EA 376·3, JA 373·6] C 447·5, measured 4 C 112·7, S 0·19. (Delezenne.) 1700*c*, Lille. Dilapidated small organ of L'Hospice Comtesse, the torn bellows modern, the date a conjecture by M. Mazingue (see A 384·3). There is no front, no date, no signature. The C of the principal is a square-stopped pipe, 610 mm. long (deducting thickness of cover), section 75 mm. by 58 mm. It is made of oak, and speaks badly. Beats slightly with the experimental pipe described in A 373·1. Temperature not stated.

MA 375·2 [JA 373·9, EA 377·3], C 448·8, S 0·24. (Näke.) 1714, Germany, Saxony. Chamber Pitch, according to Näke, reckoned as a whole meantone flatter than the Freiberg Cathedral organ. I think this conjecture of Näke's to be probably erroneous (see A 415·5 and 419·5).

MA 376·6 [JA 375·5, EA 378·8], C 450·5, pressure 3½ in., S 0·31. (Ellis.) 1765, Paris. Dom Bédos ("L'Art du Facteur d'Orgues," p. 77), gives a table, from which it may be calculated that his 1 C of the *prestant*, or tuning stop, was 324·84 mm. long, and 28·08 mm. in diameter (the measurement on the plates is something less, owing to the shrinking of the paper, which he estimates at 1 in 72). I had a pipe constructed 326 mm. long and 27 mm. wide, which spoke V 450·1, 451·3, 452·5, under pressures of 2½, 3½, and 4 inches respectively. Multiplying these numbers by 1113 (= 3 × 326 + 5 × 27) and dividing by 1114·92 (= 3 × 324·84 + 5 × 28·08), according to the rule, Art. 8, we obtain for Dom Bédos's pipe V 449·2, 450·5, 451·7, under these three pressures respectively, and these taken as C give MA 375·6, 376·6, 377·6 respectively, of which I select the second as most probable, and have calculated the above numbers from it. Bédos particularly rejected equal temperament as "dure et moins harmonieuse que l'ancienne" *(ibid.*, p. 429). This would give for the 4-foot pipe V 112·6. Compare Delezenne's V 111·6, under A 373·1. It does not follow that this was really Bédos's pitch, for he directs it to be brought to the church pitch, which he says was constant in France, but it could not well have differed more than a comma (at this pitch V 1·4 for the 4 C), compare A 373·1, 373·7, 374·2. This is S 2·51, or only a quarter of tone less than a minor Third, below the present French normal pitch. The Rev. Sir F. A. Gore Ouseley tells me (letter, 16 May, 1878) that "in France, when Dom Bédos wrote, the "Ton de Chapelle" was about a minor Third *below* the present French normal pitch," and that "most of the old *untouched* organs in the French Cathedrals are of this low pitch." Mr. Hopkins ("Organ," ed. 1870, p. 191) says that "of the three fine organs built by [A.] Silbermann [at Strasburg], those in the cathedral, finished 1716, and that in the Protestant church, proved on trial, in 1853, to be *a whole tone below* the pitch of" that fork he had with him, and which I have measured as C 518, that is Sir G. Smart's pitch (A 433·2), or, as we should now say, French pitch. I have not succeeded in getting the Strasburg pitch, but this indication, if taken strictly, would give A 387·5, and the probability is that as Strasburg was then (Aug. 1716) a French city, the old French pitch was used, either the present (Bédos's) A 376·6, or the higher Versailles A 395·8, either of which would sound a Tone flat. Delezenne says ("Lille Mem.," 1854, p. 12) that at Gonèse, near Paris, the longest show-pipe was 2·60 mètres or eight French feet long, which would make it of this pitch. It will be observed that this pitch is almost exactly a whole tone below Handel's A 422·5. Sir F. O., in the letter already quoted, says, "I have seen a fork of the period [O. Gibbons's], said to have belonged to Adrian Batten [organist of St. Paul's in 1624, and a composer], which was more than a whole tone below Handel's fork. It was in the possession of a music-seller of Newcastle in 1839 or 1840." This is the only indication I have of so low a pitch in England.

MA 377·0 [JA the same, EA 380], MC 451·0 [JC 452·5, EC 451·9], 2 F 391·6, S 0·33, pressure 3½ inches. (Ellis.) 1511, Germany, Heidelberg. Arnold Schlick (Art. 22, n. 8) recommends that the lowest note of a small organ should be 8 F, and that the pipe should be 16 times the length of a given stroke, which his editor measured as 4½ Rhenish inches. This makes the length of 8 F pipe to be 6½ Rhenish feet = 2040 mm. He says nothing about the diameter, and I have supposed it may be one-sixteenth, one-thirteenth, or one-twelfth the length. Then a pipe of a quarter the length and diameter would be 510 mm. long, and 32, 39·23, or 42·5 mm. in diameter respectively. I had a pipe constructed, 510 mm. long and 42·2 mm. in diameter, which spoke V 291·8, 292·8, and 293·8 under pressures 2½, 3½, and 4 inches respectively. Now three times the length, added to five times the diameter of this pipe, and of the three other conjectural pipes, are 1741, 1690, 1726·2, and 1742·5 respectively. Hence, by rule Art. 8, dividing the V at the different pressures by the three last numbers respectively, and multiplying by the first, we obtain the following V for the three kinds of pipe: at 2½ inches, 300·6, 294·3, and 291·6; at 3½ inches, 301·6, 295·3, and 292·6; and 4 inches, 302·7, 296·3, and 293·6 respectively. These, taken as F, give respectively for A considered a just major Third higher, for the three kinds of pipe: at 2½ inches, A 375·8, 367·9, and 364·5; at 3½ inches, A 377·0, 369·1, and 365·8; and at 4 inches, A 378·3, 370·4, and 367·0. These numbers show about the limits of uncertainty. But as I consider it probable, from an examination of Bédos's proportions, that this 8 F had a diameter about one-sixteenth of its length, I have selected A 377 as the most probable pitch, and calculated the above accordingly, choosing the meantone temperament, because it cannot have differed materially from that which Schlick himself recommends. Schlick, however, also allowed this pipe to stand for 2 C, which will therefore be C 301·6 on the same supposition, (see MA 504·2).

2. *Church Pitch, Low.*

A 384·3, MC 459·7 [EC 457·0, JC 461·1], S 0·66. (Delezenne.) 1700*c*. Old Fork found before 1854 in an old iron shop at Lille by M. Mazingue, composer and organ-builder. It sounded so badly that it could only be heard for a moment when placed close to the ear. The stem is large and without a button. Delezenne says that, as a major Second, above V 384·3 is V 432·3, "of the violins of Stradivarius, we may conjecture that it was a century and a half old. It is also perhaps the fork used to tune St. Sauveur" (see A 384·6). He does not give his authority for the A 432·3 of Stradivarius. It would seem as if he assumed C 256 as the pitch of the resonance of a Stradivarius violin (on which see above, end of Art. 26), and then taking 4 C 128 to be in consequence the lowest note of the viola, reckoned 3 perfect Fifths up; giving 2 A 432, which see. It is difficult to see how the fact of a fork being a whole Tone flatter than the supposed pitch of Stradivarius should lead us to assign it to his date.

A 384·6, EC 457·2 [MC 460·0, JC 461·5], S 0·69. (Delezenne.) 1851, Lille. Organ of St. Sauveur, rebuilt at this date, but pitch probably nearly preserved. It belongs to the same class as A 384·3. (See A 432·2.) Equal temperament was probably adopted in 1851.

A 392·2, MC 466·14 [EC 469·1, JC 470·6], S 1·00. (Euler. "Tentamen novæ Theor. Mus.," cap. 1, §§ 8, 9, and 10, pp. 6 and 7, giving the theory of determining the rate of vibration of a string.) 1739, St. Petersburg, Clavichords (according to Marpurg.) Euler gives as an example, length of string 18·067 English inches, weight of string 6·2 grains, stretching weight 46·082 grains, whence (by the formula in Art. 13.) V 196·1, and observes "huic autem sono congruere deprehendi clavem signatam a." He does not say whether this is any particular pitch, or whether it is organ pitch or concert pitch, or Russian or German pitch. Hence it is quite indeterminate.

(1) **MA 395·2** [JA 393·9, EA 397·5], MC 472·7 [JC 469·8, EC 470·8] D 528·5, S 1·14. (Dr. R. Smith, Cambridge.) 1759. Trinity College Organ built by Bernhardt Schmidt 1708, after it had been new voiced, and by altering the disposition of the keys depressed a tone lower and thereby reduced to the Roman Pitch, "as I (Dr. R. Smith) judged by its agreement with the pitch pipes made about 1720." (R. Smith, "Harmonics," second edition, 1759, p. 148). For the calculation of the D see MA 441·7. It was measured by means of a weighted wire brought into unison with a lower Octave. Mr. C. A. Bishop informs me that he has "cut down a Father Smith chamber organ to Smart's pitch," that is, to A 433·2. It is possible therefore that B. Schmidt made chamber organs in this low pitch himself, which would be a minor Third flatter than his sharpest pitch, A 474·1. This organ to which Bishop alludes may, however, have been only in Handel's pitch, A 422·5, or may have been previously lowered.

(2) **MA 395·2**. (Dr. R. Smith.) Rome, 1720, from pitch pipes compared with organ of Trinity College, Cambridge, in 1759, see A 403·9 and preceding entry.

A 395·8. MC 478·5 [JC 475·0, EC 470·7], S 1·17. (McLeod and Ellis.) 1789, France, Versailles Organ. Copy (compared with the original, which is in good condition) of a fork (No. 410 of catalogue) in the Musée du Conservatoire at Paris, which belonged to the Abbé M. C. Roze (1745-1819) who was librarian of the Conservatoire during tho twelve last years of his life. It gives the A of the chapel of the palace of Versailles in 1789. M. Cavaillé-Coll, who compared the copy with the original, considers it to be perfectly authentic, because about ten years previously, when repairing this organ, he had noticed that its pitch was about a Tone (actually 1·65 eq. sem.) lower than the ordinary French pitch. The temperature at which the pitch was taken is not known, probably a mean temperature would have been chosen. The original fork is four inches from bend to point inside, and the prongs are three-eighths of an inch apart at the end of the bend, and three-sixteenths of an inch at the end of the prongs, stem flat at end; rusty in some places, but not very much. This organ was built by Charles Dallery and François Clicquot.

MA 396·4 [JA 395·1, EA 398·7], C 474·1, pressure 3¼ inches, S 1·19. (Ellis.) 1615, Palatinate of the Rhein. Solomon de Caus ("Les Raisons des Forces Mouvantes," Franckfurt A.M. 1615, Liv. 3me., traitant de la fabrique des orgues) fixes the F pipe as 3 feet and the C pipe as 2 feet Rhenish. I take, then, the 1 C pipe as one Rhenish foot (= 313·85 mm.) in length, and assume the diameter to be one-twelfth the length (= 26·15 mm.) as in B. Schmidt's B *flat* (see (1) A 441·7.) I had a pipe constructed 315 mm. long and 25·5 mm. in diameter, which spoke V 472·85 and 474·04 under pressures of 3¼ and 4 inches respectively. Correcting according to the rule Art 8, by multiplying by 1072·5 (= 3 × 315 + 5 × 25·5) and dividing by 1072·3 (= 3 × 313·85 + 5 × 26·15) we obtain C 472·9 and 474·1 respectively, whence MA 395·4 and 396·4 respectively; and selecting the last pressure as most probable, we obtain the above numbers.

A 398·7. EC 474 [MC 476·9, JC 478·4], S 1·29. (Delezenne.) 1854*a*. Lille, old organ of La Madeleine restored.

3. *Chamber Pitch, Low.*

MA 402·9 [JA 400·4, EA 401·3], MA 482·0 [JC 480·5, EC 477·3.] B *natural* 450·5. S 1·48. (Ellis.) 1648, Paris, Mersenne's spinet. In the diagram which he gives [De instrumentis, lib. i., prop. 41] the keyboard begins with B *natural*, and (Harmonie Universelle, lib. iii., des instruments à chordes, p. 143) he says that the lowest string is in unison with the 4 foot pipe, for which I take Bédos's value (see A 376·6, and A 373·7.) In Germany Praetorius makes almost all the old organs begin with B *natural* (Syntagma Musici, vol. 2, p. 112).

MA 403·9 [JA the same, EA 407·1], MC 483·2 [JC 484·7, EC 484·1], 1 F 646·2, S 1·52. (Ellis.) 1730, Padua. Copy made for me, under the direction of Prof. Rossetti, of the old lower F fork preserved in the bell foundry Colbacchini of Padua (see A 425·2 for references.) This is the nearest approach to Dr. R. Smith's Roman pitch-pipe (see (2) A 395·2) which I have found in Italy. It is nearly a semitone flatter than Colbacchini's pitch-pipe, and hence could not have been Zantedeschi's F, which he found to be a semitone sharper than these pipes.

MA 406·6 [JA 405·2, EA 405·8], MC 486·4 [JC 486·4, EC 482·6], 4 E 152, S 1·63. (Sauveur, "Mém. de l'Académie Française," 1713, p. 335.) Sauveur made many attempts to determine pitch, giving C 487 (whence MA 407·1), and A 408, as well as the present pitch. The C 487 is derived from V 121·75, which he obtains from his formula for the number of simple vibrations of a string, 40 Paris inches (42·631 Eng. inch) long, weighing 20½ grains French, and stretched by a weight of 92·160 grains, the whole length of the string between the bridges being 67 Paris inches (which is indifferent.) By the formula Art. 13, n. 6, this gives only V 101·3, a very serious difference, so that there must be an error somewhere. In 1700 he considered the 5 (French) foot pipe to give 100 vib., but he corrects this in 1713 to 102, which he identifies with the lowest A of the clavecin, thus reaching A 408. Sauveur, in 1700 ("Hist. Acad.," pp. 134-143) wished to make the five foot pipe his standard of 100 vibrations. In his final memoir of 1713, he says that he made several experiments on four different days, in 1699, 1700, and 1704 at the works of the organ-builder Deslandes, in presence of Father Sebastien Truchet, and many others, using organ pipes of four and two feet, and that he found the E below the key of F-ut-fa made V 152. From this he calculated JC 243·4, and I have calculated the above. We have therefore from Sauveur, MA 407·1, A 408, MA 406·6, which agree fairly well, and also agree with Taskins' fork A 409, which see. It is to be observed that Sauveur mentions no particular clavecin, or organ, or opera, so that his results can only be looked upon in the light of experiments. On Sauveur's methods see end of Art. 17.

M 407·1. C 487. (Sauveur.) See A 406·6.

A 407·3. EC 484·31 [MC 487·2, JC 488·9], S 1·66. (Delezenne.) 1854, Lille. Organ of St. Maurice, repaired. Apparently an old pitch preserved. It is exactly an equal semitone higher than Mazingue's old fork, A 384·3.

EA 407·9. C 484·8 [EC 485·0, MC 488·0, JC 489·5], S 1·69. (Schmahl and Ellis.) 1762, Germany, Hamburg. St. Michaelis Kirche, organ built (1681-99) by Hildebrand, of Dresden, under the direction of Handel's early friend, J. Mattheson, the composer, who contributed 44,000 marks banco = £3,221 3s. 4d. towards its expense. It was in the chamber pitch of the period, and its pitch has never been changed. It is a magnificent organ, containing 68 speaking stops and 4,945 speaking pipes, and by recent improvements of the wind, under direction of Herr Schmahl, it has been brought into first-rate condition. It is S 0·93, or almost an equal semitone flatter than French pitch, and is exactly a *just* (not an equal) minor Third flatter than the St. Jacobi organ, A 489·2. The pitch was measured from C and E *flat* by Herr Schmahl with forks measured by me. The EA from the C was V 407·7, but Herr Schmahl advised me to go by E *flat*, the difference is only V 0·2; and is quite unimportant. It is certainly now in equal temperament, and was possibly always meant to be so. As Mattheson knew Schnitger, the builder of St. Jacobi organ (See A 489·2), Herr Schmahl thinks that the just minor Third between the organs was intentional, and that while St. Jacobi was in the true high church pitch of the period, St. Michaelis was in the true chamber pitch. Certainly, these are the best existing representatives of these pitches.

A 408. (Sauveur) see MA 406·6.

A 409. MC 489·27 [JC 490·8, EC 486·38], S 1·74. (Lissajous, "Bull. Soc. Encour.," liv, 1865) 1783, Paris, Court Clavecins. Fork of Pascal Taskin, their tuner, tuned from A of oboe of Antoine Sallentin, of the Opera and Chapelle du Roi, given by Taskin to M. Pfeiffer, who possessed it in 1859, according to de la Fage.

A 410. MC 490·46 [JC 492, EC 487·56], S 1·78. (Lissajous, "Bull. Soc. Encour.," liv, 1865.) Eighteenth century, Paris. Pitch-pipe found by Lissajous in the Cabinet of the Faculty of Sciences. Temperature under which it was measured, and force of wind not stated.

A 411·4. EC 489·2 [MC 492·1, JC 493·7], S 1·84. (Schmahl and Ellis.) 1688, Germany, Hamburg. The Chamber Pitch on the former eight-foot Gedact of the organ of St. Jacobi Kirche, being an equal minor Third flatter than the church pitch of the organ itself, so that the C of this stop was in exact unison with the A of the other stops of the organ; see A 489·2.

A 413·3. MC 494·36 [EC 491·4, JC 495·9], S 1·91. (Näke.) Germany, but neither date nor place mentioned. The Fork labelled "Schneider's oboe 826·5," formerly belonging to Herr Nake, and lent me by Frau Näke. My own measurement was the same as Herr Näke's.

MA 414·4 [JA the same, EA 411·1], MC 495·7 [JC 497·3, EC 488·9] C sharp 518, S 1·96. (F. W. Marpurg, Versuch über die musikalische Temperatur, Breslau) 1776, Clavichords. This is the result of an experiment made by Marpurg to tune a stretched wire to his C *sharp*, and calculate its pitch by the usual formula. This is a little flatter than Euler's MA 418. Marpurg himself determines JA, and then JD 276,$_{\frac{6}{7}}$, as a just Fifth below it, but this JD is in the major scale of A, and is therefore a comma lower than D in the scale of the JC here given, which is calculated as a just minor Third above the A. Of course we must not be too certain of the exactness of these numbers, on account of the method by which they were obtained.

4. *Mean Pitch of Europe for Two Centuries.*

A 415. MC 496·5, [JC 498, EC 493·5] S 1·99. (Ellis.) 1824*a*, Dresden. Roman Catholic Church, built by Gottfried Silbermann, 1754; see A 418·1 for present pitch. The above was taken from a fork formerly chained to the organ, for the purpose of giving the pitch to the orchestra that always plays with the organ in this church; these chained forks seem to have been placed there by command of King Friedrich August der Gerechte (1763-1827), who would not allow the pitch of the organ to be changed. The fork I measured, which had the perfect chain and staple still attached, was lent me by Frau Näke of Dresden, and sent by Herr Moritz Fürstenau, librarian to the Court Theatre, in 1878. Attached to it was a label giving the pitch as 415·1068, from the late Herr Näke's measurements by Scheibler forks, from which mine differs only by 0·1 vib. Herr Näke gives the pitch of another of these forks, in his book, as 415·3055, so that 415 may be regarded as the pitch intended; these forks disappeared from the church after 1824. Herr Näke says that the pitch of the fork was selected by the Kapellmeister Morlaschi and Carl Maria von Weber, assisted by the Court organ-builder Uthe, to give the pitch of the organ in spring and autumn.

A 415·5. MC 497·1 [JC 498·6, EC 494·1], S 2·01. (Näke.) 1722, Germany, Dresden. Organ of St. Sophie, built by Gottfried Silbermann. Näke conjectures that this pitch was brought from Venice by the Kapellmeister Antonio Lotti, who, in 1717, first conducted a grand Italian opera in Dresden, before Augustus the Strong, and says it was then called chamber pitch. This may be the case, and I consider these pitches, A 415, 415·5 to 419·5 to be only flatter forms of the Mean Pitch A 422·5. In that case, however, Näke must have been in error in supposing there was another chamber pitch a whole tone lower, see A 375·2. That could only have been a low church pitch.

(1) MA 418·0 [EA 420·4, JA 416·7], C 500, S 2·11. (Euler, "De motu aeris," Nov. Com. Ac. Sci. Petrop., vol. xvi. for 1781, p. 335.) 1780, St. Petersburgh, organs. Euler, after remarking that in a tube of 1,000 feet, open at both ends, the number of oscillations made by the air would be also 1,000, and in one of eight feet would be 125 (these tubes are to be carefully distinguished from organ pipes) incidentally observes, "cui numero (125) respondet sonus in instrumentis musicis litera C indicari solitus." (To this number, 125, corresponds the note usually marked C in musical instruments, by which perhaps organs are intended.) I do not think that either this or the former (see A 392·2) observations are to be taken as determining precise pitches. This pitch

is 1·11 eq. sem., about a great semitone sharper than A 392·2, which gives B *flat* 419·6, so that the two instruments would be related in the manner explained under A 454·2 and A 457·6.

2) **A 418**, MC 500·1 [JC 501·6, EC 497·1], S 2·12.' (Näke.) 1760-90, Germany. A flute made by Floth gave this pitch when Näke observed it, but all determinations by flutes are most uncertain. Delezenne says (Lille Mem., 1854, p. 6): "A flute, an oboe or a clarionet gives the pitch in the orchestra; hence orchestral pitch is delivered over to the caprice of the manufacturer, and it also depends on the *embouchure* of the artist, as I have ascertained by my tonometer that the same flute gives different sounds in different hands. Similarly, I have established, in conjunction with M. Hermann, Laureate of the Conservatoire, and first flute in the Lille theatre, that a flute may be made to vary in pitch by 5·4 commas [= S 1·16], that is by more than a semitone, according to the closeness of the lips, and the force with which the lamina of air is driven against the edge or the middle of the hole. For this reason I have renounced my attempts to discover ancient orchestral pitches by means of old flutes, of which I had already formed a collection for that purpose." See A 426·5.

A 418·1, EC 497·2 [MC 500·2, JC 501·7], S 2·12. (Ellis.) 1878. Germany, Dresden. Roman Catholic Church, Silbermann's organ, from a fork tuned for me by the Court organ-builder, Jehmlich, at 15° R, and reduced. For older pitch see A 415. The C was taken at the same time, and being similarly reduced, gave C 496·4, which is only ·8 vib. too flat. At what time equal temperament was adopted is not known.

MA 419 [JA 417·7, EA 421], C 501·3, S 2·15. (Ellis.) London, about 1700, organ of St. John's, Clerkenwell, attributed to Renatus Harris. When measured (1 Oct., 1878), the pressure of wind was very weak. It was ill regulated by broken gravestones as weights. The choir organ was measured, which is 1 vib. sharper than the great organ. It has the "short octave," see A 424·3 and pedal keys without pipes, and had originally no couplers. The organ has been put into equal temperament, but very slightly changed; the old temperament is here assumed. This organ is reported to be at least part of the one put up in the Temple in rivalry to B. Schmidt's, but the church books have been impounded for a lawsuit, and are inaccessible, so that this statement cannot be verified.

MA 419·5 [JA 418·2, EA 422], C 501·8, S 2·17 (Näke.) 1714, Saxony, Freiberg; organ built by Gottfried Silbermann. Näke says the pitch is A 422 equally tempered, but that the organ is *not* tempered. I presume then that he measured C, and then deduced EA. I have calculated backwards, and from C have calculated both MA and JA, and, thinking MA more probable, have calculated S from it. Näke may have confused JA and MA, being probably unacquainted with the latter. Näke conjectures that this pitch was introduced by Heinrich Schütz in the 17th century from Italy, and that it had become gradually higher. He calls it Lombard pitch. He says also that this organ is in high church pitch, two semitones above chamber pitch. Taking this as one mean tone, it would give the chamber pitch at MA 375·2; see this pitch and also A 415·5.

(1) **EA 419·6**, EC 498·93 [MC 501·8, JC 503·46], S 2·18. 1858 Madrid, ton de chapelle. This was calculated as an equal semitone lower than A 444·5 (which see) on the authority of de la Fage, but the temperament used may, after all, have been the meantone temperament. See next entry.

(2) **A 419·6**. (Ellis.) 1785-90, Spain, Seville Cathedral. This fork was tuned by me, and sent to Seville to compare with the old organ of Torje Bosch (a Spaniard of Majorca) and was pronounced by the organist, Don Yñiguez, to be exactly in unison with 2 A of the organ at a mean temperature. He also informed me that in Spain they have not abandoned the system of Salinas, or the meantone temperament, and that the band played with the organ by screwing down the strings of bowed instruments, and adding pieces to the wind instruments for the occasion. He also said that this was the pitch of all organs in Spain. As the precise temperature was not stated, there may be an error of two or three vibrations, but not more, in supposing this mean temperature to be 59° F. It might thus be as high as Handel's pitch, A 422·5.

A 419·9 (measured 4 A 209·93), MC 502·3 [JC 503·8, EC 499·3] Rev. G. T. Driffield, rector of Bow, possessor of Handel's fork, S 2·19. (Ellis.) About 1715, England. Very old fork, belonging to see A 422·5. This is a large rude tenor fork, pyramidical at end of stem, difficult to measure as its beats in the octave could scarcely be counted for more than 5 sec. Mr. Driffield thinks it was made by John Shore, the inventor of tuning forks, see Art 10 above. This 4 A would be the tuning string of the lute, and John Shore was lutist to the Chapel Royal.

MA 420·1 [JA 418·82, EA 423·6], C 502·6, S 2·20. (Ellis.) 1780, England, Winchester College organ, built by R. Harris 1681, and repaired by Samuel Green, 1780. The C measured at Messrs. Bishop's works was a stopped diapason, and Mr. C. K. K. Bishop, put the tuning ears in the ordinary position, but he may have possibly flattened it. The tone of the pipe was very dull. The pipe was one of Green's. See A 422·6.

A 421·3, MC 504·0 [JC 505·5, EC 501·0], S 2·25 (Näke.) 1780, Austria, Vienna. Fork of the Saxon organ-builder, Schulz, who lived in Vienna in Mozart's time, giving the pitch of organs then used. Herr Näke's full measure was 421·2885.

A 421·6, MC 504·3 [JC 505·9, EC 501·3], S 2·26. (Näke and Ellis.) 1780, Vienna, pianos. Fork of Herr Stein, the celebrated clavichord maker of Vienna, in possession of his son-in-law, Streicher, the celebrated pianoforte maker at the same place. A copy of this fork, made for Herr Näke, was kindly lent to me by Frau Näke, and I measured it as above; Herr Näke had measured it as 421·3625. The difference is unimportant. Herr Näke usually cites it as 421·5. This was the pitch to which Mozart's clavichords and pianos were tuned, and this was in fact Mozart's pitch, being almost imperceptibly different from Handel's, A 422·5.

A 421·9, MC 504·7 [JC 506·2, EC 501·7], S 2·27 (Marpurg as cited by the French Commission.) 1752, Berlin, Opera. I have been unable to find this in any of Marpurg's works accessible to me, but see A 414·4. The pitch is very probable.

A 422, MC 504·8 [EC 501·85, JC 506·4], S 2·28 (Näke.) 1783, Germany. A clarionet in D with two keys, by A. Grenser. See Delezenne's observations under (2) A 418.

(1) **A 422·3**, MC 505·2 [JC 506·8, EC 502·2], S 2·29 (Näke). 1780. Dresden, fork of the former Court organist, Kirsten; in possession of the late Court Organist, Dr. Schneider.

(2) **A 422·3** (Ellis), 1780*c*, Verona. The bell foundry of Cavedini at Verona has two C forks, and one series of forks from C to B flat. Copies of all these forks were kindly made for me under the direction of Prof. Rossetti (see A 425·2 for references) with the assistance of Sig. Cavedini, who attested their accuracy. The C was believed to be the Roman C of 100 years ago. The following are the pitches of the whole series:—In the two foot octave, C 246·44, C *sharp* 263·64, D 281·24, E *flat* 292·72, E 317·54, F 330·27, F *sharp* 355·14, G 376·23. G *sharp* 405·72, A 422·34, B *flat* 449·44, the B *natural* is wanting. On examining the series, the forks will be found to be very imperfectly tuned. Every major Third is much too sharp, and hence every Fifth is slightly too sharp. Remembering that in equal temperament the Fifths are S 0·02 too flat, and the major Thirds S 0·14 too sharp, we may see how bad the present scale would be in harmony, where the Fifths *c g*, *e* sharp *g* sharp, *d a*, *e* flat *b* flat, are respectively S 0·31, 0·44, 0·02 and 0·40 too sharp, and the major Thirds *c e*, S 0·53; *c* sharp *e* sharp, S 0·04; *d f* sharp, S 0·18; *e* flat *g*, S 0·48; *e g* sharp, S 0·34; *f a*, S 0·39; *f* sharp *a* sharp, S 0·21; too sharp. Now Zantedeschi says that on comparing this C 246·4 with the (more recent) pitch-pipe of Colbacchini he found it was D, which has really V 288·9, and consequently concludes that the fork had risen a Tone. Probably the bad state of the pitch pipe rendered it impossible to measure with any degree of accuracy. Cavedini's C 246·4 is actually flatter than the C 252·13 of the pitch pipe, see A 425·2. Zantedeschi also says that the theatre at Verona used the Vienna A (which he estimates at V 265 to V 268), and was a semitone sharper than the C of the Colbacchini pitch pipe, which has C *sharp* 272·4. But the Vienna pitch seems to have been A 456·1 (which see) giving JC 273·6, which is indeed very nearly C *sharp* of the pitch pipe, so that if the least reliance could be placed on Prof. Z.'s observations (which I am afraid is not the case), the old Vienna pitch, as given by Streicher's fork, is confirmed.

(1) **A 422·5**, MC 505·4 [JC 507, EC 502·4], S 2·30. (Ellis.) 1751, England, from a copy made by myself (and compared with the original some months afterwards, when it was found perfectly exact) of Handel's fork. The box containing it bears this inscription:—"This Pitchfork was the property of the Immortal Handel, and left by him at the Foundling Hospital, when the Messiah was performed in 1751. Ancient Concert, whole tone higher; Abbey, half-tone higher; Temple and St. Paul's organs exactly with this pitch. Presented to Bd. Clarke by J. Brownlow, the Dep. Sec., 1835. Invented by M. Shore, Serj. Trumpeter, time of H. Purcell." This fork was bought by Rev. G. T. Driffield, rector of Bow, near London, at the sale of the effects of Mr. Clarke, and by his permission I took and compared the copy. The fork is probably far superior to any made by John Shore, who (and not Mathias Shore, as the inscription implies) was the inventor of the Tuning-fork, see Art. 10 above. This fork probably represents the exact pitch of the organ built by Messrs. Glynn and Parker (see (2) A 424·3), which was presented by Handel to the Foundling Hospital, and opened by him "on the 1st of May, 1750, when the concourse of persons was so great that the performance was repeated fifteen days afterwards. Upon one of these occasions the audience was conveyed in no less than 800 coaches and chairs" ("John Brownlow's History and Objects of the Foundling Hospital," third edition, London, 1865, p. 78). This fork was received by the secretary, John Brownlow, from his predecessor, who was in office from 1795 to 1849, and Mr. Brownlow in a letter to Mr. Driffield, dated May 21, 1848, says, that "in an unguarded moment" he gave it to Mr. Clarke. He did not remember the story of Handel's leaving it in the orchestra, and imagined that that might be "apocryphal." Mr. John Reid, a partner in Messrs. Broadwood's house, writing to Mr. Driffield on June 13, 1859, says that that house had once possession of Handel's fork, and they do not know how it came out of their possession. Handel was a friend of Tchudi, the founder of the house. Richard Clarke, to whom the fork was given, died Oct. 5, 1856, aged 76½, and his effects were sold by auction, May 2, 1857, when Mr. Driffield bought both this fork and A 419·9. I am indebted to Mr. E. J. Hopkins, of the Temple organ, for furnishing me with a MS. note made by Mr. Leffler (d. 1819), organist of St. Katherine's, then by the Tower, with Mr. W. Russell, then organist of the Foundling, which describes the great peculiarity of this organ. It had the usual 12 keys to the octave, but a means of altering the notes sounded by four of them. There was a slider with three rests above the draw stops on each side. When the sliders were at the central rest, the 12 notes were the usual 12 of the meantone temperament, E *flat*, B *flat*, F, C, G, D, A, E, B,

F *sharp*, C *sharp*, G *sharp*. If the left-hand slider were put full to the left, E *flat* was changed into D *sharp*, and if the right-hand slider were put full to the right, B *flat* was changed into A *sharp*. If, however, the right-hand slider were put full to the left, G *sharp* was changed into A *flat*, and if the left-hand slider were put full to the right, C *sharp* became D *flat*. These three positions of the sliders may be indicated thus: Left hand, D *sharp*—(E *flat*, C *sharp*)—D *flat*. Right hand, A *flat*—(G *sharp*, B *flat*)—A *sharp*. The two notes in the parenthesis are the usual notes of the meantone temperament, when unaltered by the sliders. There were were separate sets of sliders for swell, great and choir organs. Mr. Hopkins always understood that this arrangement was due to Dr. Robert Smith, of Trinity College, Cambridge. The sliders, long disused and not understood, were removed by Mr. Bishop, by order of the organist, Mr. C. Edwin Willing, who was appointed in 1848, but "the organ was still tuned in unequal meantone temperament, to avoid the alteration in the pipes and any further expense" (letter from Mr. Willing, then organist, Sept. 21, 1863). Its present state, after rebuilding by Bevington, is described in "Hopkins on the Organ," ed. 1870, p. 467. As respects the indications of pitch in 1835, given by Mr. Clarke in the inscription on the box, it is possible that both the Temple and St. Paul's organs were originally tuned at A 441·7, but had been flattened (the first in 1843) by Mr. C. A. Bishop to agree with Sir George Smart's pitch, A 433·2, which would be probably considered the same as Handel's by Mr. Clarke. The Temple Organ and the oldest Durham organ had an E *flat* and D *sharp*, an A *flat* and G *sharp*, that is two and not four additional notes, and these were introduced by divided keys and not by sliders. The alteration of pitch was made partly by shifting, and partly by piecing the pipes. The Temple Organ was put into equal temperament about 1835, and then the back parts of the divided keys were unused. Mr. Clark seems to be entirely in error respecting the Ancient Concerts, as these concerts were held in the Hanover-square Rooms after 1804. In 1805 that organ was built by Elliott, in the usual flat pitch of the time (that is about A 422·5); then it was sharpened by Hill, when Knyvett was conductor, 1831-7, and was probably put into Sir G. Smart's pitch (A 433·2). Afterwards, while Costa was conductor of the Philharmonic Concerts, 1846-54 (see A 452·5) it was sharpened to his pitch, certainly not S 1·2 above Handel, that is, very far short of a tone, though more than a semitone.

(2) **A 422·5.** 1820*s*, England, Westminster Abbey Organ, built by Schreider and Jordans. The pitch is conjectural. Mr. T. Hill says it was a "flat organ," so that it must have been near this pitch, and that he sharpened it himself. The present pitch is therefore intentionally his standard, A 441·7. Dr. Stone's observations, in May, 1877, made it A 438. Mr. J. Turle, of the Abbey, informs me that the pitch was originally flat, but after the coronation of George IV., 1821, it was slightly raised, by desire of his predecessor, Greatorex; and that this pitch was unaltered when the organ was reconstructed by Mr. Hill in 1848, up to which time it had a "short octave," or G organ (see A 424·3), and was in mean tone temperament. As Mr. Hill says, he sharpened it, most probably the organ was raised in 1821 from A 422·5 to A 433·2 (which see), or thereabouts as this was the pitch of the period, that is, by S 0·43, or not quite a quarter of a tone; and the subsequent smaller rise to A 441·7, or thereabouts, being only S 0·35, or a comma and a half, was not noticed. Organs are constantly raised slightly in pitch when reconstructed, owing to the trimming of the pipes and clearing the dust from the mouth. See end of notes on (1) A 427·2. But there is some reason to suppose that when the organ was first built in 1730, it was a very sharp organ (see A 474·1), and that it was flattened a whole tone before Mr. Turle knew it.

(3) **A 422·5.** 1838, England, Bath Abbey Church as rebuilt by Smith, of Bristol. Sharpened by Mr. T. Hill, who told me that it was a "flat organ," and hence must have been near the pitch here conjecturally assigned. As it was originally built by the Jordans, it may have been much sharper at first (see A 474·1).

(4) **JA 422 5.** 1877 *c*, England. Tonic Sol-fa Standard, using JC 507 only, and the whole scale in just intonation.

(1) **A 422·6.** MC 505·6 [JC 507·1, EC 502·6], S 2·30 (Delezenne.) 1754*c*, Lille. Very old fork found in the workshops of M. François, sen., musical instrument maker at Lille. Judging from its construction and that of its case, Delezenne considered it to be one hundred years old in 1854.

(2) **MA 422·6.** (Ellis.) 1790*c*, London; Samuel Green's organ at Kew Parish Church, built as a chamber organ for George III., and kept in Kew Palace till it was given to the parish by George IV. in 1824, quite untouched, and, when examined in 1878, in the meantone temperament.

(3) **MA 422·6** [JA the same, EA 425·9], MC 505·5 [JC 507·1, EC 506·5], 1 F 676·15, S 2·30. (Ellis.) 1780*c*, Padua; copy made for me under the direction of Prof. Rosetti (see A 425·2 for references) of the higher old F fork preserved in the bell foundry of Colbacchini at Padua. Prof. Zantedeschi mentions an F fork there preserved as old as 1777 at least, but says he found it a semitone higher than Colbacchini's (more recent) pitch pipe. But the octave of the F of the pipe measured by me (see A 425·2), that is 2 F 343·6, is 1 F 687·2, which is very nearly the same as this fork. Colbacchini did not know which of their two F's Zantedeschi had examined, and sent me copies of both (see the other under A 403·9). Neither would agree with Prof. Zantedeschi's unfortunately inaccurate observations.

MA 422·7 [JA 421·4, EA 425·2], C 505·7, S 2·31. (Ellis.) 1800*c*, London; old fork belonging to Messrs. Broadwood.

(1) **A 423·0.** MC 506·0 [JC 507·6, EC 503·0], S 2·32. (Drouet, as cited by Fr. Com.) 1810, Paris, Opera. The pitch is very probable; but as I have been unable to find the original account I do not know how it was obtained.

(2) **A 423·0.** (McLeod actually 423·02; Ellis, 423·09.) 1820, France, Paris, Théâtre Feydeau, Opéra Comique; copy (compared with the original by M. Cavaillé-Coll, and found "sufficiently exact") of the original (No. 494 of Catalogue) preserved in the Musée du Conservatoire. The original is 3⅞ in. from bend to point, converging prongs with a disk at end of stem, much spotted with rust, the disk being black with it; in a wooden case inscribed, "Feydeau, 1820; donné par M. Dauprat." My son measured the original as 423·06.

(1) **MA 423·2** [JA 421·9, EA 425·7], C 506·3, S 2·33. (Ellis.) 1778, London; Green's organ at St. Katherine's Church, Regent's Park. A large fine organ, short octave (see MA 424·3), long keys white, still in mean tone temperament (I measured A 423·6 on the instrument, but have calculated the above pitch of A from C as most likely to be correct); pipes evidently untouched, but ill-treated in tuning; coned in and out, and often jagged at the end (the 1 C was coned out, and the 2 A coned in).

(2) **EA 423·2** [MA 420·7, JA 419·4], C 503·3, S 2·33, or if taken from MA 420·7, then S 2·22. (Ellis.) 1815-21, Dresden; Band of the Opera. From a fork lent me by Frau Näke, of Dresden, contained in a box labelled, "Dresdener Kapelle, 1815-1821, c''." C. M. von Weber (1786-1826) was Kapellmeister at Dresden during this time. I have taken the EA in preference to MA, because it agrees more closely with the fork of Anton von Weber, his father (see A 424·1). The pitch of the Dresden opera began to rise in 1821, according to Näke, in consequence of the celebrated flutist Fürstenau, then using a new flute made by Koch of Vienna. But as late as 1824 it was lower than in Munich. For present pitch see A 437·8 and references.

MA 423·3 [JA 422, EA 425·8], C 506·4, S 2·33. (Ellis.) 1813, London; Original Philharmonic. This is a second copy of Peppercorn's fork (see first in MA 423·7), prepared for the Society of Arts in 1860 (now in possession of Messrs. Broadwood); but whether this or the other is the better is uncertain. The difference is only ·02 eq. sem.

MA 423·6 [JA 422·3, EA 426·1], C 506·7, S 2·34. (Ellis.) 1800*c*, London; old fork belonging to Messrs. Broadwood.

MA 423·7 [JA 422·4, EA 426·2], C 506·81, S 2·35. (Ellis.) London, 1813; Original Philharmonic. This is a copy (in the possession of Mr. Hipkins) made before 1860, of the original fork (now lost) by which Mr. Peppercorn, of Broadwood's, tuned the pianos of the Philharmonic Society, from its foundation in 1813 to 1828. Mr. Hipkins believes that this fork was settled in a consultation of Sir George Smart (conductor) with Braham (tenor), Griesbach (oboist), and Mrs. Billington (soprano, who left England in 1817). For other pitches of Sir George Smart, see A 433 and 433·2; see also MA 423·3.

A 424, EC 504·2 [MC 507·2, JC 508·8], S 2·36. (Näke.) 1862, Germany, Dresden. Orchestra of the Roman Catholic Chapel, according to Näke, who says that, consequently, the organ can agree with it only in the hottest days of summer. If we suppose the organ to have been at A 418·1 (which see) at 59° Fahr., then temperature must rise to 72·6° Fahr., according to the usual formula of reduction, before the organ would agree with this orchestral pitch. When the instruments were taken to the Opera-house in 1862, for experimental performances of Mozart's operas, Näke says they rose from A 424 to A 427·5, through the mere heat of the house.

A 424·1, EC 504·3 [MC 507·3, JC 508·9], S 2·36. (Näke.) 1740—1812, Germany; Eutin (18 miles N. of Lübeck, in North Germany, of which principality it was capital, though surrounded by Holstein). Fork of Franz Anton von Weber, father of Carl Maria von Weber. As equal temperament was, in intention, used at this early period in Hamburg, and probably Lübeck for the very sharp organs there, I have placed EC first. Compare A 423·2. Näke's precise measure of this fork is 424·0035.

(1) **MA 424·2** [JA 422·9, EA 426·7], C 507·3, S 2·37. (Ellis.) 1619, Brunswick. "Suitable" Church Organ Pitch. Praetorius ("Syntagma Musicum," vol. ii., p. 231-2) gives what he terms "a correct drawing of the proper church-pipe measure for c'''," or the half-foot tone of the organ-builders;" that is, ½ C. This figure gives the dimensions of the whole octave from ½ C to ¼ C. It is a rough woodcut, on very bibulous paper, which must have shrunk much in drying. At the back of the title of the "Theatrum Instrumentorum seu Sciagraphia," in the same volume, Praetorius gives a scale of six Brunswick inches, which, on the figure, measure 140·5 mm. in place of 142·68 mm. Dividing the latter by the former, we obtain 1·0155 as the multiplier of the dimensions of the drawing to correct for shrinkage. The actual drawing on the paper gives 133·8 mm. for the length, and 25·2 mm. for double the side of the square pipe, corresponding to ½ C. Multiplying by 1·0155, we find 135·87 and 25·59 respectively. Doubling the first to get the 1 C, we have 271·74 mm. for the length, and 25·59 mm. for the side of the square of a wooden pipe giving this recommended pitch. I had a wooden pipe constructed which was 272 mm. long and 25·5 mm. in the side, and spoke 503·6, 507·25, and 511·86 under pressures of 2¾, 3¼, and 4 inches respectively. Correcting this (by rule Art. 8), by multiplying by 323 (= 272 + 2 × 25·5) and dividing by 322·92 (= 271·74 + 2 × 25·59), we obtain C 503·7, 507·4 respectively; practically, the same as before, the errors in length and side being in opposite directions, giving

MA 421·1, 424·2, and 428·0 respectively. As 3¼ in. was, according to Herr Schmahl (see "Authorities") almost precisely the force of wind used by Praetorius, I assume the second as most correct, and hence obtain the above figures. This is the "mean pitch," being practically the same as Handel's A 422·5, and it is the earliest example of it that I have found. It was not then the ordinary pitch, but it was, in Praetorius's mind, the most suitable. It was this pitch to which Praetorius must have referred when he said that the Halberstadt organ, A 505·8, was a good Tone, and nearly a Tone and a half sharper than the suitable church-pitch (*als die unsrige itzige Chormessige Werke stehen*). The difference of pitch was S 3·04, just an equal minor Third; and just less than S 3·103, the meantone minor Third. These two pitches, therefore, confirm each other. The lengths and sides of the other pipes in the Octave were not engraved with sufficient accuracy to draw out the exact temperament; but, as Praetorius explains how to tune in the meantone temperament, and no other (perfect major Thirds, and Fifths a quarter of a comma too small), there was no necessity to attend to the pitch of any but the lowest note, which had the longest pipe, and was, therefore, in all probability, most accurately rendered in the woodcut.

(2) **A 424·2**, EC 504·4 [MC 507·4, JC 509·0], S 2·37. (Fischer; for references and explanations, see A 437·3.) 1823, Paris; Italian Opera. Mean of 20 trials. The fork measured was 4 A 212·08, and was given by Spontini. Probably, MC should be used. I have used Fischer's V 424·17, but this requires the length of the string to be 23·721, and not 23·712, Prussian inches, as he gives it, and I consider this transposition of 1 and 2 the most probable misprint.

(1) **MA 424·3** [JA 423·0, EA 426·8], C 507·6, S 2·37. (Ellis.) 1750*c*, London. Old forks, formerly belonging to the late Prof. Faraday, lent me by Mr. Blaikley, of Messrs. Boosey. The C 507·6 was clearly a common music-shop fork, giving the pitch of 1750 and later. Calculating from this JA *flat* 406·1, JE *flat* 609·1, JA 423·0, as just minor Thirds, to JF 338·4, and C, and comparing them with the forks of the set A *flat* 404·7, E *flat* 609·5, A 422·7, there seems little doubt that these were attempts at tuning the former correctly by ear. These were made for lecture purposes, most probably. The MA 424·3 is selected to take the real pitch from.

(2) **MA 424·3** [JA 423·8, EA 426·7], C 507·4, S 2·37. (Ellis.) London, 1749. Glyn and Parker's Organ, at All Hallows the Great and Less, Upper Thames-stret. This firm (who lived at Salford, Manchester) were the builders of the organ which Handel presented to the Foundling Hospital, and which had probably the pitch of Handel's fork (see (1) A 422·5. The present organ is in equal temperament, and the actual pitches of A, B, C, in September, 1878, were A 426·7, B 478·0, C 507·4, which are very closely the equal temperament A 426·7, B 478·9, C 507·4. The organist (Mr. Yeatman) informs me that equal temperament has been adopted for some time, but I have adopted the old MA. The organ has no couplers, an octave of pedal keys, but no pipes, very shallow touch, a raised cornet on the great organ, a "short octave"—that is, the lowest notes are G, C, A, D on the keys which look to be B, C, C *sharp*, D; great and choir organ 4½ octaves, swell 3 octaves. The B pipe is exactly 12 in. long, and 0·95 in. in diameter. Organ inscribed, "Erected by voluntary subscription of these United Parishes, A.D. 1749." The pitch was taken from the choir organ, the C of which was exactly of the same pitch as that of the great organ. Probably owing to the residence of the builders at Salford, A. Jordan was its first caretaker. Dr. Boyce was organist in 1749.

EA 424·4 [MA 421·9, JA 420·6], C 504·7, pressure 3¼ in., S 2·37. (Ellis.) 1833, Weimar; organ. J. G. Töpfer, an organist and author of a well-known work on the organ (chiefly adapted from Bédos) in his "Orgelbaukunst," p. 41, gives for his wide principal 1 C a pipe 1 Weimar foot (= 282 mm.) long and 15·76 Weimar lines (= 30·86 mm.) in diameter. I had a pipe constructed 279·5 mm. long and 30 mm. in diameter, which spoke V 510·1, 510·7, 512·9, under pressures of 2½, 3½, and 4 in. respectively. Reducing these for a pipe of the proper dimensions (see rule Art. 8) by multiplying them by 988·5 (= 3 × 279·5 + 5 × 30, and dividing them by 1000·3 (= 3 × 282 + 5 × 30·86) we obtain C 504·1, 504·7, 506·9 respectively, giving EA 423·9, 424·4, and 425·9 respectively, where I use EA, because Töpfer says that the unequal temperament had been almost entirely superseded by the equal. But the value of C belongs to the time of meantone temperament, and the three MA are 421·4, 421·9, 423·7 respectively. The middle pressure is most probably correct.

A 424·6, MC 507·9 [EC 505·0, JC 509·5], S 2·38. (Ellis.) 1800*c*, England; old fork said to have been used at Plymouth Theatre at the beginning of 19th century, lent me by Dr. Stainer.

A 424·9, MC 508·3 [JC 509·6, EC 505·27], S 2·39. (Nake.) 1800*c*, Germany; fork of the bassoonist Kummer, sen.

A 425·2, MC 508·7 [JC 510·2, EC 504·5], S 2·41. (Ellis.) 1730*c* and 1780*c*, Padua; two ancient pitch-pipes belonging to the bell foundry of Colbacchini at Padua, and kindly lent to me at the request of Sig. F. Rossetti, professor of physics at the University of Padua, in order that I might verify some experiments made upon them by Prof. Zantedeschi, his predecessor (died 1873). The foundry was established in 1730, and the older pipe, which extends from 4 B to 1 F *sharp*, is believed to be of that date; but the more recent one, which extends from 4 A to 1 A, is believed to be fifty years more recent. It was the latter, with 2 octaves, which Prof. Zantedeschi had used, and he treated it as proceeding in just intonation from 2 C 256. When they came into my hands both pipes were unusable, and could not be made to give any intelligible note, so that any pitch might have been assumed for them. I put them into the hands of Messrs. Hill & Sons, the organ-builders, who softened the leathern pad at the end of the piston, and made them speak easily, without any alteration of the mouth or length, and prepared an adapter, so that both could be tried on a proper bellows. Each A was measured on two different days, and the results reduced to 59° F. The older pipe gave V 425·7 and V 426·73; the newer pipe gave V 422·2, and V 426·3; both under 2½ in. of wind, which was as much pressure as they could well bear. As there was no means of determining the pitch of such an instrument accurately, for it probably varied every time it was used, I have assumed the mean of all four measures as the possibly intended value of both A's. It was necessary to employ different pressures with the older pipe, to bring out the notes, and I always used the smallest possible. The pitches of the 2 ft. octave of the two pipes were as follows, reduced to 59° F.:—Older pitch-pipe (1½ in.) C 250·4, C *sharp* 265·6; (1¾ in.) D 283·6, E *flat* 299·0; (2 in.) E 317·9, F 337·2; (2½ in.) F *sharp* 357·9, G 380, G *sharp* 403·5; (2¾ in.) A 426·7 or 425·7; (2½ in.) B *flat* 453·8, B 479·4, C 509·6, which is considerably sharper than the true octave 500·8 of the lower C. The pitches of the notes in the same octave in the more recent pitch-pipe are as follows: the pressure being 2½ in. throughout and * marking those pitches which were taken on the second day—C 252·13, *C *sharp* 272·4, *D 288·9, *E *flat* 304·8, E 325·6, *F 343·6, *F *sharp* 362·0, G 378·1, *G *sharp* 403·7, A 422·2, or *426·3, B *flat* 444·9, B 469·5, C 497·5, which is a good deal flatter than the true octave 504·3 to the lower C. It is evident that this was very different from a justly intoned octave to C 256, as was assumed by Prof. Zantedeschi (in his memoir on the variability of tuning-forks, "Sitz. Ber. Math. Kl. k. Acad. der Wiss." Vienna, 1857, p. 172), and that all measurements of pitch made with this pipe must have been faulty. For the forks examined by Prof. Zantedeschi see A 403·9, (2) A 422·3, (3) A 422·6, A 436·6, A 433·7. The above pitch-pipe scales should be compared with Cavedini's forks (2) A 422·3. All three were supposed to be Roman pitch of one hundred and fifty years ago, but look more like Lombard pitch. (See Art. 26, note 10.)

A 425·5, EC 506 [MC 509, JC 510·6], S 2·42 (Lissajous, reported by de la Fage), 1829, Paris. Pitch of opera piano as distinct from the orchestra, see A 425·8 and (2) A 434, verified by Monneron for A. de la Fage.

(1) **MA 425·6** [JA 424·3, EA 428·1], C 509·1, S 2·42. (Ellis.) 1740-80, England; Schnetzler's organ at the German Chapel Royal, St. James's Palace. A chamber organ, formerly at Buckingham Palace, with C untouched, but put into equal temperament, having actually A 428·4, which, as seen above, is nearly correctly EA, but I have taken the pitch from MA 425·6, as that belonged to the time when the organ was built. *Schnetzler's* name is so spelt on an organ belonging to Mr. Drew of Dublin. English books generally give *Snetzler*.

(2) **A 425·6**. (Hill.) 1764, England, Halifax; one of Schnetzler's organs sharpened by Messrs. Hill & Son. The pitch is presumed to be the same as that of Schnetzler's German Chapel organ, for Mr. T. Hill said, it was "flat," and the organist Mr. Frobisher had always to transpose a semitone, in case of having to play with other instruments, at festivals.

(1) **A 425·8**, EC 506·3 [MC 509·31, JC 510·9], S 2·43 (Lissajous, from de la Fage). 31 March, 1824, Paris, opera. Pitch suddenly lowered for Mdme. Branchu, whose voice was failing. The piano for rehearsals was also lowered, and was not raised immediately when the orchestra was raised. The piano was said to be of *opera pitch*. See A 425·5.

(2) **A 425·8** (de la Fage). Bologna, Italy, 1839; pitch of fork used by Tadolini, the best tuner in the town, to tune A. de la Fage's piano.

MA 425·9 [JA 424·6, EA 428·4], C 509·5, S 2·44. (Tunbridge and Ellis.) 1740, England; St. George's Chapel, Great Yarmouth, retaining the original pitch, though put into equal temperament in 1840; built by Byfield, Jordan, and Bridge. The pitch of C was measured by beats with a fork counted by the organist Mr. T. Tunbridge, and the fork subsequently measured by me. The organ had originally a short octave (see (2) A 424·3), but it had no quarter tones, as has been reported.

(1) **A 426·5**, MC 510·2 [JC 511·8, EC 507·2], S 2·46. (Delezenne, as cited by de la Fage). 1800*c*, Germany (?); a flute by Holtzappel, bought in 1805. See Delezenne's observations under (2) A 418.

(2) **MA 426·5** [JA 425·0, EA 429·0], C 510·14, S 2·46, pressure 2½ in. (Ellis.) 1843, England, Wimbledon Church, built by Messrs. Walker; from a pipe preserved by them.

A 427·0, EC 507·7 [MC 510·8, JC 512·3], S 2·48 (Scheibler, "Tonmesser," p. 52, No. 1, gives A 426·75 at 69° F, here reduced to 59° F.) 1811, Paris, Grand Opera. Scheibler does not trust it so much as A 434·0. A. de la Fage gives the date 1811, but cites the pitch as A 426·735.

(1) **MA 427·2** [JA 425·8, EA 429·7], C 511·0, S 2·49. (Ellis.) 1878*a*, Norwich. Organ of Norwich Cathedral as it was in the mean-tone temperament before it was altered by Messrs. Bryceson in that year, measured from a pipe tuned as the octave below a ½ C pipe, just brought from the organ by Messrs. Bryceson, and cleaned. In June, 1877, Dr. Buck, who was then organist, tuned a fork to it, which I measured it as A 431·6; but the temperature was not stated, and probably may have been high, since 69° F. would give the same pitch as above. The building of the organ is attributed to Renatus Harris, though an open diapason was added by Byfield. The organ had been much altered at

various times, but it apparently retained the pitch R. Harris used at St. Andrew, Undershaft, London. (See A 427·7.) The little pipe measured seemed to be quite untouched. The pitch has now been somewhat raised by Messrs. Bryceson. It was intended to be raised to French pitch, but from the state of the pipes it was found necessary to make it higher.

(2) **MA 427·2.** (Ellis.) 1826 *c*, London; old fork belonging to Messrs. Broadwood. See (2) A 427·5.

(1) **A 427·5**, MC 511·4 [EC 508·4, JC 513], S 2·50. (Lissajous, from de la Fage.) 1800 *c*, London; old fork in possession of Adrien de la Fage in 1859.

(2) **MA 427·5** [JA 426·2, EA 4·30], C 511·4, S 2·50. (Ellis.) 1826 *c*, London; old fork belonging to Messrs. Broadwood.

(3) **A 427·5.** (Nüke.) 1862, Dresden Church Orchestra, when transferred to the theatre. See A 424.

(4) **JA 427·5** [MA 428·8, EA 431·4], C 513, S 2·50. (Ellis.) 1877 *a*, London. Standard fork of the Tonic Solfa College up to 1877. It had been intended for 512, and obtained from the siren and Koenig's fork, which is 512·55. But finding that it measured 517·8 by Appunn's tonometer, Mr. Curwen, the president of the College, resolved to adopt Appunn's 512 as his standard. This would be about 508, and would be as nearly as possible JC to Handel's pitch (see A 422·5), as it would give JA 423·4. Actually the forks sold are often C 507, which is exactly JC to Handel's A. As the Tonic Solfaists sing in just intonation, JA is used above for the determining pitch.

A 427·6, EC 508·5 [MC 511·5, JC 513·1], 2 A 218·8, S 2·50. (Fischer, for references and explanations see A 437·3.) 1823, Paris, Théâtre Feydeau, or Opéra Comique; fork given by Spontini, mean of 20 trials. Probably mean temperament is more correct. By a typographical error in his abridged table, p. 211, Fischer gives the pitch as A 408 in place of A 428, and this had misled Bindseil and probably others.

MA 427·7 [JA 426·4, EA 430·5], MC 511·7 [JC and EC the same], 2 G *sharp*, 399·74, S 2·51. (Ellis.) 1696, London; old organ of St. Andrew, Undershaft, built by Renatus Harris. The pipe measured was a G *sharp*, the double octave major Third of 8 E, marked *Tee*, a solitary pipe preserved by Messrs. Hill and Sons when they rebuilt the organ. This is considered as the just major Third of E, and as E is of C, in accordance with the meantone temperament. This gives MC identical with JC, and this C is taken as the starting point for equal temperament also, and then the other pitches were calculated as above. The pipe had no ears, and the upper lip was slightly arched. (See MA 434·7.

A 427·8, MC 511·8 [JC 513·4, EC 508·7], S 3·51. (Ellis.) 1788, Windsor Castle, St. George's Chapel, made by Green, and presented by George III. It has evidently been sharpened through trimming. (See (2) A 422·6.) On 10th February, 1880, I measured A 427·8, B 478·6, C 511·5, at 59° F. Calculations from the measured A, assuming meantone temperament, we should have B 478·3, C 511·8; calculating from the measured C, we should have had A 427·6, B 478. Hence the A, B, C, were very accurately in meantone intonation, as was intended.

MA 428·4 [JA 427·2, EA 431·0], C 512·5, S 2·54. (Ellis.) 1826 *c*, London; old fork belonging to Messrs. Broadwood.

(1) **MA 428·7** [JA 427·3, EA 431·2], C 512·8, S 2·55. (Ions.) 1670, St. Nicholas, parish church of Newcastle-on-Tyne, built by Renatus Harris. It has been frequently improved and added to, but the pitch does not seem to have been altered (see A 427·7 with which it is practically identical). "It has been tuned in equal temperament since 1842, when it was altered for the Grand Musical Festival of that year. Sir George Smart then complained of the lowness of the pitch, and several of the orchestra found it difficult, if not impossible, to tune to it. Mr. Nicholson, the organ-builder, who made the change, is still living, and he says that C was not altered by him." Letter from Mr. W. J. Ions, the organists, who took the pitch by beats with a fork measured by me, at a known temperature, here reduced to 59° F.

(2) **A 428·7**, MC 512·8 [EC 509·8, JC 514·4], S 2·55. (Delezenne, 1800 *c*, Lille.) Fork in the possession of the family of M. Cohen for more than 50 years before 1854. The case is of an ancient form.

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5. The Compromise Pitch.

A 430·0, MC 514·4 [JC 516, EC 511·35], S 2·60. (Lissajous, "Bull. Soc. Encour.," liv. 1865.) 1810 *c*, Paris; fork belonging to a celebrated amateur, M. Lemoine, acquainted with all the principal artists, and head of an institution. A. de la Fage supposed it was intended for EA to C 512. In that case it was merely a fancy fork at that period.

MA 430·3 [JA 427·6, EA 432], MC 514·8 [JC 513·2, EC 513·8], 2 G 384·9, S 2·62. (Ellis.) 1826 *c*, London. Old G fork, formerly belonging to Faraday, lent by Mr. Blaikley, of Messrs. Boosey's. An isolated fork, and apparently intended for JG 384 to C 512. If, however, we take meantone temperament, we have almost exactly the pitch of Fulham Parish Organ before it was put into equal temperament (see A 430·4); so it may have been simply a music-shop G of about 1826.

MA 430·4 [JA 429·1, EA 433·05], C 514·87, S 2·62. (Ellis.) Fulham Parish Church organ, built by Jordans, 1701, but tuned to equal temperament by H. Jones, 136, Fulham-road, about 1858, who does not remember altering the pitch. I have therefore arranged it under meantone temperament. On measuring I find EA 433·8 tolerably correct, and EB 486·9, each nearly ·8 vib. too sharp. The pitch may be that of Gray and Davison, who had it in hand 1830, as the pitch belongs to that period.

A 430·5, EC 512·0 [MC 515·0, JC 516·6, S 2·62. (Wieprecht, cited by French Commission.) 1806-14, Berlin, Opera. The original statement by Wieprecht has not been found. The pitch may have been C 512, whence the French Commission calculated at EA 430·5, which may have been right, but the date implies MA 428 (whence S 2·52) and JA 426·7. The pitch is therefore doubtful. A. de la Fage says that Marloye proposed this 2 A as a standard, which amounts to selecting 1 C.

A 430·8, EC 536·4 [MC 539·6, JC 541·3], S 2·63. (Drouet in French Commission.) 1830. France, Paris Opera. The original account has not been found.

(1) **A 431·7**, EC 513·4 [MC 516·4, JC 518], S 2·67. (Fischer, for reference and details see A 437·3.) 1826, Paris Grand Opera. The fork, which measured V 215·85 was given to Fischer by Spontini. The vibrating length of string used was the mean 30 experiments. By an error of calculation Fischer gives the pitch as 431·36, and consequently, in his table, p. 211, where he only gives the pitch to whole numbers, he gives it as A 431 in place of A 432. Or if his result is right, then the length of his wire was 23·164 Prussian inches, in place of 23·307 as he gives it.

(2.) **MA 431·7** [JA 430·3, EA 434·2], C 516·4, JE 322·8, S 2·67 (Ellis.) 1826 *c*. London. Old forks formerly belonging to Prof. Faraday, lent by Mr. Blaikley of Messrs. Boosey's, compare MA 424.3. The C is apparently a music-shop fork of the transition period, see A 433·2, to which the E was tuned correctly as JE below.

A 432, PC 512 [EC 513·7, MC 516·8, JC 518·4], S 2·75. (Meerens.) 1876, Brussels. In a paper presented to the Institute of Geneva, 21st of October, 1876, and printed separately, as "Mémoire sur le Diapason" (Brussels, 1877), M. Ch. Meerens proposes this as a standard, from a paper by M. Elie Ritter in vol. viii. of "Trans. of Inst. Gen.," where M. Ritter, bases the choice on 432 being a multiple of 2 and 3. M. Meerens takes it as the PA to C 512, as it would be tuned on a Viola having 4 C 128, 4 G 192, 2 D 288 and 2 A 432, and considers that this is the only proper A to the tonic C 512, inasmuch as the JA 426⅔ belongs to the tonality of F 341⅓. This again depends upon his peculiar view of the scale, which does not allow the scale of C to be composed of four notes, forming three perfect Fifths, as F, C, G, D, and the major Thirds to the three first, A, E, B. But composes it of the four notes C, G, D, A, forming perfect Fifths, and E, B, the major Thirds to the first notes, C, G, and the minor Third F to the third note D. The notes F and A in this case are then a whole comma higher than in the former. In this scale the subdominant chord chord, F, A, C, would be a strong dissonance, and consequently no written music using that chord would be endurable on his scale. I am not aware that this standard has ever been used.

A 432·2, EC 514·0 [MC 517, JC 518·6], S 2·69. (Delezenne.) Lille, 1854*a*. Organ of St. André, repaired, and probably retuned to the chamber pitch of the time. It is exactly one tone higher than St. Sauveur at Lille, see A 384·6. Temp. not stated.

MA 432·3 [JB 431, EA 434·9] C 517·2, S 2·70. (Ellis.) 1846 *c*, London. Old fork in possession of Messrs. Bryceson, organ-builders, which belonged to their father, and had not been tuned for more than 30 years before 1878, but it had been unwillingly sharpened a little before that time. It probably shews the rise in the Philharmonic pitch then made (see A 433·2) which Mr. Bryceson, senior, seems to have objected to.

MA 432·6 [JA 431·3, EA 435·2], 2 C 258·77 (517·54), S 2·71. (Ellis.) 1846 *c*, London. Old fork bought by me about 1863 (see A 433·7), and hence I reckon pitch by meantone temperament.

MA 432·8 [JA 435·4, EA 435·4], C 517·8, 1 E 647·2, S 2·72. (Ellis.) 1826 *c*, London. Old forks formerly belonging to the late Prof. Faraday, lent by Mr. Blaikley, of Messrs. Boosey. The C was nearly correctly Sir G. Smart's (see A 433 and 433·2), and the E was perfectly tuned as a just major Third above.

A 432·9, MC 517·8 [EC 514·7, JC 519·4], S 2·72. (Delezenne.) Cited as an "old fork" in Delezenne's table, 1854, without further specification.

MA 433 [JA 431·7, EA 435·6], C 518, S 2·72. (Ellis.) 1826, London. Fork approved of by Sir George Smart, conductor of the Philharmonic, in possession of Mr. Hipkins. This seems to have been a second fixing (see MA 423·7.) This was in general use in the shops as the London Philharmonic from 1840 to 1846, but it was not the pitch of the Philharmonic at that time. The mean temperament is employed because it was the only one used by Sir G. Smart. If equal temperament is used, this C 518 (see A 433·2) gives practically modern French A 435·4, which was thus anticipated by 30 years in England, and is found on many restored organs. Used in this way, it is Broadwood's lowest pitch, and is London No. 1 of the French Commission of 1860, where the report gives it as A 434, which is much better than for No. 2 and No. 3 (see A 445·5 and 452·5.) Another copy prepared for Society of Arts in 1860, gives C 517·72, which is still nearer to modern French pitch.

(1) **A 433·2**, MC 518·2 [JC 519·8, EC 515·1], S 2·73. (Ellis.) 1820 *c* (according to Mr. Hipkins), London. Sir George Smart's own Philharmonic fork, left by him to the late Mr. John Black, and now in the possession of Mr. Algernon Black; the original fork was in a well-worn plaid silk case. This pitch was adopted, after a consultation, as a kind of standard, and was used as such by organ-builders. Sir G. S. considered that this

fork agreed with the C 518 given under A 433, which proves that he used the mean tone temperament. To this pitch Mr. C. A. Bishop tuned the Temple and St. Paul's organs (see end of remarks A 422·5).

MA 433·5 [JA 432·1, EA 436], C 518·52, S 2·74. (Ellis.) 1846 *a*, London. This is the same fork as is entered under (2) EA 436, for the reasons there stated.

(1) **MA 433·6** [JA 432·3, EA 436·2], C 518·8, S 2·75, pressure 2¾ in. (Ellis.) 1830 *c*, Ireland, Belfast, Christ Church. Date conjectured from pitch which, may have been altered between 1820 and 1850. From a pipe at Messrs. Walker's organ works.

(2) **MA 433·6**, C 518·8 (Byolin and Ellis', Shrewsbury, St. Mary's, originally built by Byfield and Green; pitch probably altered by Messrs. Gray and Davison, 1840 *c*. Pitch of C measured by the organist, Mr. Byolin, by means of a fork measured by me, and then reduced. The organ is still in meantone temperament.

MA 433·7 [JA 432·3, EA 436·2], C 518·77, S 2·75. (Ellis), 1846 *c*, London. Old fork bought in London, at the same time with C 258·77 (see MA 432·6) of which it apparently was meant to be the Octave. Belongs to A 433·2, hence pitch is reckoned from MA.

A 433·9 EC 516·0 [MC 519·0, JC 520·7], S 2·76. (Scheibler, "Tonmesser," No. I, 433·68 at 69° F, here corrected for temperature.) 1834 *c*, Vienna orchestra, fork belonging to Scheibler or his friends. This is the lowest of the Vienna forks cited by Scheibler, and is apparently that referred to as "Vienna minimum" by Delezenne, who gives only A 433, and also cited as a minimum by de la Fage, who gives the right number.

(1) **A 434**. EC 516·1 [MC 519·2, JC 520·8], S 2·76. (Cagnard de la Tour, from Cavaillé-Coll, "du Ton Musical," p. 13). 1819, Paris. No other particulars given.

(2) **A 434** EC 517·31 [MC 519·18, JC 520·8], S 2·76. (Cagnard de la Tour from de la Fage.) Paris, 1829; opera. Fork verified at the time by M. Montal, piano maker. This was after the orchestra of the opera had recovered its pitch (see A 425·8), which is said to be due to the cornist, Jean Mengal, having quietly shortened his horn. The opera piano remained at the low pitch (see A 425·5).

(3) **A 434·0**, EC 516·1 [MC 519·1, JC 520·8], S 2·76. (Scheibler, Tonmesser, p. 52; No. 2, given as A 433·75 at 69° F., here corrected to 59° F.) 1834 *c*, Paris, opera. Fork made by Petitbout, luthier de l'opéra, and trusted by Scheibler, because he knew the maker to be skilful.

A 434·3, MC 519·5 [JC 521·2, EC 516·5], S 2·78. (McLeod and Ellis.) 1818, France, Paris; organ of the Chapelle des Tuileries. Copy (compared with the original by M. Cavaillé-Coll, and found "sufficiently exact") of a fork (No. 493 of the catalogue) preserved in the Musée du Conservatoire. The original is of the same size and shape, down to the conical brass cup, as (1) A 439·5. The mean pitch of the fork, as measured by my son, was A 434·4. Label attached, "Chapelle Royale, No. 3." There are a few spots of rust, but no stamped marks or letters. This was evidently tuned to the pitch of the opera of the time (see A 434, (1) and (2).

A 434·5, EC 516·7 [MC 519·8, JC 521·4], S 2·78. (Ellis.) 1869, Germany, Baden. Fork sent officially to the Society of Arts, and lent to me. Intended for diapason normal (see A 435·4).

MA 434·7 [JA 432·1, EA 433·0], MC 520·1 [JC 518·5, EC 515·0], B *natural* 486·1, 3¼ in. pressure, S 2·79. (Ellis.) Experimental pipe to represent All Hallows, Barking, built by Renatus Harris. The 2 B *natural* of this organ had, as I was informed by Mr. Hill, a pipe 12 in. long and 1 in. in diameter. I had a pipe made 12 in. long and ·95 in. in diameter, which spoke V 486·9, 488·7, and 490·5 at 2¾, 3¼ and 4 in. pressure. Correcting according to the rule in Art. 8, by multiplying by 40·75 (= 3 × 12 + 5 × ·95), and dividing by 41 (= 3 × 12 + 5 × 1), there result B *natural* 483·9, 486·1, 487·5, giving MA 432·8, 434·7, 436·0 respectively. Selecting the second as most probable, we obtain the above figures. It is, however, not unlikely that this pitch may have been sharper than that of the real organ. Compare the copy of B. Schmidt's pipe (1) A 445·8, and compare A 427·7 for Renatus Harris's St. Andrew's, Undershaft, which is more probably correct. Perhaps the cause of the difference lay in the mouth of the pipes, which in Harris's is very peculiar and arched.

(1) **A 435·0**, EC 517·3 [MC 520·4, JC 522·0], S 2·80. (Nüke.) 1825, Germany, Saxony, Dresden, Opera. Tuning fork of Kapellmeister Reissiger, successor to C. M. von Weber. Nüke considers this to have been the Dresden pitch from 1825 to 1830.

(2) **A 435·0**. (Cagnard de la Tour, from de la Fage.) Paris, 1829; Italian Opera.

(3) **A 435**. (Ellis.) 1849 *a*, London; old fork long in possession of a gentleman in Ireland, marked "Philharmonic;" date conjectural, evidently of Sir George Smart's time (see A 433·2). The fork was very bad, and did not beat uniformly for four seconds, so that the pitch was only approximately determined by a unison.

(4) **A 435**. (Fr. Com.) 1859, Carlsruhe Opera. M. Jos. Strauss, Kapellmeister at Carlsruhe, informed the French Commission that this pitch fatigued his singers, both male and female, the least, and is best adapted for the execution of operas, both ancient and modern. The French Commission was often taunted with adopting as its pitch that of a tuning fork which the Carlsruhe Kapellmeister pulled out of his pocket; but reference to the pitches in this table, from A 433·5 to A 437, of about 1830 and earlier, will shew that A 435 or thereabouts, was a pitch very much used 30 years and more before the French Commission was appointed.

(5) **A 435·0**. (Nüke.) 1862, Austria, Vienna Opera; from an oboe of Prof. Sellner in Vienna. (See Delezenne's remarks under (2) A 418.)

(6) **A 435·0**. (Ellis.) 1860, Paris, Koenig's Diapason Normal; from copy in possession of Dr. Stone. This is what the diapason normal was intended to be.

(7) **A 435·0**. (Ellis.) 1877, Paris; copy of the Diapason Normal by Secretan, in the possession of Dr. W. H. Stone.

(8) **A 435·0** (Ellis.) 1877, Paris; copy of Diapason Normal, Modèle d'Orchestre, by Secretan, in my possession; actual measure, A 434·97.

A 435·2, EC 517·5 [MC 520·6, JC 522·2], S 2·82. (Scheibler's "Tonmesser," p. 53. No. 3, given as A 434·95 at 69° Fahr., here corrected to 59° Fahr.) 1834 *a*, Paris, Conservatoire, Concerts and Italian Opera; fork made by Gand, luthier du Conservatoire, Rue Croix des Petits Champs, which Scheibler trusted because he knew the maker to be skilful.

(1) **A 435·3**, EC 517·6 [MC 520·7, JC 522·3], S 2·82. (Older fork given as A 435·05 at 69° Fahr. Scheibler, "Tonmesser," p. 53, and here corrected to 59° Fahr.). 1834 *a*, Paris Conservatoire; an oldish fork to Scheibler, in 1834, and not trusted as much as Gand's A 435·2, from which it does not differ perceptibly. Cited by de la Fage as *Violons Gand*, 1834, as if from Scheibler, who says nothing of the kind.

(2) **A 435·3**, EC 517·7 [MC 520·7, JC 522·4], S 2·82. (Ellis.) 1859, Paris; copy of the Diapason Normal made by Secretan, and presented by the French Commission officially to Messrs. J. Broadwood and Sons, lent for measurement by Mr. Hipkins. (See A 435·4.)

A 435·4, EC 517·8 [MC 520·9, JC 522·5], S 2·82. (Ellis.) Paris, 1859; the French Diapason Normal as actually constructed for the French Commission by Secretan, and now (1880) existing in the Museum of the Conservatoire at Paris. It was constructed under the direction of Lissajous, and its pitch was determined by the Siren, as driven by Cavaillé-Coll's bellows of constant pressure. The actual pitch has been arrived at thus: M. Cavaillé-Coll measured the Diapason Normal by his copies of Scheibler's forks, of which the first was probably in unison with a fork which he tuned for me to represent V 440, but was really V 439·59. Now, he made the diapason normal 4·125 flatter than this; result, A 435·465. He may, however, have made it ·875 vib. above a fork of nominally V 435, which he sent me, and which was really 434·44 vib. This gives A 435·315 for the diapason normal. In the summer of 1878 my son took beats between the diapason normal and four other forks since measured, and the mean of 30 observations gave A 435·53. In the same year Mr. Hipkins found the diapason normal make 4·1 beats with a fork measured as V 439·5; this gives A 435·4, and is the mean of the other three. The following copies of the diapason normal were made by Secretan:—

	Measures.
For Berlin, sent to the Society of Arts in 1869 ...	435·5
Bought in Paris by Society of Arts	435·5
For French Commission, 1859, and given to Broadwoods	435·3
For French Exhibition, 1867, and given to Broadwoods	435·5
For Baden (dukedom), evidently too flat	434·49
For A. J. Ellis, "Modèle d'Orchestre"	434·97
For A. J. Ellis, a second copy, larger, and made with more care	435·79
In possession of Dr. W. H. Stone	434·95
Mean of 7 of these 8 forks (excluding Baden) ...	435·35
A (poor) Munich fork, stamped as correct at the Royal Office, and sent to the Society of Arts in 1869	435·05
A (fine) Russian fork made at St. Petersburg, and sent to the Society of Arts in 1869	435·74
Fork made by Koenig	434·95
A copy by Goumas, obtained for Covent Garden Opera, 1880	435·49
General mean of 11 of these 12 forks (excluding Baden)	435·34

Hence there is room for hesitation between 435·3 and 435·5, and I assume their mean, A 435·4, as due to Mr. Hipkins, armed with an excellent fork made by Kammen, and to the probable observations of M. Cavaillé-Coll. The original fork is in perfect condition, gilt but not burnished, 4$\frac{1}{16}$ in. from bend to extremity of prong, parallel prongs, mounted on resonance box, but inverted with the box uppermost, and the stem fastened to the top cross bar of a lyre, the strings of which are imitated by the prongs, furnished with two hammers with keys, one to strike and the other to damp, the whole under a glass case; the sound is very powerful. It has the maker's name, "Secretan," on one side, and on a brass plate on the stand is "Diapason Normal, 870 vibrations par seconde à la température de 15°." A second brass plate below has, "Arrêté Ministériel, en date du 16 Février, 1859. S. E. Monsieur Achille Fould, Ministre d'état." Thus preserved, it is the only authentic standard of pitch in the world, and like other standards, as those of length and weight, must be taken for what it is, not for what it was intended to be. The excellent forks of Koenig's are private

property, and may in various ways become injured (one I know has been so injured), but this standard is public property, is well guarded from injury, is perfectly accessible, and no other country has anything similar.

(1) **A 435·5.** EC 517·9 [MC 521·0, JC 522·6], S 2·82. (Ellis.) 1869. Berlin Opera. Copy of the Diapason Normal, made by Secretan, and sent officially to the Society of Arts to represent the pitch then used; lent for measurement. (See A 435·4.)

(2) **A 435·5.** (Ellis.) 1867, Paris. Copy of the Diapason Normal, made by Secretan, and presented officially to Messrs. J. Broadwood and Sons by the Commissioners of the French Great Exhibition of 1867. (See A 435·4.)

(3) **A 435·5.** (Ellis.) 1869, Paris. Copy of the diapason normal, made by Secretan, and purchased by the Society of Arts; lent for measurement. (See A 435·4.)

(4) **A 435·5.** (Ellis.) 1880. Copy by P. Goumas and Cie., of the French Normal obtained by the Covent-garden Opera in January, 1880, in order to reduce the orchestra to French pitch for the approaching season. The fork could scarcely ever be counted for more than 4 sec.

MA **435·6** [JA 434·2, EA 438·2], C 521·0, S 2·82; pressure, 3 in. (Ellis.) 1830 *c*, England; Arundel Parish Church. The date is conjectural, corresponding to the pitch, which may have been raised between 1820 and 1850. Measured from a pipe at Messrs. Walker's.

A 435·7. EC 518·2 [MC 521·2, JC 522·8], S 2·83. (Ellis.) 1869, Russia; St. Petersburgh. Russian copy of the Diapason Normal, sent officially to the Society of Arts, to represent the pitch then used in St. Petersburgh. A fine large fork. (See A 435·4.)

(1) **A 435·8.** EC 518·2 [MC 521·3, JC 522·9], S 2·83. (Drouet, from de la Fage.) 1830, Paris, opera. This is probably only another measurement of the pitch, taken as A 434 by Cagnard de la Tour.

(2) **A 435·8.** (Ellis.) 1878, Paris. Large copy of the Diapason Normal, made for me by Secretan, who was charged to correct it by the original. It has been subsequently tuned correctly by myself. (See A 435·4.)

(1.) **A 436·0.** MC 521·6 [JC 523·2, EC 521·6] S 2·84. (Sarti, maître de Chapelle to the Emperor; paper sent in 12th of May, 1796, in "Nova Acta Acad. Sci. Petr.," tom. xiii., 102, p. 30.) 8th of October, 1802, St. Petersburgh, opera. Successful experiments were made before the academy this day, with the two five-foot organ pipes (the Russian foot is the same as the English), with separate bellows and stops, a monochord and seconds pendulum. The pitch of the pipes could be altered by a small slit near the top, which could be wholly or partially closed by a slide. It was found, by help of the monochord, that when the beats of the pipes were one in a second, the pitch of the pipes was as 100 to 99, and hence as the difference was 1, the pitches of the pipes themselves were 100 and 99. When comparing these tones again with the 2 A of a violin in the St. Petersburgh band, also by means of the monochord, the 2 A was found to be A 436. Now, here we have at last three unisons to determine with the monochord and several lengths to measure. It is therefore impossible that the result should be accurate. An organ pipe five Russian (English) feet long, and four inches in diameter will produce V 100·4, according to Cavaillé-Coll's rule, Art. 8, note 5. Chladni speaks of this pitch as being very high. ("Akustik," p. 34).

(2) **EA 436·0** [MA 433·5, JA 432·1], C 518·52, S 2·84. (Ellis.) 1846 *p*, London. Copy, belonging to Mr. Hipkins, of an old fork bought by Mr. E. Greaves, tuning-fork maker of Sheffield, at the shop of Bates, the organ-builder of Ludgate-hill, and marked "Philharmonic." It has not since been retuned, and it now forms Mr. Hipkins's vocal pitch. As Broadwood's have used equal temperament since 1846, this is here entered under EA 436, but, when bought, it belonged clearly to mean temperament, being evidently a commercial copy of C 518, see MA 433, and A 433·2, and hence it is also entered under MA 433·5, as it belonged to mean temperament before 1846, and to equal temperament afterwards. It was the Philharmonic Pitch with which Mr. Hopkins compared the organs of Lübeck, Hamburg, and Strasburg ("The Organ," Chap. 38, ed. 1870), as I have ascertained by measuring his fork. Bates, the organ-builder, lived near the spot where the railway crosses the bottom of Ludgate-hill.

(3) **EA 436·0** [JA 432·1, MA 433·4] C 518·5, S 2·84. (Ellis.) London, 1878. Messrs. Bishop's standard for church or ans, taken from Metzler's fork, representing the EC to French Diapason Normal, see A 435·4.

(1) **A 436·1.** EC 518·6 [MC 521·7, JC 523·3] S 2·85. (Ellis.) 1869, Munich. Copy of the Diapason Normal made and stamped at the Government Office at Munich, sent officially to the Society of Arts to represent the pitch then used, see A 435·4.

(2) **A 436·1.** EC 518·6 [MC 521·7, JC 523·3] S 2·85. (Ellis.) 1878, London. Fork, in the possession of Messrs. Bryceson, to which they tuned the organ at Her Majesty's Theatre, Italian Opera. Meant for French pitch reduced a few years ago. See (2) A 445·5, and (2) A 444·9.

A 436·5. EC 519·1 [MC 532·2, JC 523·8], S 2·86. (Scheibler, "Tonmesser," p. 53, No. II. given as A 436·33 at 69° Fah., here corrected to 59° Fahr.) 1834 *c*, Vienna Opera. Fork belonging to Scheibler or his friend.

MA 436·6 [JA 433·9, EA 438·4], MC 522·3 [JC 520·5, EC 521·3], 4 G 195·26, S 2·87. (Ellis.) 1790 *c*, Padua. This was a copy made for me under direction of Prof. Rossetti from Stratico's fork (Zantedeschi's No. 2) at Padua, see A 425·2 and A 483·7, for references, and was inscribed *ol* for *sol*. Zantedeschi supposes that it was originally V 192, and that it had become about V 200, which he considers to represent an increase of about a semitone. But a semitone higher than V 192 is about V 203·5. The real difference between this G 195·2 and the high 1 G 385·1 (of A 483·7), or when reduced to the same octave G 390·53 and G 432·56 is S 1·77, not quite a tone. It is uncertain whether this fork was taken from an actually used pitch.

A 436·7. EC 519·3 [MC 522·4, JC 524·04], S 2·87 (Delezenne.) 1845, Florence, opera. (!) Fork obtained and sent to M. Delezenne by M. Marloye.

MA 436·8 [JA 435·4, EA 439·4], C 522·5, S 2·87. (Ellis.) 1740-80. Green's Organ in the refectory of Trinity College, Dublin. But as Green's usual pitch was C 506·3, see (1) A 423·2, this was probably sharpened about Sir G. Smart's time, see A 433·2. It has not been sharpened by Telford, who has had charge of it since 1843, and says that it could only have been sharpened by Ferdinand Weber.

A 436·9. EC 519·6 [MC 522·7, JC 524·3], S 2·88. (Ellis.) 1869, Würtemberg. Fork sent officially from Stuttgardt to the Society of Arts, as representing "the pitch usually adopted" in Würtemberg. It was stated at the same time that "there is no officially prescribed pitch in that country, although the new French is commonly in use;" so that this may be, after all, an imperfect copy of the French Diapason Normal. (See A 435·4.)

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6. *Modern Orchestral Pitch, and Church Pitch, Medium, marked* (*).

(1) **A 437·0.** EC 519·7 [MC 522·8, JC 524·4] S 2·88. (Cagnard de la Tour, from de la Fage.) 1836, Paris Italian Opera.

(2) **A 437·0.** (Fr. Com.) 1859, France, Toulouse; Conservatoire. See the Theatre, A 442·5, which is about a comma higher; the Fr. Com. says a quarter of a tone, and considers the difference remarkable, because Toulouse is a very musical place, with good singers. It also states that young singers here trained often found much difficulty, and even suffered a perceptible deterioration of voice, on exchanging their low pitch for the high pitch of Paris, then A 445·8 to A 446·2.

*(1) **MA 437·1** [JA the same, EA 440·6], MC 522·9 [JC 524·6, EC 524·58], 2 F 349·72, S 2·89. (Ellis.) England, 1666; Worcester Cathedral Organ, built by Thomas and Renatus Harris. This pitch is rather uncertain. It was measured from an original show-pipe belonging to Messrs. Hill and Sons, who rebuilt the old organ in 1842. Being a show-pipe, it was much too long, and holes had been cut behind to bring it to pitch. This part of the pipe had been broken off, and the pipe in this state measured V 361 at 57° F, or V 362 at 59° F, giving MA 452·5, which would have been exceedingly sharp. To imitate the shading effect of the piece cut off, which Mr. Hill's voicer estimated would reduce the pitch by ⅛ of a tone, a roll of paper was put on at the end, nearly two parts round, and then the result was as above. But very probably the pitch was thus lowered too much, and it is much more likely that the pitch was B. Schmidt's (see A 441·7.) If we suppose this to be the case, and that Thomas Harris, sen., who built the organ of Magdalene College, Oxford, used the same pitch, then R. Harris's proposal to reduce this last organ by "half a note" (see Rimbault's "Hist. Org." ed. 1870, p. 120) would mean to reduce it from a B *flat* foot organ to a B foot organ, which was R. Harris's own pitch (see A 427·7.) It would also show that B *flat* foot organs existed in England before B. Schmidt's time. It is very probable, however, that this may have been an A foot organ, see A 474·1, but then the pipes must have been shifted. The Magdalene organ may have also been A 474·1, and then R. Harris's proposal would have been to shift the pipes and make it A 441·7. The pitch of Messrs. Hill's organ in 1878, according to Mr. Done, the organist, as communicated to Mr. Hipkins, was C 532 at 66° Fahr., that is, at 59° Fahr., C 528·13, EA 444·1.

(2) **A 437·1.** (Delezenne.) Lille, 1841. Organ of St. Etienne, which had been completely rebuilt in this year, and hence this was probably the pitch of the period.

(1) **A 437·2.** MC 523·0 [JC 524·6, EC 519·9], S 2·89. (Ellis.) London. Old fork, formerly belonging to the late Prof. Faraday, lent by Mr. Blaikley, of Messrs. Boosey. This seems to have been merely a music-shop fork. There was no second fork tuned in accordance with it.

(2) **A 437·2.** (Ellis.) London. Old fork, stamped A Philharmonic, but rather sharp for its apparent date.

A 437·3. EC 520·1 [MC 523·1, JC 524·6], 4 A 268·65, S 2·89. (Fischer, Abhandl. Akad. Wiss., Berlin, 1822 and 3, p. 206.) 1822, Berlin; from a fork furnished by Kammermusikus Pichler, who tuned the piano for the great theatre. A vertical wire, stretched by a constant weight, was limited by a bridge till it sounded in unison with a certain fork. Of course, the stretching weight should be increased by the length of the string below the limiting bridge and the constant weight; but this was not regarded. This neglect is one element of uncertainty. The thickness of the wire necessary to support 480 Prussian Loth = 247·46 English ounces, is another source of error. Delezenne thinks that all Fischer's determinations may be V 5 too flat from this cause alone (see A 431·7, 424·2, and 427·6). The string sounded only three or four seconds, so that the unison was very difficult to seize, experiments had to be made at night, and much practice was required. By

dint of great care, the difference between the least and greatest lengths was reduced, under favourable circumstances, to ·03, and unfavourable, to 0·5, Prussian or English inch. The value in the present case was the mean of 30 trials. Fischer, however, reckons that he cannot be more than one simple vibration wrong in any case, and, in this case, not more than 0·1 vibration. In Fischer's memoirs there are curious misprints. His constant $= \frac{1}{3}$ (log 375 + log 50 + log 480 − log ·0889) $= \frac{1}{3} \times 8{\cdot}0053407$, and he has accidentally only divided the characteristic, and printed 4·0053407 in place of 4·0026703; but the calculations are made from the correct value. See the formula Art. 13, note 6. The present pitch is high, and I have reckoned equal temperament, as that was used early in the North of Germany (see A 489·2).

A 437·4. EC 520·2 [MC 523·3, JC 524·9], S 2·89. (Delezenne.) 1854, Paris; opera. Four forks, purchased before 1854, by Delezenne, and found in unison; a fifth fork, not in unison, was rejected. There is no other authority for this pitch.

A 437·5. EC 520·3 [MC 523.4, JC 525·0], S 2·90. (Naeke.) 1823, Vienna. Performance of Weber's Euryanthe.

***EA 437·7** [MA 435·1, JA 433·8], C 520·5, S 2·91. (Ellis.) England; Great Yarmouth Parish Church, built by Byfield, Jordan, and Bridge (see MA 425·9), after it had been equally tempered by Messrs. Hill and Son, and "trimmed." Probably the old C was C 509·5, and it was certainly then in meantone temperament. From a fork sent me by the organist, Mr. Henry Stonex, which was said to beat so slowly that the beats could not be counted. This organ never had any quarter tones as reported.

A 437·8. EC 521·8 [MC 523·1, JC 525·4], S 2·91. (Ellis). 1862, Dresden. Fork given by the Direction of the Court Theatre to its librarian, Herr Moritz Fürstenau, to represent the pitch after the Conference and Experiments of Pitch held at the theatre (see above Art 28), and kindly sent to me for measurement. Meant for A 440. (See A 438·9 and A 439·1.) This is a good specimen of varieties of forks meant to have the same pitch.

(1) **A 438·0.** EC 520·9 [MC 524, JC 525·6], S 2·92. (Cagniard de la Tour from de la Fage.) 1829, Paris; Opéra Comique.

*(2) **A 438·0.** (Stone.) 1877, Westminster-abbey. Observed by Dr. W. H. Stone with a König's V 435, in the Abbey, in May; temperature unknown. (See (2) A 422·5.)

EA 438·2 [MA 441·7, JA the same, if we assume it to be a major Third below the C *sharp* measured], EC 521·2 [MC 528·4, JC 530, if we take it a just minor Third above the JA just determined], 2 C *sharp* 276·07, S 2·93. (De Prony, "Mée. Anal.," Part II, p. 495.) 1815, Paris. An iron wire, 0·5825 metres long, weighing 0·615 grammes, and stretched by a weight of 11134 grammes, was in unison with C *sharp*, but of what pitch is not said. Perhaps this C *sharp* and the F of EA 444·5, which see, were only those on De Prony's own pianoforte. The pitch given agrees with that calculated by the common formula (see Art. 13, note 6).

MA 438·5 (JA 437·1, EA 441·1), C 524·5, S 2·94. (Cavaillé-Coll.) 1800c, England. Fork of English make, formerly belonging to M. Aristide Cavaillé-Coll's father, communicated by M. Cavaillé-Coll.

*(1) **MA 438·9** [EA 436·3], MC 525·2 [EC 518·8], 2 F *sharp* 366·9, S 295. (Ellis.) England; Boston Organ, Lincolnshire. Attributed to Christian Smith, 1696. The pipe was a flute stop, and very uncertain. There was, also, a 2 A, much cut, giving A 458·4, which could not fit into the above, and is extremely sharp, belonging to the A 454·2 series; so that there is, probably, some mistake. As measured from F *sharp*, the organ approaches to the pitch of B. Schmidt, of whom Chr. Smith was a nephew. Both pipes belong to Messrs. Hill and Son, who repaired the organ.

(2) **A 438·9,** EC 522·0 [MC 525·1, JC 527·3], S 2·95. (Ellis.) 1869, Dresden Theatre. Fork sent officially from Leipzig to the Society of Arts, and lent for measurement. (See also A 437·8, 439·1, and 440·4.)

***MA 439·0** [JA 437·5, EA 441·5], C 525, S 2·95. (Ellis.) London; St. Mary's Chapel, Paddington, next the Lying-in Hospital, date and maker unknown. The organ was repaired by Messrs. Bevington, and the 2 C 262·5 was measured direct; also another C 526·3, a fifteenth of the mounted cornet, great organ; a stop which has long gone out. I have taken the pitch from the larger pipe.

(1) **MA 439·4,** MC and JC 525·6 [EC 521·5], 4 E 164·25, S 2·97. (Delezenne.) No date, Lille. Old fork, purchased at the sale of the Marquis d'Aligre; prongs, 174 mm. long. From its value, 4 E 164·25, Delezenne first derived 4 JC 131·4; and then, taking three just Fifths up, reached 2 A 443·48, which he regarded as the pitch. But this would only do on the open strings of a tenor violin. The organs used the flatter Fifths of the meantone temperament. Hence I have derived the MA, MC, and JC, and EC immediately from the pitch of E.

(2) **A 439·4,** EC 522·5 [MC 525·6, JC 527·2], S 2·98. (Scheibler's "Tonmesser," p. 53, No. III.; given as A 439·15 at 69° Fahr., here corrected to 59° Fahr.) 1834c, Vienna; Opera. Fork belonging to Scheibler or his friends.

(3) **A 439·4,** EC 522·6 [MC 525·6, JC 527·3], S 2·97. (Ellis.) 1878, Dresden Opera. Fork prepared for me by the Court organ-builder Jehmlich, and sent to me by Herr Moritz Fürstenau, librarian of the theatre. (See also A 438·9, 437·8.)

(1) **A 439·5,** MC 525·7 [JC 527·3, EC 522·6], S 2·98. (McLeod and Ellis.) 1812, France; Paris Conservatoire. Copy of a fork (compared with the original, which is not in good condition, by M. Cavaillé-Coll, who pronounced it "sufficiently correct") preserved in the Musée du Conservatoire (No. 492 of catalogue), and purporting to be that used in 1812 at the Conservatoire. (Compare A 440·9, and A 435·2.) The catalogue says that it is the fifth of a tone flatter than the diapason normal; it is, actually, S 0·16 sharper. Length of the original, from bend to prong, 3⅜ in. converging prongs, conical brass cup at bottom of stem. The top is crushed, as if from being held in a vice. The fork is a very poor one, and its sound is scarcely audible for 10 sec.; but, as compared by my son, it also gave A 439·5.

*(2) **EA 439·5** [MA 436·9, JA 436·5], C 522·7, S 2·98. (Ellis.) 1855; Organ of Parish Church, Barking, Essex. The original organ was built by Byfield and Green, 1770; but the pipes were shifted a Tone, and cut and equally tempered, by Walker in 1855. It was, therefore, probably an A foot organ originally, for A 474·1 gives B *flat* 507·3, which is just a quarter of a Tone flatter than C 522·7, and hence could be easily cut down to it, and the markings on the pipes show that old B *flat* was made into new C.

A 439·9, EC 523·2 [MC 526·3, JC 527·9], S 2·99. (Delezenne.) Turin, 1845. Fork obtained and lent to M. Delezenne by M. Marloye.

(1) **A 440·0,** EC 523·25 [MC 526·36, JC 528], S 3·00 (Lissajous, cited by de la Fage.) Paris, 1829. Orchestra pitch of opera (see A 425·8). Fork verified by M. Monneron for A. de la Fage.

(2) **A 440·0.** (Wieprecht, cited by Fr. Com.) 1830, Berlin; opera. Original statement by Wieprecht not found.

*(3) **EA 440·0** [MA 437·4, JA 436], C 523·2, S 3·00. (Ellis.) 1878, London. Messrs. Gray and Davison's standard pipe for organs. They told me they had lowered their pitch lately.

(1) **A 440·2.** EC 523·5 [A1 C 526·6, JC 528·3], S 3·01. (Scheibler measured this as A 440 by his own forks, which were adapted for 69° Fahr.; hence, correcting to 59° Fahr., we have the above.) 1834, Stuttgart; Congress of Physicists, who accepted Scheibler's proposal, which Scheibler says ("Tonmesser," p. 53), was selected as the mean of the variation of Vienna grand pianos by temperature. de la Fage says that this very fork was measured by Lissajous in 1856, at the request of M. Bodin, and found to be A 440·3. The French measures are intended for 59° F., = 15° C. Hence the difference would be only V 0·1; and, if Lissajous really measured at 55° Fahr., the agreement would be complete. But, as the great Diapason Normal is A 435·4, in place of A 435, there is no reason to suppose that the measure was made with such extreme accuracy. Whether this standard fork exists still, and where, or how it is preserved, I do not know.

*(2) **EA 440·2** [MA 437·7, JA 436·3], C 523·6, S 3·01, pressure, 3 in. (Ellis.) 1879, London; Messrs. Walkers' standard pipe.

A 440·3, EC 523·6 [MC 526·7, JC 528·4], S 3·01. (Scheibler's "Tonmesser," p. 53. No. IV. given as A 440·1 at 69° Fahr, and here corrected to 59° Fahr.) 1834c, Vienna Opera. Fork belonging to Scheibler or his friends.

MA 440·4 [JA 439·0, EA 492·9], C 526·8, 2 C 263·4, S 3·01. (Ellis.) London, date unknown. Old fork, found by Messrs. Bishop in an old amateur organ at Westminster. It was a large fork, giving the 2 C.

(1) **A 440·5,** EC 523·8 [MC 526·9, JC 528·6], S 3·02. (Delezenne.) 1840, Paris Opera. Fork said to have been adjusted to this pitch by M. Pleyel, date unknown.

*(2) **A 440·5.** (Delezenne.) 1854, Lille. Organ of St. Catherine, repaired, and evidently re-tuned to concert pitch.

*(3) **EA 440·5** [MA 437·9, JA 436·5] C 523·7, S 3·02. (Ellis.) 1878; Messrs. Bevington's standard pipe. But Messrs. Bevington said that they have since raised their pitch 2 to 4 beats; hence, possibly, they use about E A 444, C 528.

A 440·9, EC 524·3 [MC 527·5, JC 529·1], S 3·03. (Scheibler's "Tonmesser," p. 53, No. 4, where it is given as A 440·7, at 69° Fahr., and is here reduced to 59° Fahr.). 1834c. Paris. Conservatoire Concerts and Italian Opera (cited by M. Cavaillé-Coll as Scheibler's pitch of Grand Opera in 1834). This was not trusted by Scheibler's so much as A 435·2.

(1) **A 441·0.** EC 524·5 [MC 527·6, JC 529·2], S 3·04. (Delezenne.) 1836-39, Paris Opera. Fork of M. Leibner, whose duty it was to keep the pianos of the opera to the pitch of the orchestra, for rehearsals. Verified by Meyerbeer at the rehearsal of the "Huguenots." In 1849 it agreed precisely with the oboe of M. Verroust, which gave the pitch at performance.

(2) **A 441·0.** (Cagniard de la Tour, from de la Fage and Cavaillé-Coll). Paris, 1836; Opéra Comique.

(3) **A 441·0.** (Fr. Com.), 1839, Dresden Opera. Fork apparently sent by Kapellmeister Reissiger, who wrote, "The great elevation of the diapason destroys and effaces the effect and character of ancient music—of the master-pieces of Mozart, Gluck, and Beethoven." Reissiger's own fork was (1) A 435. The Dresden pitch was intentionally A 440. (See A 438·9, see, also, the proceedings of the Dresden Conference, Art. 28, above.)

(4) **EA 441·0** [MA 438·3, JA 437], C 524·4, S 3·04. (Ellis.) 1879, London. Church organ pitch of Messrs. Lewis, of Brixton, from a fork lent me by these well-known organ-builders.

A 441·1, EC 524·5 [MC 527·7, JC 529·3], S 3·04. (Scheibler's "Tonmesser," p. 53. No. V., where it is given as A 440·87 at 69° Fahr., and here reduced to 59° Fahr.) 1834. Vienna opera. Fork given by Pro. Blahetka to Scheibler as a trustworthy A of the Vienna orchestra. Cited as A 440·7 by Delezenne, who confused it with the Berlin fork, A 441·8; de la Fage apparently cites this as both A 440·37 and A 440·33. This fork was found in a lumber

room in Scheibler's former dwelling in 1879, and was lent to me for examination. It had the words, "Professor Blahetka, Wiener Orchestra," written on the inside of the prongs. It had, apparently, been slightly wrenched, and could not well be counted for 6 secs.; it was also exceedingly rusty. Its present pitch, so far as I could ascertain, is A 439·9, so that it has lost V 1·2, owing to ill-treatment. This is the largest loss in any tuning fork I have yet been able to ascertain (see Art. 10 above, and A 441·8, (1)A 443·2 below).

A 441·2, EC 524·7 [MC 527·8, JC 529·4], S 3·05. (Ellis.) 1878, London, Covent-garden. Fork then in possession of Messrs. Bryceson (since retuned), giving the pitch to which the organ at Covent-garden Opera was tuned in 1878. In 1879 it was raised to A 445·6, which see, while in the theatre itself Mr. Hipkins observed it by beats with his own fork as A 449·7, which see. Mr. Hipkins also recorded the pitch of the harmonium at Covent-garden, June, 1877, as A 449·2, and in July, 1878, as A 447·5, while the orchestra at this last date was A 449·9. See these numbers. The heat of the theatre sharpens the organ, so that when, in 1879, Mr. Pitman, the organist, adopted the plan of keeping the A of the organ going for half an hour for the band to tune by, the pitch rose. In 1880, the pitch is to be reduced to the French A 435·4.

EA 441·3 [MA 438·8, JA 437·3], C 524·8, S 3·05. (Ellis.) 1842, London. Fork bought about 1842, when Mr. Hullah was giving lessons in singing on Wilhem's method, and issued by his authority, stamped, "Do. 512, vib. per sec. C. J. W. Parker, West Strand." Another copy issued at the same time, and bought by Mr. de Pontigny, measured C 525·06, or within 0·2 vib. of the same pitch. The error was therefore not the fork maker's. In his report to the Society of Arts on Uniform Musical Pitch, 3rd June, 1859, Mr. Hullah says that the original of this fork was tuned by the siren, and that it had been largely used, and that several important organs had been tuned to it, and also states in a note that Mr. J. H. Griesbach had measured the fork by his process, and found it C 521·6. This statement shows the untrustworthiness of both methods. A particular point had been made of reaching C 512, and C 524·8 resulted, being S ·43 too sharp, that is very nearly a quarter of a tone, and not, as Mr. Hullah says, a quarter of a semitone.

* (1) MA **441·7** [JA 441·0, EA 446·1], MC 528·4 [JC 531·7, EC 530·5], B *flat*, 472·6, S 3·07. (Ellis.) 1690, Hampton-court. Bernhardt Schmidt's Organ. Firstly, a B *flat* pipe (12 in. long and 1·2 in. in diameter), belonging to this organ before it was altered by Messrs. Hill and Sons, and in possession of Messrs. Broadwood, was measured as 470·9, at first; but after the mouth had been cleaned at 472·9 and 472·3, mean 472·6, here adopted, all reduced to 59° F. Messrs. Hill informed me that they had not altered the pitch of C when repairing the organ. Secondly, on 15th August, 1878, I measured the pitch of C of the Choir Organ at Hampton-court Palace as C 528·7. (See MA 442.) Thirdly, on 14th October, 1878, I measured at Messrs. Hill and Sons' a perfectly untouched 1 A from the old Echo Organ at Hampton-court. I had to tune a pipe to the Octave below, as my measuring forks did not reach so high, and this gave me A 441·25 at 59° Fahr., whence MC 527·9. Fourthly, Dr. Robert Smith ("Harmonics" 1859, p. 192) measured his Trinity College Organ D, which was B. Schmidt's original C (for the pipes had been shifted), in September, "at temperate or thereabouts," as V 524; in November, when "cold," as V 508; and inAugust, when "pretty hot," as V 536. If we assume "pretty hot" to mean 72° Fahr., "temperate or thereabouts" to be 59½°, and "cold" to be 21° Fahr., which is possible, then the numbers of these three temperatures gives the original C as 528·8, 528·6, and 528·1 respectively, which agrees remarkably well with the above MC 528·4. Dr. R. Smith's method of measuring by a weighted string was perhaps not safe within 4 or 5 vib., and the method of reduction of temperature is also not perfectly safe. From these measurements, there can be little doubt that this was one of Bernhardt Schmidt's pitches. (Mr. T. Hill is positive that there is no trace of the pipes ever having been shifted.) But it also seems to be certain that he used a sharper pitch at St. James's Chapel Royal, and Durham Cathedral. (See A 474·1.) What he used at St. Paul's cannot be inferred with certainty. (See A 444·7.) The Temple organ is also doubtful. All these organs seem certainly to have this pitch at one time, and both the Temple and St. Paul's were flattened by Bishop. (See end of remarks on (1) A 422·5.)

* (2) MA **441·7**, (Hill.) 1814*p*, London; Whitehall, Banqueting-room. Mr. T. Hill says that this organ was sharp, and of the same pitch as Hampton-court before he altered it; but it had been altered by Elliott in 1814. It is possible, however, that it was originally as sharp as the original Durham organ (see A 474·1), before Mr. Hill had to deal with it. It was the first organ built by Bernhardt Schmidt in England. Indeed, it is said that Charles II. sent for him on purpose to build it. It was always in the banqueting-room; so that it escaped the flames when the chapel was burned, and George I. afterwards opened the banquetting-room as the Chapel Royal. Purcell was organist there.

(3) **A 441·7**, EC 525·3 [MC 528·4, JC 530·0], S 3·07. (De Prony, from de la Fage.) Paris, 1832. Proposed as a standard by De Prony, according to A. de la Fage. It will be observed that the EC and JC here are different from what they are in (1) MA 441·7. The reason is that here they are taken from an original A, and there from an original B *flat*.

* (4) **EA 441·7** [MA 439·1, JA 437·8], C 525·3, S 3·07, pressure 2¾ inches. (Ellis.) London, Aug. 1878. Standard pipe of Messrs. Hill and Sons, organ-builders. Here again the numbers are different from (1) MA 441·7, because they are calculated from an original C.

A 441·8, EC 525·4 [MC 528·6, JC 530·2], S 3·07. (Scheibler, "Tonmesser," p. 53, given as A 441·625, here reduced to 59° Fahr.) 1834*c*, Berlin; Opera. Considered by Scheibler a trustworthy fork of the Berlin Orchestra; but he was certain that Berlin forks varied V 1·5 to V 2, and thought this sufficient to make a part possible or impossible to a singer. M. Cavaillé-Coll, who cites this, also cites A 441·025 as a pitch of the Vienna opera measured by Scheibler, but I do not find it in his book. This fork was found at the same time and place as A 441·1; it has been a good fork, and can easily be counted for 10 seconds, but it is very rusty. It now measures A 440·9. Hence it has lost V 0·9. The other fork had lost V 1·2. The beats between the forks in Scheibler's time were 0·75 per second. They were now, by the measurements, 1·07, and by observation 1·0, which was difficult to observe with accuracy on account of the badness of the other fork. Hence the beats between them have increased ·24 to ·3. This is accounted for by the difference of their loss, 1·2 − ·9 = ·3. This loss by rust is considerable. Large forks do not seem to suffer so much. Scheibler's V 219, found at the same time, is now V 218·77, and hence has lost ·23 by rust. (See A 443·2 below, and Art. 10 above.)

* (1) MA **442·0** [JA 440·6, EA 444·6], C 528·7, S 3·08. (Ellis.) London, 1690. B. Schmidt's Organ, at Hampton-court, measured from the unaltered C of the choir organ (see MA 441·7). Messrs. Hill had altered the temperament to equal, and I measured their EA 445, which agrees closely with the above. All reduced to 59° Fahr.

(1) **A 442·5**, EC 526·2 [MC 529·3, JC 532·0], S 3·10. (Delezenne.) 1854, Paris; Italian Opera. As determined by reeds giving that pitch, for which there is no other authority.

(2) **A 442·5**. (Fr. Com.) 1859, France; Toulouse, Opera. (See (2) A 437·0.) Fork sent by M. Mériel, Director of the School of Music at Toulouse.

(3) **A 442·5**. 1859; Brussells, Theatre. Pitch recommended and used by M. Bender, Musical Director to the King of the Belgians, a quarter of a tone flatter than his military pitch, A 455·5, which see.

* **A 442·7**, EC 526·5 [MC 529·6, JC 531·2], S 3·11. (Ellis.) 1878, Austria. Small Franciscan organ at Vienna, kept at modern pitch (compare St. Stefan, A 443·2) for the purpose of musical services and performances ("zur Benützung bey musikalischen Aemtern oder Aufführungen"). From a fork tuned for me by Organ-builder Ullmann, who also tuned C 525·5, showing that the temperament was equal, but not quite perfect. (See large organ, A 457·6.)

(1) **443·0**, EC 526·8 [MC 529·9, JC 531·6], S 3·12. (Fr. Com.) 1859; Bordeaux, Opera. Apparently the fork sent by M. Mézeral, conductor of the orchestra, who said that he first adopted the Paris pitch, A 448, but found it fatigued his singers too much. Yet the difference between that pitch and this is barely a comma.

(2) **A 443·0**. (Fr. Com.) 1859, Germany, Stuttgardt, Opera.

* (1) **A 443·1**, MC 530·1 [JC 531·7, EC 526·9], S 3·12; pressure 3 in. (Ellis.) 1815*c*, Durham; organ built by Bernhardt Schmidt, as altered by shifting. One of the original pipes, 2 B *flat*, was of exactly the same dimensions as that from Hampton-court (see A 441·7); but, as it had been pieced by Bishop, I selected the 2 A, which was unpieced. It is, however, certain that this 2 A was originally Schmidt's 2 G *sharp*, giving A 474·1, which see. The present organ, by Willis, is in his own pitch (see A 444·7).

(2) **A 443·1**, EC 527·0 [MC 530·1, JC 531·8], S 3·12. (Ellis.) 1869, Italy; Bologna, Liceo Musicale. Fork sent officially to the Society of Arts as representing the pitch used at this Liceo. Measured graphically by Sig. Lorenzo della Casa, Professor of Physics at Bologna, and the engineer Sacchetti, and by the siren by Sig. Carlo Verardi, Professor of Music there, as 443·88; apparently a mean of many attempts. Meant for A 444.

(1) **A 443·2**, EC 527·1 [MC 530·3, JC 531·9], S 3·13. (Scheibler, as cited by Delezenne, who gives A 443·0; but, if Scheibler published the numbers, they must be reduced to 59° Fahr., as above.) 1834, Vienna; Streicher. Although I cannot find this pitch in Scheibler's "Tonmesser," a fork, with diverging prongs, and very rusty, was found at the same time as the forks A 441·1 and 441·8, bearing the name "Streicher," in ink, inside one prong. The fork now measures A 442·78; hence it has, apparently, lost V 0·43 by rust, which is not excessive. (See Art. 10, above.)

* (2) **A 443·2**, EC 527·1 [MC 530·2, JC 531·7], S 3·13. (Ellis.) 1878, Austria; Vienna, St. Stefan Cathedral Organ. From a fork especially tuned for me by the Organ-builder Ullmann, giving A 440·1 at 9° R. The pitch was intended to be the same as the opera (see A 446·8), and the organ was tuned to the same fork. If so, there must have been an insufficient allowance for temperature. This is, however, a modern pitch, and does not at all represent the ancient pitch of this organ, which was a very old one when described by Hopkins ("Organ" ed. 1870, p. 406).

(1) **A 443·3**, EC 527·1 [MC 530·3, JC 531·9], S 3·13. (Wölfel.) 1836, Paris; Wölfel's pianos. Cavaillé-Coll, who cites this pitch, explains that Wölfel, a pianoforte-maker in Paris, made a tonometer for himself from Scheibler's description. Delezenne and de la Fage attributes the measurement to Scheibler, but I find nothing about it in Scheibler's works.

(2) **A 443·3**. (Fr. Com.) 1859, Germany, Gotha, Opera.

* EA **443·4** [MA 440·8, JA 439·4], C 527·3, S 3·13. (Ellis.) 1878, London; Messrs. Bryceson's standard pipe.

A **443·5**. EC 527·4 [MC 530·5, JC 532·2], S 3·14. (Fr. Com.) 1859, Germany, Brunswick, Opera. Fork apparently sent by Kapellmeister Franz Abt.

* (1) EA **443·7** [MA 441·0, JA 439·6], C 527·6, S 3·14; pressure, 3 in. (Ellis.) England; Salisbury, St. Edmund's; the pitch subsequently raised. From a pipe at Messrs. Walkers. Date unknown; pitch apparently modern.

* (2) EA **443·7**. (Ellis.) London, St. George's-in-the-East. From a pipe in possession of Messrs. Walkers.

EA **444·0** [MA 441·4, JA 440], C 528, S 3·16. 1860. Intended, but unexecuted standard of the Society of Arts. For real standards, see A 449·4 and 445·7; and for copies, see A 448·0, 448·4, 445·1. This was also proposed by M. Aristide Cavaillé-Coll in 1858 (see A 444·3).

EA **444·2** [JA 440·2, MA 441·5], C 528·2, S 3·16. (Ellis.) London. Old fork, date unknown, marked "C., Philharmonic." I cannot assign a date, but, as it does not belong to the old C 528 pitch, I put it in eq. temp.

* A **444·3**, EC 528·4 [MC 531·5, JC 533·1], S 3·17. (Cavaillé-Coll, "du Ton Normal," p. 13.) 1840. France; St. Denis, cathedral organ, as re-built by M. Cavaillé-Coll, who advocates the use of A 444, EC 528 for the standard, like the Society of Arts.

(1) EA **444·5** [MA 441·0, JA the same], EC 528·5 [MC 527·5, JC 529·2], 16 F 44·098, S 3·18 (De Prony, "Méc. Anal.," Part 2, p. 495.) 1815, Paris. It was determined as the unison of a brass wire, 1·48 mètres long, weighing 12·783 millegrammes, and stretched by a weight of 15,000 millegrammes. The usual formula (Art. 13, note 5) gives the same result. Of course, there is considerable uncertainty. Possibly both this experiment and the former (A 438·2) referred to the same real pitch, but, if so, as they differ by V 6·3, they would serve to show the untrustworthiness of the method. De Prony uses equal temperament only, and considers that this pitch is that of the actual orchestra, which he says is about one-twelfth of an octave above the old ton d'église employed by Sauveur. He reduces this and the experiment in EA 438·2 to give C 132·29 and C 130·36 (which should be, taking equal temperament, EC 132·14 and EC 130·28). Then he reduces both by one semitone, and obtains what he supposes to be the old ecclesiastical pitches, C 124 and C 123 (which should have been C 124·7 and C 122·97); and he then compares them with Sauveur's C 122 (which should have been C 120·875, see A 406·6). The whole process is entirely erroneous. Equal temperament should not have been employed, nor can the orchestral pitch of 1815 be assumed as the ton de chambre of the ton d'église of 1713; nor, finally, does Sauveur represent his pitch as the ton d'église. The mean of these two experiments of de Prony, is EA 441·35. M. Cavaillé-Coll ("Du Ton Normal," p. 13) cites from de Prony the mean of two experiments in 1832 (instead of 1815) as A 441·915. Can they be corrections of the same?

(2) **444·5**, EC 528·6 [MC 531·74, JC 533·3], S 3·18. (Lissajous, from de la Fage). 1858, Madrid, Theatre Royal. Sent to Adrien de la Fage by D. Hilarion Eslava, Maître de Chapelle to the Queen of Spain. The ton de chapelle is said to be an equal semitone flatter. (See A 419·6.) [French pitch was adopted by the Spanish Government, 18th March, 1879.]

* EA **444·6** [MA 442, JA 440·6], C 528·7, S 3·18. (Ellis.) 1877, London; St. Paul's Organ. Fork, in possession of Mr. Hipkins, tuned to a piano which had been tuned to St. Paul's organ for the performance of the Passion Music in March, 1877, and had been observed by the organist, Dr. Stainer, to go well with it. But this was after the organ had been adjusted and almost rebuilt by Willis to his own pitch, A 445·2, which is only V 6 sharper than the above, and hence implies that the piano was tuned to the organ at 57·5° Fahr. in place of 59° Fahr.

* A **444·7**, EC 528·9 [MC 532·0, 533·6], S 3·18. (Ellis.) 1879, England. Durham Cathedral organ, after it had been rebuilt by Willis to his own pitch, A 445·2, from which my measurement differs by only V 0·5, and considering that the Durham organ was measured in the organ at 44° Fahr., and Mr. Willis's standard pipe separately at 61·5° Fahr., and then both reduced to 59° Fahr., it shows a very satisfactory agreement.

(1) A **444·8** EC 528·9 [MC 532·0, JC 533·7], S 3·19 (Fr. Com.) 1859, Italy, Turin, Opera. This was apparently the fork sent to the Commission by M. Coccia, director of the Philharmonic Society at Turin, and *maestro di capella* of the Cathedral of Novara. M. Coccia says that this pitch is the mildest (*il più mite*) that he has met with.

(2) A **444·8** (Fr. Com.) 1859, Germany, Weimar, Opera.

(3) A **444·8** (Fr. Com.) 1859, Würtemberg; concerts. Fork apparently sent by Herr Joseph Abenheim, Kapellmeister.

(1) A **444·9**, EC 529·1 [MC 532·21, JC 533·8], S 3·19. (Lissajous, from de la Fage.) Naples, 1857; San Carlo. Fork sent by Mons. E. Guillaume, conductor of the band of the Theatres Royal, Naples, to the (French) Society of Pianoforte-makers.

(2) A **444·9**. (Hipkins.) 1880, London; her Majesty's Opera. Fork of the theatre. See (2) A 436·1, and (2) A 445·5.

(1) A **445·0**, EC 529·2 [MC 532·3, JC 534], S 3·20. (Näke.) 1862. Austria, Vienna, Pianos. The piano of Kapellmeister Proch, while the opera was at A 406, which see; and also A 454·.

(2) A **445·0**. (Schmahl.) Germany, Hamburg. This is given me by Herr Schmahl (see A 494·5) as the "old Hamburg pitch," but at what date is not stated.

(1) A **445·1**, EC 529·3 [MC 532·4, JC 534·1], S 3·21 (Scheibler's "Tonmesser," p. 53, No. VI., given as 444·87, at 69° Fahr., and here reduced to 59° Fahr.). 1834 *c*, Vienna, Opera. Fork belonging to Scheibler or his friends, the highest of six of Vienna, of which he gives the measure, and he considers it to be a "monstrous growth" (*Auswuchs*). This is, apparently, the fork cited as A 445 by Delezenne (Lille Mem., 1854, p. 15), and also by Cavaillé-Coll ("Du Ton Normal," p. 13). It is cited both as A 445 and A 445·44, apparently by de la Fage, who gives the latter number to the Vienna Conservatoire.

(2) EA **445·1** [MA 442·5, JA 441·1], C 529·3, S 3·20. (Ellis.) London, 1878. Fork sold by Cramer as Society of Arts pitch, in possession of Messrs. Bishop, organ-builders.

*EA **445·2** [MA 442·5, JA 441·2], C 529·4, S 3·20. (Ellis, at 59° Fahr.), London. Church pitch of Mr. Henry Willis, to which are tuned the present organs of St. Paul's and Durham Cathedrals (see A 444·6 and A 444·7), and also of Salisbury Cathedral, built 1878, of Glasgow Cathedral (Established Church of Scotland), and the new Episcopal Cathedral of St. Mary, Edinburgh, all recently built by Mr. Willis. This pitch was derived from a pipe tuned at 65° Fahr. to a Society of Arts fork, by an unknown maker, now mislaid. Now, the pipe giving C 529·4, at 59° Fahr., will sound C 532·7, at 65° Fahr., whence we derive EA 447·9. This makes it probable that it was one of Cramer's forks (see A 448·4). It was really flatter than Griesbach's C 534·46, intended for C 528 (see A 449·4). I am much indebted to Mr. Willis for much polite attention respecting his organs.

A **445·4**, EC 529·7 [MC 532·9, JC 534·5], S 3·21 (Delezenne.) Vienna, 1845; Conservatorium. Fork obtained, and lent to M. Delezenne by M. Marloye.

(1) EA **445·5** [MA 442·8, JA 441·5], C 529·7, S 3·21. (Ellis.) London, 1860. Copy of Broadwood's medium pitch, made for the Society of Arts, 1860 (see EA 445·9 and 446·2).

(2) A **445·5**. (Hipkins and Ellis.) October, 1879, London. Her Majesty's Opera band during performance, from a fork tuned by Mr. Hipkins, and measured by me (see (2) A 444·9).

A **445·6**, EC 529·9 [MC 533·1, JC 534·7], S 3·22. (Ellis.) 1879, London, Covent-garden. Fork in the possession of Mr. Pitman, organist, and Sig. Vianesi, conductor, to which the organ at Covent-garden Opera was tuned at the beginning of the season of 1879. Mr. Pitman said that the new pitch was settled at the end of the previous season, because it was impossible to get the oboe, bassoon, and flute to play at a lower pitch. He also said that the singers themselves, having been used to a higher pitch, objected to using a low one. During actual performance, when the organ A was given out for the band to tune from, Mr. Hipkins found A 449·7; see also A 441·2.

A **445·7**, EC 530·1 [MC 533·2, JC 534·8], S 3·22. (Ellis.) 1880, London. Fork made by Mr. J. H. Griesbach to represent 2 A equally tempered to his 1 C 528, which was really C 534·46 (see A 449·4). The box containing it says:—"The Pitch of the Fork producing the note 2 A [in musical notation] derived from the above-named 1 C [also in musical notation], was obtained by a monochord, the length of its string 20 in., tuned to the note 2 C [in musical notation] from the 1 C 528 vibrations in a second, the whole length of string being equal to 1,000, the tempered 2 A is produced by ·594 thousands." It should be ·5946036. With so short a string, tuned to the Octave below by ear only, errors were inevitable. It is remarkable that this pitch is more nearly what was wanted (A 444) than Griesbach's C 534·46 (see A 449·4). Fork lent by the Society of Arts. (See (2) A 448·4.)

*(1) **MA 445·8** [JA 447·2, EA 450·2], MC 533·3 [JC 536·6, EC 535·4], 2 B *flat* 477; pressure, 2¾ in.; S 3·23. (Ellis.) Experimental pipe, intended to be an exact copy of the Hampton-court B *flat* pipe (see A 441·7). The length, diameter, and pressure of wind were the same; yet, instead of 472·6, I obtained 477. The difference must have been in the mouth, foot, and newness, and serves to show the kind and amount of error (8·0·15) that may be expected in the numerous cases where I have had new pipes constructed. Under 3¼ in. and 4 in. pressure, the pipe gave B *flat* 478·1 and 480·01, whence MA 446·8 and 448·6. But the pressure, 2¾ in., has been retained here because it was that used at Hampton-court, where the original pipe existed.

(2) A **445·8**, EC 530·15 [MC 533·33, JC 535], S 3·23. (Lissajous, from de la Fage.) 1856, Paris, Opera. Exact pitch, on the authority of M. Bodin, professor of the piano and harmony.

(3) EA **445·8** [MA 443·1, JA 441·8], C 530·1, S 3·23; pressure, 3 in. (Ellis.) 30th September, 1867, London, Exeter-hall. Both organs, built by Messrs. Walker; measured from a pipe of the larger organ in their possession. It has since been sharpened to A 447·3.

EA **445·9** [MA 443·3, JA 441·9], C 530·3, S 3·23. (Ellis.) London, 1849-54. Broadwood's original medium pitch, belonging to the widow of the tuner Alex. Finlayson, who died 1854. The original fork having gone out of the possession of Messrs. Broadwood, a copy was substituted for it, C 530·6. An older copy, made for the Society of Arts in 1860, is C 529·7. These different values, 529·7, 530·3, 530·6, are good examples of the errors usually made in copying. (See EA 445·5 and 446·2.) This pitch was chosen quite empirically, by filing down an older fork. The present fork is the one of which a copy was sent to the French Commission on Pitch, 1859, and is called in their Report No. 2, A 452·5, showing that some grave mistake must have been made in measuring, calculating, or printing.

(1) **A 446·0**, EC 530·4 [NC 533·5, JC 535·2] S 3·23. (Delezenne.) 1854*a*, Paris; Pleyel's pianos. Fork given to Delezenne by M. Saunier, organist and music-seller, Lille.

(2) **A 446·0**. (Näke.) 1859, Dresden, Opera. No authority but Näke's own is given, and, in Dresden, it is denied that the pitch was ever so high. (See, 438·9.) But, during the performance, the pitch may have risen with the temperature, as it would affect the wind instruments. This was probably the case here, the pitch being taken during performance. (See A 445·6, 447·5, 449·9.)

(3) **A 446·0**. (Fr. Com.) 1859. Austro-Hungary, Pesth, Opera. Apparently from a fork sent by the Kapellmeister, Herr Franz Erkel, who considered it high time to stop the irregularities which had been hitherto allowed in pitch.

* (4) **MA 446·0**, MC 533·6, *B natural* 498·63; pressure, 3½ inches; S 3·23. (Ellis.) This was merely an experimental pipe, to show the effect of a difference of diameter, when the length remains unaltered. This pipe was 12 inches long and ¾ inch wide; compare A 445·8, for one, 12 inches long and 1·2 inch in diameter; A 434·7, for one, 12 inches long and ·75 inch diameter. The following is a comparison of results:—

	Pressure.		
Diameter.	2½ inch.	3½ inch.	4 inch.
1·2 in.	V 477·04	478·1	480·01
¾ ·95 in.	V 486·87	488·71	490·49
·75 in.	V 497·21	498·63	500·15

(1) **EA 446·2** [MA 443·6, JA 442·2], C 530·6, S 3·24. (Ellis.) London, 1854-79. The copy of Broadwood's medium pitch, now used in their house for pianos not meant for public concerts. See EA 445·9. This is the pitch to which Mr. Randegger has adapted his indications of compass of voice. See Art. 21 above.

(2) **A 446·2**, EC 530·63 [MC 533·77, JC 535·2], S 3·24. (Lissajous, from de la Fage.) 1856, Paris, Opera. Fork communicated to the French Society of Pianoforte-makers, 1st September, 1856.

(3) **A 446·2** (Lissajous, from de la Fage.) 1856, Paris Conservatoire.

(4) **A 446·2**, EC 530·6 [MC 533·7, JC 535·4], S 3·24. (Fr. Com.) 1859, Holland; the Hague Conservatoire. Apparently the fork sent by M. Lubeck, director of the Conservatoire there, who said that he himself had had to contend with continual rise of pitch.

A 446·6, EC 531·1 [MC 534·2, JC 536], S 3·26. (Delezenne.) Milan, 1845. Fork obtained and lent to M. Delezenne by M. Marloye.

A 446·7, EC 531·2 [MC 534·4, JC 536] S 3·26. (Ellis.) 1876, London. Fork bought at Messrs. Cramers', as giving concert pitch; I was offered the Society of Arts forks if I liked, "they only differed by a shade." The corresponding C fork bought at the time was C 533·24, and hence not quite in correct tune with it. I don't know where they were using such a pitch at the time. But I had bought a fork elsewhere, marked "A Walker," some years before, which gave A 446·4, practically the same.

(1) **A 446·8**, EC 532·5 [MC 535·7, JC 536] S 3·27. (Delezenne.) Lille, 1851. Festival organ. Fork by which M. Mazingue tuned the organ.

(2) **A 446·8**, EC 531·3 [MC 534·5, JC 536·27] S 3·27. (Ellis.) 1878, Austria, Vienna. Pitch of the opera from a fork sent to me by the organ-builder, Ullman, who had charge of the organ there, as the pitch to which it was tuned. This would, of course, rise with the temperature of the house. In 1860, French pitch was introduced and, was still the rule in 1869, as officially communicated to the Society of Arts. See A 435·4. The modern rise, which is stated to be several years old, is comparable to that of Covent Garden Theatre. See A 441·2, 445·6, 449·9. For the pitch of the Vienna opera, before 1853, see A 456·1. To the above pitch were tuned the organs of St. Stefan (see A 443·2), St. Michael, St. Peter, and St. Maria Schnee (formerly Minoriten Kirche). This must, however, be taken only as the mean pitch. The church organ of St. Michael was once as high as the larger Franciscan organ (see A 457·58), but the pipes have been pieced throughout, and the pitch lowered. (Abstracted from notes by Herr Ullmann).

A 447·0, EC 531·8 [MC 534·7, JC 536·4], S 3·27. (Fr. Com.) 1859, France, Marseilles, Conservatoire. M. Aug. Morel, director of the School there, a branch of the Paris Conservatoire, wished to retain old French pitch in order to preserve the brilliancy of the orchestra.

A 447·3, EC 531·9 [MC 535·0, JC 536·7], S 3·28; pressure, 3 in. (Ellis.) 1879, London, Exeter-hall. Both organs built by Messrs. Walker; from a pipe in their possession (see their former state B 445·8.)

A 447·4, EC 532·06 [MC 535·2, JC 536·9] S 3·29. (Lissajous, cited by de la Fage.) Paris, 1856; Italian Opera. Fork communicated by M. Bodin, professor of the piano and harmony.

A 447·5, EC 532·2 [MC 535·3, JC 537·0], S 3·29. (Hipkins.) July, 1878, London. Harmonium at Covent-garden opera. See A 441·2.

EA 447·7 [MA 445·1, JA 443·7], C 532·4 at 59° F., S 3·29. (Ellis.) 1877, Gloucester Festival organ, built by Messrs. Walker, and subsequently removed to Brecon; tuned especially at 64° Fahr, to a fork sent by the organist, Mr. Lloyd, Mus.B. Cantab, which measured C 535·16 at 59° Fahr. Hence the organ pipe was C 535·16, at 64° Fahr, and, consequently, C 532·4 at 59° Fahr. my standard temperature.

(1) **A 448·0**, EC 532·8 [MC 536·0, JC 537·5] S 3·31. (Delezenne.) 1854, Paris. Opera Comique, as determined by reeds; sold as giving that pitch, for which there is no other authority.

(2) **A 448·0**. (Lissajous, in Fr. Com.) 1858, France, Paris; Grand Opera.

(3) **A 448·0**. (Fr. Com.) 1859, Belgium, Liège. Pitch stated by M. Dussoigne-Méhul, director of the Conservatoire, to be the same with that of Paris. He wished to adopt this pitch, as the extreme limit, to prevent further advance.

(4) **A 448·0**. (Fr. Com.) 1859, France, Lyons, Opera, stated to be the same as Paris. M. Georges Hainl, conductor of the orchestra at Lyons, thought the Paris pitch should be retained, although it was so high, lest the brilliancy of the orchestra might be impaired. This shows how merely orchestral the pitch had become.

(5) **EA 448·0** [MA 445·4, JA 444], C 332·8. (Ellis.) 1877, London. Copy made by Mr. Hipkins of a fork shown to him at the Society of Arts Rooms as their standard, but different from Griesbach's. See EA 449·4.

(6) **A 448·0**. (Schmahl.) 1839-40, Germany, Hamburg. Opera under Krebs.

(1) **A 448·1**, EC 532·9 [MC 536·0, JC 537·7], S 3·32 (Fr. Com.), 1859, Germany, Munich, Opera. Fork apparently sent by Kapellmeister, Franz Lachner, who was warmly in favour of a settled pitch.

(2) **EA 448·1** [MA 445·5, JA 444·1], C 532·9, S 3·32 (Ellis.) 1878, London. Fork in the possession of Messrs. Bishop, made by Walker. No other note.

A 448·2, EC 533·1 [MC 536·2, JC 537·9], S 3·32. (Ellis.) 1869, Germany, Leipzig, Gewandhaus Concerts. Fork sent officially to the Society of Arts, and lent for measurement.

A 448·3, EC 533·1 [MC 536·2, JC 537·9] S 3·32 (Delezenne.) 1854, Paris, Opera, as determined by reeds, sold as giving opera pitch. They beat slowly with the Lille theatre fork, see A 450·5, There is no other authority for this pitch.

(1) **A 448·4**, EC 533·25 [MC 536·42, JC 538·1], S 3·33 (Lissajous, cited by de la Fage.) 1857, Berlin Opera. Fork sent by Herr Taubert, conductor of the Opera at Berlin, to the French Society of Pianoforte-makers.

(2) **EA 448·4** [MA 445·8, JA 444·4], C 533·3, S 3·33. (Ellis.) 1860, London. Fork purchased at Messrs. Cramer and Co., the authorised agents of the Society of Arts, stamped "Society of Arts, C 528 vib. per sec." Another copy sold by Cramer measured C 531·1, and I observed that most of the copies showed me beat 1 or 2 in a sec. with one another. (See also (2) A 445·1, 445·7, 449·4, 450·3.) A fork bought at the same time as the first, and stamped "Aeq. tempt. to C 528 vib. per sec. Society of Arts," was exactly A 448·4, and hence was an exact EA to this C, but not to C 528, which would give EA 444.

A 448·8, EC 533·7 [MC 536·8, JC 538·5], S 3·34. (Fr. Com.) 1859, Leipzig. Fork apparently sent by Herr Ferdinand David, director of the Leipzig Conservatoire, who expressed himself strongly in favour of a uniform pitch as "putting an end to many doubts, annoyances, and even caprices."

A 449·0, EC 533·96 [MC 537·13, JC 528·8], S 3·35. (Lissajous, Bull. Soc. Enc. liv., 1854.) 1855, Paris, Opera. Experiments made by Lissajous and Ferrand, a first violin at opera. It is stated that Marloye could find no fork or fixed pitch of the French Grand Opera.

A 449·2, EC 534·2 [MC 537·4, JC 539·0], S 3·36. (Hipkins.) June, 1877, London. Pitch of the harmonium at Covent-garden opera. (See A 441·2.)

(1) **EA 449·4** [MA 446·8, JA 445·4], C 534·46, S 3·37. (Ellis.) 1860, London. Fork made by Mr. J. H. Griesbach, for the Society of Arts, to represent its proposed standard, 1 C 528. The box containing it has the note:—"The pitch of the fork producing the note 1 C [in musical notation], 528 vibrations in a second, was obtained by my apparatus, for registering and printing the vibrations of strings, shown at the Exhibition of the Society of Arts, 1860." See Art. 13 above. Lent by the Society of Arts; a poor fork, which can scarcely be counted for 10 secs., quite unfit to be a standard. See A 445·7 and 448·4.

(2) **A 449·4**, EC 534·4 [MC 537·6, JC 539·3], S 3·37. (Ellis.) 1869, Germany; Dresden Opera. Fork sent officially to the Society of Arts, as representing the pitch of the Dresden Band, by the late Kapellmeister Rietz, who, at the same time, says that the Dresden pitch is A 446. Both are apparently errors. Herr Moritz Fürstenau, the librarian, says that no such pitch was ever used at the theatre, and sent me his official fork, A 437·8 (see A 438·9), which he believed to be A 440. Herr Rietz apparently transcribed the pitch A 446 (which see) from Näke, and sent by mistake a Leipzig Gewandhaus fork (see A 448·2). But the fork is officially sealed, and hence I feel bound to insert it. Lent for measurement by the Society of Arts.

A 449·7, EC 534·8 [MC 538·0, JC 539·7], S 3·38. (Hipkins.) 1879, London; Opera, Covent-garden. Pitch of the band during actual performance. Taken by beats with a measured fork while the organ A was held to tune from (see A 441·2 and 445·6).

A 449·8. EC 534·9 [MC 538·0, JC 539·7], S 3·38. (Fr. Com.) 1859, Prague; Opera.

(1) **EA 449·9** [MA 447·2, JA 445·8], C 535, S 3·39. (Ellis.) 1877, London. Copy made for me by Mr. H. Keatley Moore, of Messrs. Moore and Moore, of the Standard fork used by Messrs. Collard, supposed to be meant for the Society of Arts pitch (see A 449·4, 448·4, 445·7).

(2) **A 449·9**, EC 535·0 [MC 538·2, JC 539·8], S 3·39. (Hipkins.) 1878, London; Covent-garden Opera. Pitch of the band during actual performance (see A 441·2 and 449·7).

(1) **A 450·3**, EC 535·5 [MC 538·7, JC 540·4], S 3·40. (Lissajous, cited in Fr. Com.) 1856, Milan; Opera.

(2) **EA 450·3** [MA 447·6, JA 446·3], C 535·5, S 3·40. (Ellis.) 1860, London. Copy by Mr. Allen, of Percy-street, of Society of Arts standard, lent me by Mr. Blaikley, of Boosey's.

A 450·5. EC 535·6 [MC 538·8, JC 540·6], S 3·40. (Delezenne.) Lille, 1848 and 1854; Opera. From forks tuned by M. Colin, Oboist, during the performance of "Robert le Diable," 27 April, 1854, between the acts, and carefully verified. It was on the occasion of measuring this fork, that Delezenne ascertained the importance of having a string on his sonometer, which was as thin as could bear the strain of tuning. Using strings of ·6154 and ·1280 millimètres in thickness, he found that the lengths which gave the unison to the fork were 203·8 mm. on the first, and 198·9 on the second. The former gave a pitch of V 439·645, and the latter V 450·4776. He, therefore, believes that the thickness of the string produces an error of V 10·8326, or S 0·42. (Lille, mém. 1854, p. 1.)

EA 450·6 [MA 448·1, JA 446·7], C 536, S 3·41. (Ellis.) 1877, Glasgow; Public Halls. From the fork settled by the organist, W. T Best, and the late Henry Smart, organist and composer, as the pitch for this very fine organ, erected by Messrs. T. C. Lewis and Co., of Brixton, lent me by Messrs. Lewis. This is, apparently, a rather sharp Society of Arts fork, and is nearly up to concert pitch.

A 450·8. EC 536·0 [MC 539·2, JC 540·9], S 3·42. (Wieprecht, cited by Fr. Com.) 1858, Germany, Berlin; Opera. Original statement not found.

A 451·0. EC 536·3 [MC 539·5, JC 541·2], S 3·43. (Mahillon.) 1879, Bruxelles. The standard for brass instruments made for the Belgian army, by V. Mahillon. The fork sent to me, sold commercially, was A 451·9, and as M. Mahillon could not guarantee its exactness, I have entered the pitch as it exists theoretically. A large fork sent to Dr. W. H. Stone was A 451·7. The pitch was said to have been originally determined by an optical method of which I do not know the details.

(1) **A 451·5**, EC 536·9 [MC 540·1, JC 541·8], S 3·45. (Lissajous, in Fr. Com.) 1858, Russia, St. Petersburgh; Opera. The tuning-fork sent by M. de Lwoff, master of the court and director of the Imperial Chapel at St. Petersburgh, was a C fork, from which this A must have been calculated, and as the three C forks of Broadwood were misinterpreted as A's by the Fr. Com., there is some doubt of this also. M. de Lwoff was strongly against a high pitch, and considered that it greatly deteriorated stringed instruments by imposing thin strings on them.

(2) **A 451·5**, EC 538·17 [MC 540·12, JC 541·8] S 3·45. (Naeke.) 1862, Germany; Berlin Opera. Naeke does not speak confidently, as if he had measured it.

(1) **A 451·7**, EC 537·4 [MC 540·4, JC 542·0], S 3·45. (Lissajous, from de la Fage.) 1867, Milan; Scala Theatre. Fork communicated to A de la Fage, by the director of the Journal *L'Union Instrumentale*.

(2) **EA 451·7**, [MA 449·1, JA 447·7], C 537·2, S 3·45. (Ellis.) 1878*a*, London. Fork in possession of Messrs. Bishop, marked C Philharmonic, possibly meant for the same pitch as A 452·5.

A 451·8. EC 537·2 [MC 540·4, JC 542·1], S 3·46. (Fr. Com.) 1859, Berlin; Opera.

A 451·9. EC 537·4 [MC 540·6, JC 542·3], S 3·46. (Ellis.) 1878, London. British Army Regulation. Pitch for wind instruments, from a fork sent by Dr. W. H. Stone.

A 452. EC 537·5 [MC 540·7, JC 542·4], S 3·46 (Fr. Com.) 1859, Lille Conservatoire. Apparently the fork sent by M. Victor Magnien, director of the Imperial Academy of Music, a branch of the Paris Conservatoire.

EA 452·5 [MA 449·9, JA 448·5], C 538·2, S 3·49. (Ellis.) London, 1852-1874. Mean of the pitch of the Philharmonic Band, while under the direction of Sir Michael Costa, 1846-1854; tuned, in 1859, by Mr. J. Black, of Broadwood's, from records made by Mr. Hipkins. Retained as Broadwood's highest pitch till 1874, when the pitch was sharpened at the instance of Mr. Charles Hallé, see EA 454·7. This was London, No. 3, of the French Commission of 1859, where it is given as A 455, showing an inaccuracy of measurement, calculation, or printing. The copy of this fork, prepared for the Society of Arts in 1860, was C 538·1.

A 452·9, EC 538·6 [MC 541·8, JC 547·2], S 3·50. (Ellis.) 1878, London; Kneller-hall Training School for Military Music. From a fork lent by Dr. W. H. Stone. The fork belonging to Messrs. Boosey, horn-makers, lent by their manager, Mr. Blaikley, gives A 452·5, the difference, ·4 vib., is merely a difference of fork-makers. Messrs. Boosey also used a fork C 538·2, which is in close agreement with the calculated EC above.

A 453·0. EC 538·7 [MC 541·9, JC 543·6], S 3·50. (Schmahl.) Glückstadt, in Holstein. Organ built 1645; improved by Schnitger, 1665; examined by Herr Schmahl, in 1879, who found A between V 445 and 444·5, at 4° R. = 41° F, giving A 453·3 or A 452·8, at 59° F, for which I have selected 453 as a mean. This cannot be distinguished in intention from Lehnert's *positiv*, A 455·2, although it is S 0·09 flatter.

EA 453·4 [MA 450·7, JA 449·3], C 539·2, S 3·52. (Ellis.) London. Copy by Mr. Allen, of Percy-street, of a fork used by Sir M. Costa, at Covent-garden Opera; date unknown. Sent me by Mr. Blaikley, of Messrs. Boosey.

EA 453·9 [MA 451·2, JA 450·0], C 539·8, S 3·54. (Ellis, at 59° F.) London. Concert organ pitch of Mr. Henry Willis, to which are tuned the large organs of the Albert Hall, and Alexandra Palace. This important pitch, writes Mr. H. Willis to me, "was arrived at by actual and continued observation of the pitch of orchestras, especially when there was no organ to embarrass it." It gives C 543·2 at 65° F, for which Mr. Willis estimated it at C 541. At 61·5° F, when I measured the pipe, it was C 541·2, precisely the same as Albert Hall when measured by Mr. Hipkins (see A 455·1). Mr. Willis builds all his concert organs to this pitch, thus re-establishing the old difference between chamber (= concert) and church pitch, for which see A 445·2.

A 454·0. EC 539·9, [MC 543·1, JC 544·8], S 3·54. (Naeke.) 1862, Austria, Vienna. Piano of Kapellmeister Esser, while the orchestra was at A 466, the fork at A 456·1, and the piano of the other Kapellmeister at A 445; see those pitches.

EA 454·1 [MA 451·4, JA 450] C 540, S 3·55. (Ellis.) London, Feb., 1877, Crystal Palace. From a fork in Mr. Hipkin's possession, tuned under his direction to the piano supplied for the Crystal Palace concerts of that day. N.B.—This is the pitch wrongly attributed to the Philharmonic of that date in my former paper, Soc. Arts *Journal*, 25th May, 1877, p. 683, under C 544·3. Dr. Stone had an A fork, made to the same band in March, 1877, which I measured by Appunn as A 458, and on reducing 7·6 per thousand, this will become A 454·6, agreeing very closely with the above, but the fork having been lost, I have been unable to re-measure it.

A 454·2. MC 543·4 [JC 545·0, EC 540·2], S 3·55. (Ellis.) 1715*c*, England, London. Very old fork, of the same shape and workmanship as Mr. Driffield's tenor A (see A 419·9), but S 1·36 sharper. It is nearly as sharp as the highest London pitch in 1879. Found in Myatt's market gardens, Brixton, March, 1878 (gravelly subsoil), when the land was cleared for building, and given me by Mr. Hipkins. There is no impressed mark upon it; but it was written on with ink, and this has left a rust mark. The whole fork is, however, so rusty, and the surface of the iron so disintegrated, that it is difficult to discover what was meant. To the naked eye there seems to be LA on one side, and A on the other, and I have adopted this theory; but under a magnifying-glass, the letters seem to disappear. It is exactly a mean-tone large semitone sharper than A 424·5, that is, it would coincide with a mean tone B *flat* on an organ of that pitch, and it seems, therefore, intended to be a semitone higher than the ordinary pitch of the time, the semitone being necessarily taken large in order to agree with a note on the organ. It thus became a higher chamber pitch, and would seem to establish the existence of such a pitch in England. See notes on the two organs at the Franciscan Church at Vienna, under A 457·6. On account of its very rusty state it may have flattened a little, but certainly not more than V 4 in V 1,000, or V 1·8; see above Art. 10. Supposing it had suffered to this extent, it would be A 456, or MB *flat* to A 426·2, which is almost precisely the original pitch (A 425·9) of Jordan and Bridges organ, at St. George's Chapel, Great Yarmouth.

(1) **EA 454·7** [MA 452·0, JA 450·6], C 540·8, S 3·57. (Ellis.) Unknown date, London. Copy made for me by Mr. H. Keatley Moore, of Messrs. Moore and Moore, of a fork at Messrs. Collard's, used by Sir M. Costa at Covent-garden Opera, several (unknown) years ago.

(2) **EA 454·7.** (Ellis.) London, July, 1874. Fork representing the highest pitch of the Philharmonic concerts, observed by Mr. Hipkins; tuned under his directions. Used as Broadwood's highest pitch since 1874, at the suggestion of M. Charles Hallé (see EA 452·5).

(3) **454·7.** (Ellis.) London, 1879. Fork lent by Messrs. Steinway, as showing the pitch to which their London pianos are tuned.

(4) **EA 454·7.** (Ellis.) London, 1878. Messrs. Bryceson's band pitch, to which they tune their high pitch organs. They, however, also tune in French pitch. St. Michael's, Cornhill, which was rebuilt by Messrs. Bryceson, was tuned to this pitch.

EA 455·1 [MA 452·4, JC 451·6], C 541·2, S 3·58. (Hipkins and Ellis.) May, 1877. Wagner Festival at Albert Hall, giving, therefore, the pitch of the Albert Hall organ. Observed by Mr. Hipkins with a fork measured by me; temperature probably 61½° Fahr. (see A 453·9). Dr. Pole, on the delivery of my first paper, May 23, 1877, said he had just been dining with Herr Wagner, who "complained bitterly of the inconvenience his singers had been put to, on account of the fact that the pitch they were obliged to sing to here was so much higher than that which they were accustomed to." For Munich pitch see A 435·4; for Vienna see (2) A 446·8; these were the chief places the singers came from.

EA 455·2, EC 541·3 [MC 544·5, JC 548·7], S 3·59. (Schmahl and

Ellis.) 1749, Hamburg: an old chamber organ, or *positiv*, built for a bürgermeister by Lehnert, in possession of Herr Schmahl, who took the pitch by forks, which I measured and reduced, as 2 B *flat* 483·9 and 1 C *sharp* 572·8; these are only S 2·92 apart, which may be possibly an equal minor Third out of tune. The two measurements give respectively EA 455·8 and 454·6, of which I have taken the mean, which is S 1·90, or very nearly one equal tone sharper than St. Michaelis, Hamburg (see A 497·9), and almost exactly in accordance with present English concert pitch.

A 455·3, EC 541·5 [MC 544·7, JC 546·4], S 3·59. (Ellis.) London, 1879. Fork lent by Messrs. Erard, as representing their concert pitch.

A 455·5, EC 541·7 [MC 544·8, JC 596·6], S 3·59. (Fr. Com.) 1859, Belgium, Brussels; band of the Guides (see A 451·0). Apparently the fork sent by M. Bender, musical director to the King of the Belgians, and of the regiment of Guides. M. Bender was in favour of two standard pitches, one for military music, and another a quarter of a tone lower for theatres, and he put this in practice himself (see (2) A 442·5). He considered the Guides pitch unsuited for vocal music.

EA 455·9 [MA 453·2, JA 451·8], C 542·2, S 3·62. (Ellis.) 1877, London. From a fork lent by Dr. W. H. Stone, copied from one used by one of Messrs. Chappell's tuners. The fork was a very poor one, and its beats could not be counted for more than four secs., hence there is a possible error of V 0·5.

(1) EA 456·1 [MA 453·4, JA 452·0], C 542·4, S 3·62. (Lissajous, from de la Fage.) London, 1857. Sent by M. Bettini, director of music at the London Italian Opera to the (French) Society of Pianoforte-makers. There is no English corroboration for this pitch so early as 1857, and it has even now not been reached.

(2) A 456·1, EC 542·4 [MC 545·6, JC 547·3], S 3·62. (Ellis.) 1859*a*, Vienna. Fork kindly tuned for me by Messrs. Streicher, pianoforte-makers, of Vienna, from a fork in their possession, giving the orchestral pitch of Vienna, the celebrated "sharp Vienna pitch," in use before the introduction of the French Diapason Normal. See end of notes on (2) A 422·3.

EA 457·2 [MA 454·5, JA 453·1], C 543·7, S 3·66. (Ellis.) 1879, New York. Fork obtained from New York by Messrs. Steinway, to show the pitch to which they tune their pianos there. See A 454·7, for their English pitch, which has been assimilated to Broadwood's.

7. Church Pitch, High.

A 457·6, C 544·7, EC 544·2 [MC 547·4, JC 549·1], S 3·68. (Ellis.) 1640*c*, Austria, Vienna. Great Franciscan organ, which, in Herr Ullmann's notes, is stated to be 240 years old in 1878, and to possess its original pitch (*ihre Urstimmung*). It is only used for leading the ecclesiastical chants ("zur Führung des Kirchengesanges"), the original use of these high organs. Comparing its pitch with that of the Brixton fork, A 454·2, and the notes there, it seems probable that the original pitch of the smaller organ in this Franciscan church, may have been that of a MA 427·7 = the MB *flat* on this higher instrument, which would have allowed the two instruments to be played together by transposing a semitone. Afterwards, and for the same reason, when the higher organ was put into equal temperament (the actual C of the instrument is 544·7, in place of the correct 544·2 given above), the MB *flat*, 427·7, would have become EB *flat*, 431·9, which, taken as A, may have been the pitch of the lower instrument. Even after the lower pitch had been raised to A 442·7, as at present, Herr Ullmann says, that the higher instrument is half a Tone above the lower, though the difference is now only ·57 eq. sem., that is, very nearly a quarter of a tone, and, consequently, the organs can no longer be played together. The real intention of the lower instrument was clearly to introduce the lower concert pitch (Kammerton) at half a note lower, so as to be capable of playing the two instruments together. The pitch is derived from two forks tuned for me by organ-builder Ullmann, as A 454·4 and C 540·9 at 9° R, which reduce, as above, at 59° F.

A 466·0 EC 554·2 [MC 557·5, JC 559·2], S 3·99. (Nüke.) 1862, Austria, Vienna. The highest pitch known to Naeke. But see A 456·1. In a letter of 27 Aug., 1878, to Mr. Hipkins, Herr Streicher, the great Vienna pianoforte-maker, says:—"The reason why Herr Karl Naeke makes the pitch much higher than the fork I sent you, may be simply that, in former years, the orchestra of the Opera House practically played a strong beat higher than the usual fork, as is also practically the case now. At present, the French Diapason Normal passes for being the official fork; but, practically, the real pitch is a strong beat sharper than the official fork." See (2) A 446·8 for this practical pitch, and for similar phenomena, at Covent-garden Opera, see A 445·6 and 449·7, and (2) A 449·9. Hence we must take this as an extreme pitch, partly caused by the warmth of the house. See A 424, for another instance.

A 474·1, MC 567·2 [JC 568·9, EC 563·8], S 4·29. (Ellis.) England, 1668. Tomkins.—(Dr. Armes.) 1683, Bernhardt Schmidt's organ, at Durham Cathedral.—(Ellis.) 1708, B. Schmidt's organ, at the Chapel Royal, St. James's Palace.—(Ellis.) 1708 to 1748, the Jordans's organ, at St. George's, Botolph-lane. To begin with the second. In Feb., 1879, I measured an old A pipe at Durham, as A 443·1 (which see). Since that time, Dr. Armes, the organist of Durham, has examined every pipe and board of the old instrument, and discovered that, as originally built, it was a 16 F organ; and that shortly after, two "quarter-tones," namely, A *flat* and D *sharp*, were added to G *sharp* and E *flat*, as on the Temple organ (written, however, as two G *sharps* and two D *sharps*, in Schmidt's own hand, still legible). In 1815, as Dr. Armes thinks to be most probable, the pipes were shifted a whole tone, and the organ made a 16 G organ. In this case, one of Schmidt's G *sharps* was made into an A, and the other into B *flat*, and two new pipes were added, which Dr. Armes now has, so that the compass which extended originally to ½ C, was raised to ½ E. The pipe I measured as 2 A, was a 2 G *sharp* in the old organ, and that gives the pitch at the head of this article. That is, the organ was originally a great semitone sharper than it was when Bishop dealt with it. The B *flat* pipe I saw, which was exactly a foot long, was, therefore, originally an A pipe; that is, the Durham was an A foot organ; and this leads directly to Tomkins's pitch. In the preface to Rev. Sir F. A. Gore Ouseley's "Collection of Sacred Compositions of Orlando Gibbons, 1873," he quotes from the end of a list of errata appended to the "Pars Organica" of Thomas Tomkins's "Musica Deo Sacra," "published in 1668, but composed for the most part before the time of the Commonwealth," the note "*f* [meaning 4 F] *sit tonus fistulæ apertæ longitudine duorum pedum et semissis; sive 30 digitorum geometricorum*" [let the pipe 4 F be 2½ ft. or 30 in. in length]. This note, Sir F. Ouseley informs me, in a private letter, "occurs in an extra page of errata at the end of the 5th volume, or 'Pars Organica.' I have reason to believe," he continues, "that it must have been a subsequent insertion after many copies of the work had been printed off, as it does not occur either in the Bodleian copy, or the copies preserved in the British Museum and the library of Christ Church, Oxford, which I have collated." In the preface, already cited, he observes that "an open pipe two feet and a-half in length will not produce our modern F, but a somewhat sharp G, so that it is plain that, by transposing the Church music of that period upwards of a whole tone, we are, in fact, restoring it to that which was intended by the composer." This estimation of the pitch of Tomkins's F is slightly incorrect. Tomkins's F was Handel's G, being the modern concert F sharp; that is, Tomkins's was only a semitone sharper than our present concert pitch, a circumstance of importance as respects the conclusion drawn from Tomkins's rule for Orlando Gibbons's pitch, on which see A 567·3, towards the end, where it appears that his pitch may have been much sharper still. On the Durham organ, however, such a pipe as Tomkins described existed, the resulting pitch being a great semitone sharper than Schmidt's Hampton-court pitch, which might always be obtained by shifting the pipes of the sharper organ, although it was, most probably, original at Hampton-court. The sharper pitch was a whole tone sharper than Handel's. At this time, however, there was a still further reduction of a whole tone below Schmidt's usual pitch, used at Trinity College, Cambridge (see A 395·2). Now Tansur (b. 1700), having a son a chorister at Trinity College, Cambridge, and writing in 1749 ("New Musical Grammar," by W. Tansur, for the use of which I am indebted to Mr. Herrman Smith), says (p. 57), "Our *new Consort Pitch* is more fitter for *vocal performance* than the *old Consort Pitch*, which is half a *tone* lower," probably showing one of these changes. Even B. Schmidt himself may have used one of these flatter pitches for chamber organs, for Mr. C. A. Bishop informs me that he remembers "cutting down" such an organ to Smart's pitch, A 433·2, which, of course, implies that the organ may have been as flat as Handel's A 422·5, or a tone below B. Schmidt's higher pitch. Now the following note (for which I am indebted to Mr. Ebenezer Prout), makes it probable that there were two pitches current in England about or before 1714. "In a version of one of the Chandos anthems (Chrysander says earlier), written for the Chapel Royal, and published by the G.H.S. [German Handel Society] for the first time, called "O sing unto the Lord a new song," the air, "Sing unto the Lord and praise His name" is in Handel's MS., in the key of E minor; but, as in this key the voice part lies very high, a note is added in the composer's handwriting, intended for the copyist. 'This verse must be transposed a tone lower in all parts—*in the organ part two tones lower.*" This, of course, ought to imply that the organ was one tone too high. Which Chapel Royal was intended does not appear. The Chapel Royal, Whitehall, was burned in 1698, and the banquetting-hall, in which was B. Schmidt's organ, was opened as a Chapel Royal in 1715, but I am told that no anthems were performed there. I think, however, that this organ was very probably as sharp as the Durham one, as it was the first B. Schmidt built in England, 1662. Elliott, in 1814, removed all the old pipes of this organ, except a few stopped wooden ones, and tuned it to the flat pitch (Handel's) then in vogue. It was stored away from 1827 to 1837, and then re-erected without alteration. But, in 1844, the swell was added, and the pitch raised to that of Hampton-court. This information was given me by Mr. T. Hill. Nothing, therefore, can be learned of the original pitch of this organ. The old organ of St. James's Chapel Royal was also built by B. Schmidt, in 1708, and erected, after his death, by his son-in-law and successor, Christopher Schreider, in 1710. This organ remained in the chapel till 1837, when it was removed to a private chapel in Long-acre, and thence it was removed and set up in the chapel of Mercers-hall by Robson in 1868. This organ I measured and examined on 25 February 1880. The pitch at 59° F. gave C 529·1, B 498, A 442. Supposing the C to be right, we should have MB 494·4, MA 442·2, and EB 499·4, EA 444·9. Hence the organ was very imperfectly tempered, but assuming that C 529·1 was right, we have MA 442·2 as its pitch, which is practically that of Hampton-court A 441·7. After measuring, I examined the marks on several pipes of the prin-

cipal on the great organ, and found that it had been shifted a great semitone; thus, the old B *natural*, B *flat*, C, D, D *sharp*, had become new C, B, C *sharp*, D *sharp*, E, respectively. The old marks were quite distinct and of the old form, the D and D *sharp* in particular being the German old forms used by Praetorius. The shifting was effected probably more than 100 years ago, as the newer markings had every mark of age. This, then, pretty well established the fact that B. Schmidt or Chr. Schreider made organs in this sharp pitch as late as 1708-10. Also, as I am told that Handel constantly played upon this very organ, it seems not improbable that his note to the copyist referred to it. At the same time, the probability of the Whitehall Banquetting-hall organ having been as sharp, is strengthened. Purcell, 1658-95, was organist there, and also at Westminster-abbey, organ built by Schreider and Jordan in 1730. Now, Sir F. A. Gore Ouseley says, in a private letter:—"To illustrate the variations of pitch, it would suffice to compare together the sacred and secular vocal music of English composers from Gibbons to Blow, *i.e.*, throughout the 17th century. In the case of Purcell, what tenor could possibly sing 'Come if you dare' or 'Britons strike home' at the pitch indicated in Tomkins's book? Or what bass could possibly have sung his 'They that go down to the sea in ships' [which has a scale from 2 D to 8 D in the key of D] if the pitch had been so low as the forks of that period indicate?" But Handel wrote both higher and lower, and Mozart as low. Now, as to Westminster, I put it flat in (2) A 422·5 as the earliest pitch I could find. But this organ of St. James's Chapel Royal makes a high pitch probable for Schreider, one of its builders; and the organ built by Jordan in St. George's, Botolph-lane, shows that the other of the two builders of Westminster-abbey organ also used a sharp pitch. This organ was rebuilt by Mr. T. Hill, and he found it so sharp that he was obliged to shift the pipes a semitone down, that is, to make the old C his C *sharp*, in order to bring it approximatively to his own pitch, which is that of Hampton-court; this, of course, means taking B *natural* as C, and this pitch gives MB *natural* 526·7. Mr. Hill's being C 525·3, so that they are practically identical. But perhaps this may belong to the series of organs represented by the Brixton fork A 454·2. I beg to express my obligations to Rev. Sir F. A. Gore Ouseley, Dr. Armes, Messrs. Ebenezer Prout, T. Hill, C. A. Bishop, Herrman Smith, R. Massey (late of Whitehall Chapel Royal), C. S. Jekyll (of St. James's Chapel Royal), and N. W. B. Collyer (of Mercers-hall), for their assistance in conducting this difficult investigation. In order to compare the series of English organs which existed in England, I give the pitches of their 12 notes in mean tone temperament, assuming, not the pitches as determined by actual measurement, but the pitches as derived from Handel's fork. 1). Is the pitch of Trinity College, Cambridge (see A 395·2), here derived as a mean Tone below (3). 2) Is Handel's pitch derived from his own fork (see A 422·5). 3) Is the pitch of Hampton-court Organ derived as a great semitone below (5). 4) Is the Brixton Fork pitch (see A 454·2), here derived as a great semitone above (2). 5) Is the pitch of this article, here derived at a mean Tone above (2). It will be seen that these pitches agree practically with those found by measurement, and it will also be seen what kind of errors are introduced by shifting, and have to be corrected by the organ-builder.

Mean Tone Notes.	1. Trinity College.	2. Handel.	3. Hampton-court.	4. Brixton.	5. Durham.
2 C	236·2	252·7	264·1	270·4	282·5
2 C *sharp*	246·8	264·5	276·0	282·6	295·2
2 D	264·1	282·5	295·2	302·3	315·9
2 E *flat*	282·5	302·3	315·9	323·5	330·1
2 E	295·2	315·9	330·1	338·0	353·2
2 F	315·9	338·0	353·2	361·7	369·0
2 F *sharp*	330·1	353·2	369·0	377·9	394·9
2 G	353·2	378·8	394·9	404·4	422·5
2 G *sharp*	369·0	394·9	412·6	422·5	441·5
2 A	394·9	422·5	441·5	452·1	472·4
2 B *flat*	422·5	452·1	472·4	483·7	493·6
2 B	441·5	472·4	493·6	505·6	528·2
1 C	472·4	505·4	528·2	540·8	565·1

A 480·8. C 575·3 [MC 575·1, EC 571·8, JC 577·0], S 4·54. (Degenhardt and Ellis.) 1879, Germany, Hamburg; St. Catherinen Kirche. This organ was built by Hans Stellwagen in 1543, and has been frequently repaired. Herr Schmahl (see A 489·2) thinks it hardly possible that it should have kept its original pitch. But Herr Degenhardt, the organist, himself assures me that, even at the last repairing, 1867-9, the pitch was never altered. It must, however, be considered doubtful, as there is no proof that it may not have been somewhat altered in olden times. The pitch was taken for me by Herr Degenhardt, by tuning-forks at 15·2° R., and subsequently reduced. It is V 8·4, or S 0·30 flatter than old St. Jacobi at Hamburg, A 489·2, but possibly they were meant to be in the same pitch. A to C forms an almost exact mean-tone minor Third. But the C was tuned from the Choir Organ (*Oberwerk*) and the A from the Great Organ (*Hauptwerk*), and the C may have been tuned too sharp by Wolfsteller, as the temperament is intentionally equal. Herr Schmahl says that this wide minor Third, A to C, results from the method of tuning used by Wolfsteller, in which A was tuned first and C last, and became faulty, as his Fifths and Fourths were too nearly just. This was the case as early as 1840-48, so that the major keys of F *sharp* and D *flat* were better tuned than those of C and G on this organ.

MA 483·7 [JA 480·6, EA 485·6], MC 578·6 [JC 576·6, EC 577·5], 1 G 865·13, S 4·64. (Ellis.) 1790, Padua. A fork preserved in the Institute "di Fisica" of the Royal University, at Padua, and copied for me exactly, under the direction of Sig. Fr. Rossetti (see A 425·2 for references). It was inscribed *Sol*. The original was probably made under the direction of Signore Stratico, professor of mathematics and naval science at Padua, from 1764, and of physics also from 1777 to 1798, for the purposes of his excellent essay on qualities of tone (Mem. dell' I. R. Inst. del. regno Lomb. Veneto, years 1814 and 1815, pp. 171—218). It is the fork No. 1 of the memoir of Prof. Zantedeschi. Prof. Zantedeschi cites it as an example of the instability of tuning-forks, supposing that it must have been originally 1 JG 768 to 2 C 256, and finding by ear that it agreed with 1 A of Colbacchini's pitch-pipe (really V 844·4 or S 0·42 flatter), which he also believed to be 1 JA 853·3, 2 C 256, he supposed that the fork must have gained V 85¼. There is no reason whatever for supposing this fork to have been originally at a lower pitch. This 2 G 432·56 is very nearly the French A 435·4, compare A 481·1. Whether Stratico took it from any existing organ or not does not appear, so that we cannot be certain that it represented an acknowledged Italian pitch.

A 484·1. EC 575·7 [MC 579·1, JC 580·9], S 4·65. (Jimmerthal.) 1878, Germany; Lübeck Cathedral, smaller organ. Herr Jimmerthal, the organist, says that in summer, at 16° R. (68° F.), the new great organ by Schulze is at French pitch, and the old small organ has then its 2 G in unison with the 2 A of the other. The above has been calculated from these data. But Herr Jimmerthal adds that 30 years ago the old organ was a few beats (*einige Schwebungen*) lower. Possibly, therefore, it originally agreed with St. Catherinen Kirche, Hamburg (see A 480·8). Herr Jimmerthal considers that the old organs in Lower or Northern Germany are tuned thus high, out of economy.

EA 489·2 [MA 490·2, JA 488·7], EC 581·8 [MC 586·4, JC 586·4], 2 E 366·5, S 4·84. (Schmahl and Ellis.) 1688, Germany, Hamburg; St. Jacobi Kirche. This organ was built in 1688-93, by Schnitger, of Harburg, in Hanover, and afterwards of Hamburg, an admirer of Werckmeister, who in his *Orgelprobe* (2nd edition, 1698); says that he can only recommend equal temperament. Herr Schmahl, the organist (see authorities), says that he has no doubt that the organ was originally tuned in intentional equal temperament, although actual equal temperament was not produced till Scheibler's discoveries. There is no mention in the archives of the organ, which Herr Schmahl has searched for the purpose, of any alteration of tuning, and the organ was in intentional equal temperament when he became the organist in 1838, and he never recollects having heard of any other but intentional equal temperament in the North of Germany; and his master, Demuth (d. 1848), of St. Catherinen Kirche (see A 480·8), whose memory extended to 1810, also could recollect no other but such equal temperament. Of course, the temperament was never perfectly equal, and when Herr Schmahl practised on the St. Catherine's organ, the usual keys of C, G major, &c., were not so good as the unusual F *sharp* and D *flat*. In 1720, J. S. Bach played on St. Jacobi organ, and, according to Bitter's life of Bach, expressed himself very pleased with the tuning, and as J. S. Bach is known to have favoured intentionally equal temperament, this is another reasoning for calculating the pitch from 2 E on that hypotheses. It is even reported that J. S. Bach applied to be organist to this organ, but was defeated by a clerical competitor of mediocre powers, who advanced some money for the purpose. The pitch of 2 E was determined by an old pipe preserved in the organ case, which was found to beat flat four times in a second, with 2 E on the organ as now tuned, for which see A 494·5. From this all the other numbers are calculated. Observe that this old pitch is almost exactly one equal tone sharper than the modern French pitch. There is an old peal of bells in the church which is just a little flatter than the modern pitch, and probably agrees with the old pitch. There does not appear to have been any special music written for this high pitch, at least Herr Schmahl does not know of any, and he is accustomed, on the organ as now tuned, to transpose everything at sight a tone lower. Hence, probably, the traditional reason for the old high pitch had died out before this organ was built, though it was retained in the old High Church pitch, or very nearly so. But this organ originally possessed one stop, an 8-foot Gedact, which was in the chamber pitch a minor Third lower (or EA 411·4, JA 407·7), as shown by the church archives for delivery in 1693, and renovation 1721. In 1761 this stop was replaced by an 8-foot Gamba in the pitch of the other stop. This is the only instance I have met with of both church pitch and chamber pitch on the same organ. On this subject, Herr Schmahl refers to Niedt's "Handleitung zum General-Bass," vol. 2, 1720, by Mattheson, which I have not seen. The organs at Altona and St. George's, Hamburg, both by the same maker, are at the same pitch

An old tuning fork, now belonging to Herr Schmahl, but formerly to two or three generations of singers at St. Catherine's, Hamburgh (see A 480·8), was exactly in French pitch. It would seem, therefore, probable that modern French pitch was at one time a chamber pitch corresponding to this St. Jacobi as a high church pitch, but in that case there was another chamber pitch a semitone lower (see A 407·9).

8. *Church Pitch, Highest*

A 494·5, C 587·9 [EC 588·1, MC 591·6], S 5·02. (Schmahl and Ellis.) 1879, Germany, Hamburg; St. Jacobi Kirche. Present pitch, determined by beats, counted by Herr Schmahl, made with forks measured by me, all reduced to 59° F. This pitch was given to the organ in 1866, in order to agree with Scheibler's tempered forks, and is a little sharper than the original pitch, for which see A 489·2. The ragged state of the ends of the pipes necessitated their being trimmed, and had not the organ been sharpened in 1866, it would have been necessary to piece all the pipes, which was not considered advisable.

A 495·5, CE 589·3 [MC 592·7, JC 594·5], S 506. (Schmahl.) 1700, Germany, Rendsburg in Holstein, a tolerably large organ recently broken up, which was measured by Herr Schmahl as G 434 at 7·5° R, giving the above on reduction to 59° F. As the organ was very dusty, it is possible that the true pitch was higher, and may have reached that of the Halberstadt organ, A 505·8.

MA 503·7 [JA 506·8, EA 505·6], MC 602·5 [JC 600·7, EC 601·4], G 450·5, S 5·34. (Ellis.) 1636, Paris. Mersenne's church pitch, with the 8 G on the four-foot French pipe, having V 112·6. (See A 376·6 and "Harmonie Universelle," livre 3me., "Des Instruments à Chordes," p. 147; livre 3me., "Des Mouvements and du Son des Chordes," p. 169.) Mersenne observes that this is the lowest note of his own voice, and that only the deepest and bassest voices in France can descend a Fifth, to the 8 C 75·3 below. Now, in my observations, I found only 16 out of 141 basses who could get so low as this, although 17 others of this number reached 8 D 76, and 15 others got lower still. (See A 567·3.) This, therefore, agrees with Mersenne's statement. His own voice, reaching to his 8 G 112·6, or, in Broadwood's medium pitch, to 8 A 111·6, would be, probably, a rather low tenor. (See the tables in Art. 21.) This sufficiently confirms this very high French church pitch, which is nearly identical with that of Halberstadt A 505·8, and about a Tone higher than Broadwood's medium pitch A 446·2, although I can find no mention of such a high French pitch elsewhere.

MA 504·2 [JA 505·0, EA 507·2], C 603·2, S 5·35; pressure, 3¼ in. (Ellis.) 1511, Heidelberg. Schlick (see MA 377·0) recommends a pipe 6⅔ Rhenish feet long, as either 8 F, or as 8 C, a Fifth deeper. I have assumed the diameter to be one-sixteenth of the length, and the very close approximation of the pitch to that of Halberstadt (see MA 505·8), confirms the conjecture.

JA 505·8 [MA 508·9, EA 506·9], JC 606·9 [MC 608·8, EC 602·9], 4 B 284·5, 64 B 17·78, S 5·41, pressure 3½ inches. (Ellis.) Germany, Halberstadt Cathedral Organ, built 1361, repaired 1495, described by Praetorius ("Syntagma Mus.," vol. 2, pp. 97–99, 101–4), who saw it, and gives the name and dimensions of the largest pipe as B *natural*, 31 Brunswick feet long, and 3⅔ Brunswick feet in circumference. A Brunswick foot has 285·36 mm. This, therefore, makes the pipe 8846 mm. long, and allowing 1·5 mm. for the thickness of the metal, 314·3 mm. in diameter. Taking a sixteenth of these lengths, we obtain for 4 B, 552·9 mm. long, and 19·7 mm. in diameter. I had a pipe constructed 555 mm. long, and 19·86 mm. in diameter, which, under pressures of 2¾ and 3½ inches spoke V 282·5 and V 283 respectively. Correcting these numbers by the rule in Art. 8, by multiplying each by 1766·5 (= 3 × 555 + 3 × 20·3), and dividing by 1757·2 (= 3 × 552·9 + 3 × 19·7), we obtain 4 B 284 and 4 B 284·5 respectively. I have assumed the latter as most probable, and calculated the above numbers accordingly. The smaller pressure gives JA 504·9, JC 606·3. The difference is unimportant. It is probable, however, that the very narrow pipe constructed may be slightly flatter than four octaves above 64 B, so that the extreme sharpness of the result is certainly not exaggerated. Praetorius says that we see by the pipes that the pitch is a good Tone, nearer a Tone and a half above what he considers the suitable church pitch, which A 505·8 really is (see A 424·2). This 64 B would have been practically inaudible, but, being accompanied by numerous other pipes in a "mixture," became effective.

9. *Chamber Pitch, Highest*

MA 563·1 [JA the same, EA 567·6], MC 673·6 [JC 675·7, EC 675·2], 2 F 450·5, S 7·26. (Ellis.) 1636, Paris. Mersenne's Chamber Pitch, "Harmonie Universelle," liv. 3, des instruments à chordes, p. 143, where he says:—"La voix ou la note la plus grave de la basse [of a certain song] est F-ut-fa [=8 F], et parceque ceux qui font la basse dans la chambre, ne vont pas ordinairement plus bas qu'un tuyau d'orgue de 4 pieds ouvert, il s'ensuit que la plus basse note" of the air answers to the note of that pipe, which (see A 373·7 and 376·6) I take to be V 112·6, whence follow all the above numbers. Now, Mersenne gives as the lowest note of a small organ which he had at hand (*quam pre manibus habeo*), the equivalent of a 2-foot pipe (see the reference under A 373·7). It seems, therefore, probable that it was an organ in chamber pitch, similar to that formerly belonging to Christian IV., of Denmark (died 1648), figured by Praetorius ("Syntagma Musici," Sciographia, plate I.), and also described (*Ibid*, vol. ii., p. 80) which proceeded from 8 F to 1 A, having 38 keys, only Mersenne's was an octave smaller, with only 26 keys, possibly 8 F to 1 A, to which he would sing an octave lower, and thus reach his own lowest note, that of the 4-foot pipe (see A 503·7). This is the pitch which Mersenne assumes for his scales (*Ibid*, p. 146), only he takes 8 F 96 in place of 8 F 112·6, owing to his faulty measurement of the pitch of his 4-foot pipe (see A 373·7). See confirmation of this remarkably high pitch in A 567·3.

MA 567·3 [JA 570·8, EA 570·7], C 678·7, S C 84·84, S 7·40. (Ellis.) 1619, North German church pitch, called by Praetorius chamber pitch. This is corroborated by that of Mersenne A 563·1. It is, however, advanced with considerable hesitation. Praetorius ("Synt. Mus.," vol. ii., p. 30) gives a table of the compasses of the several voices, marking the notes reached with ease and with difficulty. On p. 19, he says, "It must be here, first of all, *in genere*, remembered, that, in the whole of this work" [meaning his table of compasses of the voice and instruments] "everywhere throughout, the Instruments and Voices are not reckoned and arranged by Church Pitch but by Chamber Pitch, as we have already explained that some very properly distinguished it." This refers to *ibid.*, p. 15, where he says that, in Prague, and some other Catholic Bands (*Kapellen*), pitch is divided into church pitch and chamber pitch in such a way that "the present common pitch, by which almost all our organs are now tuned, is called chamber pitch, and used only for table and convivial purposes; and this is most convenient for instrumentalists, on account of the wind and stringed instruments. But church pitch, which is a whole Tone flatter, is used only in the churches; first, to enable the vocalists, on whom the greater labour falls in the churches (especially in Catholic churches, on account of the long duration of psalm-singing, &c.), to manage better with their voices, and not be rendered so rapidly hoarse by the sharpness; and next, because the human voice, in its middle and lower regions, is much more pleasant and charming than when it has to shout and scream in its high parts, beyond its power. Hence, *propter alias etiam multifarias commoditates, nuwitem singularem ac conceatus bene susceptos*, it would be better for all our organs to be tuned and built a Tone or Second deeper. But it is quite impossible to make this change in Germany, and, consequently, we must retain our present chamber pitch (which is now commonly called church pitch in most places)." Now, it would seem almost from his recommending this reduction of a Tone, that the high pitch he speaks of was only a tone above the "suitable pitch," which he himself proposes (see A 424·2), and this would give A 474·3, which is Tomkins's pitch (see A 474·1), and not nearly so high as the existing Hamburg pitch (see A 489·2), or the old Halberstadt pitch A 505·8. In commenting on this last, Praetorius says ("Syntagma Mus.," vol. 2, p. 102):—"This (Halberstadt) organ, and similar work, was a good Tone, nearly a Tone and a-half higher than our present organs, which are suitable for church purposes [*als die unsrige itzige Chormessige Wercke stehen*, a peculiar phrase indicating those in his own 'suitable' pitch], which are shown by the length of the great pipes already cited. And it is, therefore, also probable that long previously, all organs, whether of the size already described or not, may have stood in the same pitch, or even higher, because, during the time of Popery, they were only used for the *choral* [ecclesiastical tones]. Forasmuch as finally the *choral* organs, *which were made a whole Fourth higher or a Fifth lower than our pitch* [meaning the 'suitable' pitch, A 424·2?] were recognised as the most convenient, and were kept to this pitch. And although some organs are deficient, and do not exactly agree with the pitch just described, this defect is not to be attributed to the good will and diligence of those masters who originally built the old choral organs which are still [1619] in use, but is probably due to their not having at that time selected a constant chorist or church tone [*Choristen- oder Chor-Thon*], as, thank God, is now usual. Also the organs to which good choristers [*chorales*] and screaming voices are engaged, and are present to sing, are often tuned a tone higher or lower, and also by much renovation and tuning have been sharpened considerably above their original condition. Otherwise the above-described pitch, namely, one a Fourth higher or a Fifth lower (in reference to our present usual pitch, otherwise called chamber pitch), is considered to be the most correct, and still so found in the churches of the principal ecclesiastical foundations. And yet many organs will also be found which are a Second [a Tone] lower or higher, and some—not a few—are also tuned and built a semitone higher." This passage seems to imply a general ancient pitch, which was a Fourth higher than Praetorius's own "suitable" pitch. But his language is so confused that, though I have studied it for months, I cannot pretend to be certain. A meantone Fourth above A 424·2 would be A 587·3, as here suggested. But, as I have found no existing trace of such a pitch in Germany, I have endeavoured to deduce his chamber pitch from the account of the compass of the human voice which he gives, and for this purpose, mainly, I made the series of observations recorded above in Art. 21, and with the tables there given, and Mr. Randegger's statements, should be compared the following, given by Praetorius ("Syntagma," vol. ii., p. 20):—

	Easy Limits.	*Extreme Limits.*
Soprano	2 C to 1 E or 1 F.	2 B to 1 G or 1 A.
Alto	4 F to 2 G or 2 A.	4 E to 2 B *flat*.
Tenor	8 B or 4 C to 2 E.	8 A to 2 F.
Bass	8 C to 4 A or 4 B *flat*.	16 F, 16 G, 16 A or 16 B to 2 C or 2 D.

The Sopranos are described as "Eunuchus, Falsetista, Discantista," and the Alto was the male alto, or counter tenor; and these were not the kind of voices I tried, except, perhaps, in the bass falsetto. Hence the real comparison can only be made in the Bass and Tenor. As regards the extreme limits of the bass, I heard a high pitch 16 B 63·3, from 13, and a high pitch 16 A 56·3, from 2 out of 141 basses. But 16 F, 16 G, were quite beyond any one. Praetorius ("Syntagma," vol. ii., p. 17) quotes only from hearsay that three voices in a Munich choir reached that 16 F "in a strong full voice." If we suppose that 16 F to have been 16 B *flat* 56·7 of Praetorius's suitable pitch, it would be the lowest conceivable pitch for a man to sing clearly. If, then, we assume this to be the value of his 16 F, or take 2 F 453·9, we find A 567·3. But an argument cannot well be founded on such an extremely exceptional case. Praetorius makes 8 C an *easy* note for the Bass. Now, out of 141 basses, I found only eight who could reach a high pitch 8 C 67·6 with ease. It is, therefore, quite out of the question to put the easiest note of the bass so low. The mean easy bass limit was 8 E 81·2, or, 8 E in French pitch. But it would be wrong to call this mean easy for all voices, when at least 49 basses out of 141, that is, more than one in three, could not reach it. But only 24 out of 141 basses could not reach 8 F 84·8, which is the 8 F to Praetorius's "suitable" pitch A 424·2. This, therefore, may be called easy, although about one in six cannot reach it. It is, however, nearly a semitone lower than the 8 F 88·6, which Mr. Randegger assigns as the limit. Hence, I cannot be assigning too high a value to the 8 C of Praetorius's easy bass limit by making it 8 C 84·8, but this gives as before 2 A 567·3. Now, if we adopt this value of A, we should find for Praetorius's easy limits of bass 8 C 84·8 to 4 A 287·6 or 4 B *flat* 321·5, that is, in Broadwood's medium pitch (A 446·2) adopted by Randegger 4 E 83·6 to 2 C *sharp* 281·1, or, 2 D *sharp* 315·5, which are rather low bass limits, according to my observations, so that there is no exaggeration in assuming the chamber pitch of Praetorius's limits to have been a whole Fourth higher than his "suitable" pitch, as the quotation given above seems to imply. The tenor then, would have in Praetorius the limits, 8 B 158·5, or 4 C 169·6, to 2 E 424·2, or in Broadwood's medium pitch from 4 E *flat* 157·8, or 4 E 167·2, to 2 G *sharp* 421·2, which certainly gives a very high lower limit, and a rather low upper limit to the tenor, but still a compass larger than the smallest found in my observations. Praetorius's tenor compass of an Octave and a major Third or Fourth is very small indeed; hence, so far as the bass and tenor voice are concerned, this extraordinarily high pitch accords with the other indications given by Praetorius, and hence I venture to assign it to North Germany. I was much inclined to suppose that Praetorius must have meant the pitch of his tables of compass to have been only a minor Third above his suitable pitch, agreeing with the Halberstadt organ. But to assume a tone lower would give such an impossible "easy" compass to the bass, that I felt colliged to renounce it. A comparison of Praetorius's upper limit of his voices with that used by Orlando Gibbons in England (1583-1625, that is contemporary with Praetorius) is very singular. Rev. Sir F. A. Gore Ouseley, in a private letter to me (16 May, 1878), states that he, who has thoroughly examined and published an edition of O. Gibbons's works, "knows of only three instances in which he wrote 1 E, his usual limits being, for sopranos, 1 D; for altos, 2 A; for tenors, 2 F or 2 E; and for basses, 2 C." Now Praetorius's upper limits are for Sopranos, 1 E or 1 F; for Altos, 2 G or 2 A; for Tenors, 2 E; and for Basses, 4 A or 4 B *flat*, easy, with 2 C or 2 D as extremes. It will be seen that these are practically identical with O. Gibbons's usage. The necessary inference is that the Church pitch for which he wrote was identical with this high Church pitch (confusedly called chamber pitch) of Praetorius. In his madrigals, on the contrary, O. Gibbons uses higher notes. Sir F. A. Gore Ouseley says, "in the madrigal of 'The Silver Swan' he takes his trebles up to 1 G, and in others he takes his altos to 1 C, his tenors up to 2 G, and his basses up to 2 E *flat*." This clearly indicates that Gibbons's chamber pitch was a tone to a minor Third flatter than his church pitch. Assuming his church pitch then to be A 567·3, his chamber pitch would be A 507·3 (practically identical with Halberstadt A 505·8), if we took it a Tone; or A 474·1, which is the old pitch of Durham Organ, and of Tomkins, if we took it a minor Third, flatter than his church pitch. This would seem to imply that Tomkins's pitch, thought to be extremely high, was really a much flattened pitch, the original cause of the sharpness, the Roman Catholic ecclesiastical tones having practically ceased to exist in England with Elizabeth's establishment of the Reformation in 1588. The following extract from Praetorius bears upon old English pitch, and confirms its former extreme sharpness, as also the high German pitch ("Syntagma," vol. ii., pp. 14-15):—"The ancient church pitch was about a Tone lower and deeper than at present, which may still be seen on old organs and other wind instruments [this may refer to Halberstadt, and making that organ a Tone lower than was usual when Praetorius wrote, would give the higher pitch, as above], and afterwards, from year to year, it was as much raised as is now usual in Italy and England, and in the princely bands of Germany. Although the English pitch on instruments is a very little (*ein gar geringes*) lower, which may be seen on their trumpets and shawms (*Zincken und Schalmeyen*), or oboes, as they call them, which are there manufactured." He proceeds to speak of an attempt to raise the pitch by a semitone, which he deprecates, on account of singers, especially altos and tenors, and also because stringed instruments could scarcely bear the then strain, so that strings constantly snapped, for which reason it was better to play such instruments a tone lower, which he says is a great assistance to vocalists.

TABLE II.

CLASSIFIED INDEX TO TABLE I.

ARRANGEMENT.—The countries are arranged in alphabetical order:—1. Austro-Hungary; 2. Belgium; 3. England; 4. France; 5. Germany; 6. Holland; 7. Italy; 8. Russia; 9. Spain; 10. United States of America.

Under each country, the pitches are classified as—1. Standards; 2. Old Forks; 3. Church Organs; 4. Concert Organs; 5. Operas; 6. Concerts; 7. Pianos; 8. Military Music; 9. Other Instruments.

The Pitch is always that of A, with merely a sufficient description to recognise it. For full details, the A must be looked out in Table I., which is arranged in numerical order. But the S, or number of equal semitones and cents (see Art. 5), by which the pitch is sharper than A 370, is annexed, in order that, by the difference of their S, the relative sharpness of the pitches may be immediately ascertained.

In each division, the towns are generally placed together, and the pitches for each town are arranged chronologically, as far as was practicable—the letter after the date meaning *a*, *ante*, or before; *c*, *circa*, or about; and *p*, *post*, or after; thus, 1800*c* is about 1800, 1800*a* is before 1800, 1800*p* is after 1800.

The mark ,, means that the date or name in the preceding line is to be repeated. The mark —— in the date or place column shows that the date or place is unknown. When the date is unknown, the pitches are placed in order of sharpness.

Date.	Place.	Pitch.	S	A
		I.—AUSTRO-HUNGARY.		
		3. Church Organs.		
1640*c*	Vienna	Large Franciscan Organ	3·68	457·6
1780	,,	Organ-builder Schulz.....	2·25	421·3
1878	,,	St. Stefan	3·13	443·2
,,	,,	Small Franciscan Organ.....	3·11	442·7
		5. Opera.		
1823	,,	Näke (Euryanthe)	2·90	437·5
1834*a*	,,	Scheibler I.	2·76	433·9
,,	,,	,, II.	2·86	436·5
,,	,,	,, III.	2·98	439·4
,,	,,	,, IV.	3·01	440·3
,,	,,	,, V. (Blahetka)	3·04	441·1
,,	,,	Scheibler's Streicher's Fork ...	3·13	443·2
,,	,,	Scheibler VI. (monstrous growth).....	3·21	445·1
,,	,,	Vienna Old Sharp Pitch.....	3·62	456·0
1862	,,	Näke, sharpest	3·99	466·0
1878	,,	Ullmann	3·27	446·8
1859	Pesth	From Fr. Com.	3·23	446·0
,,	Prague	,, ,, ...	3·38	449·8
		6. Concerts.		
1845	Vienna	Marloye (Conservatoire)	3·21	445·4
		7. Pianos.		
1780	,,	Stein, for Mozart	2·26	421·6
1862	,,	Esser, per Näke.....	3·54	454·0
,,	,,	Proch ,, ...	3·20	445·0
		9. Other Instruments.		
,,	,,	Sellner's Oboe, per Näke	2·80	435·0
		II.—BELGIUM.		
		1. Standards.		
1876	Brussels	Meeren's Proposed Concert Standard	2·75	432·0
1879	,,	Mahillon's Army Standard ...	3·43	451·0
		5. Opera.		
1859	,,	Bender's Pitch	3·10	442·5
		6. Concerts.		
,,	Liège	Conservatoire.....	3·31	448·0
		8. Military Instruments.		
,,	Brussels	Band of Guides (Fr. Com.) ...	3·59	455·5
		III.—ENGLAND, SCOTLAND, AND IRELAND.		
		1. Standards.		
1842	London	Hullah's C 512 = 524·8	3·05	441·3
1860	,,	Society of Arts intended C 528	3·16	444·0

Date.	Place.	Pitch.	S	A
1860	London	Griesbach's Soc. Arts C	3·37	449·4
,,	,,	,, ,, A	3·22	445·7
,,	,,	Cramer's ,, A and C	3·33	448·4
1877	,,	,, ,, (Bishop's)	3·20	445·1
,,	,,	Mr. Hipkins's copy of Soc. Arts	3·31	448·0
,,	,,	Allen's ,, ,,	3·40	450·3
1877*a*	,,	Tonic Sol-fa College 1 JC 513	2·50	427·5
1877*p*	,,	,, ,, 1 JC 507	2·30	422·5
		2. *Old Forks.*		
——	,,	Faraday's 2 C, 2 A *flat*, 2 E *flat*, 2 A	2·37	424·3
——	,,	,, 2 G	2·62	430·3
——	,,	,, 1 C and 2 E	2·67	431·7
——	,,	,, 1 C and 1 E	2·72	432·8
——	,,	,, 2 A	2·89	437·2
——	,,	Ellis's 2 A Philharmonic	,,	,,
——	,,	Bishop's 2 C, found in organ	3·01	440·4
——	,,	Ellis's 1 C Philharmonic	3·16	444·2
1715*c*	,,	Rev. Mr. Driffield's 4 A	2·19	419·9
,,	,,	Fork found buried at Brixton, 2 A	3·55	454·2
1751	,,	Handel's own Fork 2 A	2·30	422·5
1800*c*	,,	Broadwood's 1 C	2·31	422·7
,,	Plymouth	Dr. Stainer's 2 A	2·38	424·6
,,	London	Cavaillé-Coll's English 1 C	2·94	438·5
,,	,,	Broadwood's 1 C	2·33	423·6
,,	,,	,, 1 C	2·49	427·2
,,	,,	de la Fage's 2 A	2·50	427·5
1826*c*	,,	Broadwood's 1 C	2·50	427·5
,,	,,	,, 1 C	2·54	428·4
1846*c*	,,	Bryceson's 1 C	2·70	432·3
,,	,,	Ellis's 2 C	2·71	432·6
,,	,,	,, 1 C	2·75	433·7
1849*a*	,,	Irish Gentleman's 2 A Philharmonic	2·80	435·0
1878*a*	,,	Bishop's Walker's 1 C	3·32	448·1
,,	,,	Bishop's 1 C Philharmonic	3·45	451·7
		3. *Church Organs.*		
1668*a*	,,	Tomkins's rule	4·29	474·1
1669	,,	B. Schmidt's original Whitehall ?	,,	,,
——	,,	,, altered ,,	3·08	441·7
1683	Durham	,, Original Organ	4·29	474·1
1815*p*	,,	,, altered	3·12	443·1
1879*a*	,,	Willis's New Organ	3·18	444·7
1690	Hampton Ct.	B. Schmidt, Chapel Organ	3·08	442·0
,,	,,	,, Old Pipe	3·07	441·7
1708	London	,, St James'sChapel Royal, original	4·29	474·1
——	,,	,, altered, A 442, see A 474·1	——	——
1750	Cambridge	,, Trin. Coll. after shifting	1·14	395·2
	Temple	,, see under A 422·5	——	——
1666	Worcester	T. and R. Harris, Cathedral	2·89	437·1
1670	Newcastle	R. Harris, St. Nicholas	2·55	428·7
1696	London	,, St. Andrew Undershaft	2·51	427·7
1700	,,	,, St. John's, Clerkenwell	2·15	419·0
1878*a*	Norwich	,, ? Cathedral	2·49	427·2
1778	London	Green, St. Katherine's, Regent's-park	2·33	423·2
1780	Winchester	,, Restoration of College Organ	2·20	420·1
1788	Windsor	,, St. George's Chapel	2·51	427·8
1790	Kew	,, Parish Church	2·30	422·6
——	Dublin	,, Trinity Coll., restored !	2·87	436·8
1696	Boston, Linc.	Christian Smith, restored !	2·95	438·9
1749	London	Glyn & Parker, All Hallows the Great and Less	2·37	424·3
1730	Westminster	Schreider and Jordan's, Abbey original (?) see under A 474·1	——	——
1820*a*	,,	,, altered	2·30	422·5
1821	,,	,, altered for Greatorex to A 433·2	——	——
1848	,,	,, altered by Hill to A 441·7	——	——
1877	,,	,, present state	2·92	438·0
1740*p*	London	Schnetzler, German Chapel Royal	2·42	425·6
1764	Halifax	,, Parish Church	,,	,,
1740	Gr. Yarmouth	Byfield, Jordan, and Bridge, St. George's Chapel	2·44	425·9
,,	,,	,, Parish Church, restored !	2·91	437·7
1748	London	Jordans', St. George's, Botolph-lane	4·24	474·1
1830*c*	Belfast	Christchurch, restored !	2·75	433·6
,,	Arundel	Parish Church	2·82	435·6
1838	Bath	Smith, of Bristol, Abbey	2·30	422·5
——	Fulham	Jordans', Parish Church, altered !	2·62	430·4

Date.	Place.	Pitch.	S	A
1840*a*	Paddington	St. Mary's Chapel	2·95	439·0
1840*c*	Shrewsbury	Byfield and Green, St. Mary's, altered !	2·75	433·6
1843	Wimbledon	Walker, Parish Church	2·46	426·5
1855	Barking	Byfield and Green, restored by Walker (originally A 474·1)	2·98	439·5
——	Salisbury	St. Edmund's	3·14	443·7
——	London	St. George's-in-the-East	,,	,,
1877	,,	St. Paul's, present state	3·18	444·6
1878	,,	Bryceson, St. Michael's, Cornhill	3·57	454·7
1879*a*	Salisbury	Willis, Cathedral	3·20	445·2
,,	Glasgow	,, Established Church Cathedral	,,	,,
,,	Edinburgh	,, Episcopalian Cathedral	,,	,,
1878	London	Bishop's Standard Pipe	2·84	436·0
,,	,,	Gray and Davison's ,,	3·00	440·0
,,	,,	Walker's ,,	3·01	440·2
,,	,,	Bevington's ,,	3·02	440·5
,,	,,	Lewis's ,,	3·04	441·0
,,	,,	Hill's ,,	3·07	441·7
,,	,,	Bryceson's ,,	3·13	443·4
,,	,,	Willis's Church ,,	3·20	445·2
1879	,,	Experimental Copy of R. Harris's B *natural* at All Hallows, Barking	2·79	434·7
,,	,,	Experimental Copy of B. Schmidt's, Hampton-court, B *flat*	3·23	445·8
,,	,,	Narrow scale experimental B *natural* one-foot pipe	3·23	446·0
		4. *Concert Organs.*		
1867	,,	Walker, Exeter-hall	3·23	445·8
1879	,,	,, ,, sharpened	3·28	447·3
1877	,,	,, Gloucester Festival	3·29	447·7
,,	Glasgow	Lewis, Public Halls	3·41	450·6
1877*a*	London	Willis, Concert Standard, Albert Hall, Alexandra Palace	3·54	453·9
,,	,,	Albert Hall, observed	3·58	455·1
,,	Sydenham	Gray and Davison, Crystal Palace	3·55	454·1
,,	London	Bryceson, band pitch	3·57	454·7
		5. *Opera.*		
——	,,	Covent-garden, Allen's copy of Costa's Fork	3·52	453·4
——	,,	,, Collard's copy of Costa's Fork	3·57	454·7
1857	,,	Bettini's Fork of London Opera	3·62	456·1
1877	,,	Covent-garden, Harmonium	3·36	449·2
1878	,,	,, Organ	3·05	441·2
,,	,,	,, Harmonium	3·29	447·5
,,	,,	,, Band during performance	3·30	449·9
1879	,,	,, Organ	3·22	445·6
,,	,,	,, Band during performance	3·38	449·7
1880	,,	,, Theatre Fork for the Season of 1880	2·82	435·4
1878	,,	Her Majesty's, Organ	2·85	436·1
1879	,,	,, Band during performance	3·20	445·5
1880	,,	,, Theatre Fork	3·19	444·9
		6. *Concerts.*		
1813 —28	,,	Philharmonic, copy of original Fork	2·35	423·7
,,	,,	,, another copy	2·33	423·3
1826	,,	Approved by Sir G. Smart 1 C	2·72	433·0
,,	,,	Sir G. Smart's own 2 A	2·73	433·2
1846 —54	,,	Mean of Philharmonic under Costa	3·49	452·5
1874	,,	Highest Philharmonic	3·57	454·7
1876	,,	Sold as Concert-pitch by Cramer	3·26	446·7
1877	Sydenham	Crystal Palace Band	3·55	454·1
,,	London	Wagner Festival at Albert-hall	3·58	455·1
		7. *Pianos.*		
1826	,,	Broadwood's lowest	2·72	433·0
1849 —54	,,	,, medium, original	3·23	445·9
,,	,,	,, ,, copy now used	3·24	446·2
1860	,,	,, ,, copy made for Society of Arts	3·21	445·5
1852 —74*a*	,,	,, highest	3·49	452·5
1874*p*	,,	,, highest	3·57	454·7
1846*a*	,,	Hipkins's Vocal (meantone)	2·74	433·5
1846*p*	,,	,, ,, (equal)	2·84	436·9
1877	,,	Collard's Pitch	3·29	449·3

Date.	Place.	Pitch.	S	A
1879	London	Erard's Pitch	3·59	455·3
,,	,,	Steinway in England	3·57	454·7
1877	,,	Chappell	3·62	455·9
		8. Military Music.		
1878	,,	Dr. Stone's British Army Regulation Fork	3·46	451·9
,,	,,	Dr. Stone's Kneller-hall Training-school Fork	3·50	452·9
		IV.—FRANCE.		
		1. Standards.		
1648	Paris	Mersenne's one French foot pipe	0·17	373·7
1766	,,	Dom Bédos's ,, ,,	0·31	376·6
1854	,,	Delezenne's ,, ,,	0·15	373·1
1700*p*	,,	Pitchpipe at Faculty of Sciences	1·78	410·0
1832	,,	De Prony's proposal	3·07	441·7
1834	,,	Marloye's proposal	2·62	430·5
1858	,,	Cavaillé-Coll's proposal	3·16	444·0
,,	,,	French Commission's proposal	2·80	435·0
1859	,,	Diapason Normal at the Conservatoire; under this pitch see complete list of copies examined	2·82	435·4
		2. Old Forks.		
1700*c*	Lille	Mazingue's Old Fork	0·66	384·3
1754	,,	François's ,,	2·30	422·6
1800*c*	,,	Cohen's ,,	2·55	428·7
1854*a*	,,	Delezenne's ,,	2·72	432·9
1859*a*	,,	Marquis d'Aligre's Old Fork	2·97	439·3
1810*c*	Paris	Lemoine's ,,	2·60	430·0
		3. Church Organs.		
1636	,,	Mersenne's *ton de chapelle*	5·39	503·7
1700*a*	Lille	L'Hospice Comtesse	0·19	374·2
1789	Versailles	Palace Chapel, Conservatoire Fork	1·17	395·8
1818	Paris	Tuileries Chapel, ,,	2·78	434·3
1840	,,	Cavaillé-Coll's St. Denis	3·17	444·3
1851*a*	Lille	St. Sauveur	0·69	384·6
1854*a*	,,	La Madeleine (restored)	1·29	398·7
,,	,,	St. Maurice (repaired)	1·66	407·3
,,	,,	St. André ,,	2·69	432·2
1841	,,	St. Etienne (rebuilt)	2·89	437·1
1854	,,	St. Catherine (retuned)	3·02	440·5
		4. Concert Organ.		
1851	Lille	Festival Organ	3·27	446·8
		5. Opera.		
1810	Paris	Grand Opera, Drouet	2·32	423·0
1811	,,	,, Scheibler	2·48	427·0
1819	,,	,, Cagnard de la Tour	2·76	434·0
1822	,,	,, Fischer	2·67	431·7
1824	,,	,, lowered for Branchu	2·43	425·8
1829	,,	,, recovered Pitch	2·76	434·0
,,	,,	,, Cagnard de la Tour	2·92	438·9
,,	,,	,, Orchestral Pitch	3·00	440·0
1830	,,	,, Drouet	2·63	430·8
,,	,,	,, ,,	2·80	435·8
1834*c*	,,	,, Scheibler's Petitbout	2·76	434·0
1836	,,	,, Cagnard de la Tour	2·88	437·0
1836—9	,,	,, Delezenne's Leibner	3·04	441·0
1854*a*	,,	,, ,, Forks	2·89	437·4
,,	,,	,, ,, Pleyel	3·02	440·5
,,	,,	,, ,, Reeds	3·32	448·3
1855	,,	,, Lissajous & Ferraud	3·35	449·0
1856	,,	,, Pianoforte-makers' Fork	3·24	446·2
,,	,,	,, Bodin's Fork	3·23	445·8
1858	,,	,, French Commission	3·31	448·0
1823	,,	Italian Opera, Fischer	2·37	424·2
1829	,,	,, Cagnard de la Tour	2·80	435·0
1836	,,	,, ,, ,,	2·88	437·0
1854	,,	,, Delezenne's Reeds	3·10	442·5
1856	,,	,, Bodin	3·29	447·4
1820	,,	Opéra Comique or Feydeau, Conservatoire	2·32	423·0
1823	,,	,, Fischer	2·50	427·6
1829	,,	,, Cagnard de la Tour	2·92	438·0
1836	,,	,, ,, ,,	2·92	441·0
1854	,,	,, Delezenne's Reeds	3·31	448·0
1859	Bordeaux	Provincial Opera, Fr. Com.	3·12	443·6
1848 & 1854	Lille	,, Delezenne	3·40	450·5
1859	,,	,, French Commission	3·46	452·0
,,	Lyons	,, ,, ,,	3·31	448·0
,,	Toulouse	,, ,, ,,	3·10	442·5
1636	Paris	*6. Concerts.* Mersenne, Ton de Chambre	7·26	563·1
1812	,,	Conservatoire, Museum Fork	2·98	439·5
1834*c*	,,	,, Scheibler	2·82	435·3
,,	,,	,, ,,	3·03	440·9
,,	,,	,, Scheibler's Gand	2·82	435·2
1856	,,	,, de la Fage	3·24	446·2
1815	,,	De Prony (iron wire)	2·93	438·2
,,	,,	,, (brass wire)	3·18	444·5
1859	Toulouse	Conservatoire, Fr. Com.	2·88	437·0
,,	Lille	,, ,,	3·46	452·0
,,	Marseilles	,, ,,	3·27	447·0
		7. Pianos, Spinets, &c.		
1648	Paris	Mersenne's Spinet	1·48	402·9
1713	,,	Sauveur (see also A 407·1 and 408·0)	1·63	406·6
1783	,,	Pascal Taskin	1·74	409·0
1829	,,	Piano of Opera	2·42	425·5
1836	,,	Wölfel's Pianos	3·13	443·3
1854*a*	,,	Pleyel's Pianos	3·23	446·0
		V.—GERMANY.		
		1. Standards.		
1619	Brunswick	Praetorius's "Suitable Pitch"	2·37	424·2
1834	Stuttgart	Scheibler's Pitch at the Congress of Physicists	3·01	440·2
		2. Old Forks.		
1740—1812	Eutin	F. Anton von Weber's Fork	2·36	424·1
1780	Dresden	Kirsten's Fork	2·29	422·3
1800	———	Kummer's Fork	2·39	429·4
———	Hamburg	Schmahl's Fork, A 435·4 (see under A 489·2)		
		3. Church Organs.		
———	N. Germany	Praetorius (called by him *Chamber Pitch*)	7·40	567·3
1361	Saxony	Halberstadt Organ	5·41	505·8
1511	Heidelberg	Schlick, high Pitch	5·35	504·2
,,	,,	,, low Pitch	0·33	377·0
1543	Hamburg	St. Catherine (taken 1879)	4·54	480·8
1615	Palatinate	Salomon de Caus	1·19	396·4
1645	Holstein	Glückstadt	3·50	453·0
1688	Hamburg	St. Jacobi, low stop, old Pitch	1·84	411·4
,,	,,	,, high stops, old Pitch	4·84	489·2
1700*c*	Holstein	Rendsburg	5·06	495·5
1714	Saxony	Freiberg Cathedral, Silbermann	2·17	419·5
1716	Strassburg	See under A 376·6		
1722	Saxony	Dresden, St. Sophie	2·01	415·5
1749	Hamburg	Lehnert's Positiv	3·51	455·2
1754—1824	Saxony	Dresden, chained fork of R.C. Church Organ	1·99	415·0
1760	Holstein	Rendsburg	5·06	495·5
1762	Hamburg	Mattheson's St. Michaelis	1·69	407·9
1833	Weimar	Töpfer's Pipe	2·37	424·4
1862	Saxony	Dresden, Orchestra of R.C. Church	2·36	424·0
,,	,,	,, the same in the theatre	2·50	427·5
1878	,,	,, R.C. Church Organ	2·12	418·1
,,	Lübeck	Cathedral, Old Organ	4·65	484·1
1879	Hamburg	St. Jacobi, Present Pitch	5·00	494·5
		5. Opera.		
1752	Berlin	Marpurg, Fr. Com.	2·27	421·9
1806—14	,,	Wieprecht, Fr. Com.	2·62	430·5
1822	,,	Fischer's Pichler's fork	2·89	437·3
1830	,,	Wieprecht, Fr. Com.	3·00	440·0
1834	,,	Scheibler "trustworthy"	3·07	441·8
1857	,,	Taubert	3·33	448·4
1858	,,	Wieprecht, Fr. Com.	3·42	450·8
1859	,,	Fr. Com.	3·46	451·8
1861	,,	Näke	3·45	451·5
1869	,,	Sent to Society of Arts	2·82	435·5
1815—21	Dresden	Näke's Fork of Weber's time	2·33	423·2
1826	,,	Reissiger	2·80	435·0
1859	,,	Fr. Com.	3·04	441·0
,,	,,	Näke, during performance	3·23	446·0
1862	,,	Fürstenau's official Fork	2·91	437·8
1869	,,	Sent to Society of Arts from Leipzig	2·95	438·9
,,	,,	Rietz's Fork (probably an error)	3·37	449·4
1878	,,	Jehmlich's Fork	2·97	439·4
1859	Brunswick	Fr. Com.	2·78	443·5
1859	Carlsruhe	,,	2·80	435·0
,,	Gotha	,,	3·13	443·3
,,	Weimar	,,	3·19	444·8

Date.	Place.	Pitch.	S	A
1859	Stuttgardt	Fr. Com.	3·12	443·0
,,	Munich	,,	3·32	448·1
1869	,,	Sent to Society of Arts	2·85	436·1
,,	Baden	,, ,,	2·78	434·5
,,	Würtemburg	,,	2·88	436·9
1879	Hamburg	Opera, under Krebs	3·31	448·0
		6. Concerts.		
1714	Saxony	Näke's presumed Chamber Pitch	0·24	375·2
	Hamburg	Old Orchestral Pitch	3·20	445·0
1859	Leipzig	Conservatoire, Fr. Com.	3·34	448·8
,,	Würtemburg	Fr. Com.	3·19	444·8
1869	Leipzig	Gewandhaus, sent to Society of Arts	3·32	448·2
		9. Instruments.		
1770	Breslau	Marpurg	1·96	414·4
1760 —70	——	Flute by Floth (Näke)	2·12	418·0
1783	——	Grenser's Clarionet (Näke)	2·28	422·0
	——	Schneider's Oboe (Näke)	1·91	413·3
1800	——	Holtzapfel's Flute (Delezenne)	2·46	426·5
		VI.—Holland.		
		3. Church Organs.		
		The old celebrated Church Organs have all been altered, and I have not succeeded in my attempts to recover their ancient pitch.		
		6. Concerts.		
1859	The Hague	Fr. Com.	3·34	446·2
		VII.—Italy.		
		1. Standards.		
1720	Rome	Pitch-pipes (Dr. R. Smith)	1·14	395·2
1730c 1780c	Padua	Mean of Pitch-pipes of the Bell-foundry of Colbacchini	2·41	425·2
		2. Old Forks.		
1730c	Padua	Colbacchini's low 1 F	1·52	403·9
1780c	,,	,, high 1 F	2·30	422·6
,,	Verona	Cavedini's series of Forks	2·29	422·3
1790c	Padua	Stratico's 1 G	4·64	483·7
,,	,,	,, 4 G	2·87	436·6
		5. Opera.		
1845	Florence	Marloye	2·87	436·7
,,	Milan	,,	3·26	446·6
,,	Turin	,,	2·99	439·9
1856	Milan	Fr. Com.	3·49	450·3
1857	,,	La Scala (de la Fage)	3·45	451·7
,,	Naples	San Carlo (Guillaume's Fork)	3·19	444·9
1859	Turin	Fr. Com.	3·19	444·8
		6. Concerts.		
1869	Bologna	Liceo Musicale	3·12	443·1
		7. Pianos.		
1839	,,	Tadolini's Fork	2·43	425·8
		VIII.—Russia.		
		3. Church Organs.		
1781	St. Petersburg	Euler	2·11	418·0
		5. Opera.		
1802	,,	Sarti	2·84	436·0
1858	,,	Fr. Com.	3·45	451·5
1869	,,	Sent to Society of Arts	2·83	435·7
		9. Instruments.		
1739	,,	Euler	1·00	392·2
		IX.—Spain.		
		3. Church Organs.		
1785	Seville	T. Bosch's Organ	2·18	419·6
1858	Madrid	Ton de Chapelle	2·18	419·6
		5. Operas.		
,,	,,	Theatre (in 1879, A 435·4)	3·18	444·5

Date.	Place.	Pitch.	S	A
		X.—United States of America.		
		7. Pianos.		
1879	New York	Steinway's Fork	3·66	457·2

DISCUSSION.

The Chairman said that no one could regret the time Mr. Ellis had taken, considering the great interest and importance of the subject, and the very thorough manner in which he had treated it. He could not expect any discussion upon the paper, because, though they were in the habit of discussing opinions, facts of this kind admitted of no discussion. Mr. Ellis had put all his facts on such good authority, that there was nothing to question —they could only receive them with humility as information of immense value. Indeed, he could hardly express his high opinion of the value of the paper. It was a monument of research which would be referred to in future ages as a credit to the musical science of the day. He would only ask the meeting to pass a vote of thanks to Mr. Ellis for his excellent communication.

The vote of thanks was passed unanimously, and the meeting adjourned.

MISCELLANEOUS.

ARTIFICIAL DIAMONDS.

A preliminary notice by Mr. J. B. Hannay, of his successful attempt to produce the diamond artificially, was read at a meeting of the Royal Society on February 26th, 1880.

While pursuing his researches into the solubility of solids in gases, he noticed that many bodies, such as silica, alumina, and oxide of zinc, which are insoluble in water at ordinary temperatures, dissolve to a very considerable extent when treated with water-gas at a very high pressure. It occurred to him that a solvent might be found for carbon; and as gaseous solution nearly always yields crystalline solid on withdrawing the solvent or lowering its solvent power, it seemed probable that the carbon might be deposited in the crystalline state. After a large number of experiments, it was found that ordinary carbon, such as charcoal, lampblack, or graphite, were not affected by the most probable solvents he could think of, chemical action taking the place of solution.

A curious reaction, however, was noticed, which seemed likely to yield carbon in the nascent state, and so allow of its being easily dissolved. When a gas containing carbon and hydrogen is heated under pressure, in presence of certain metals, its hydrogen is attracted by the metal, and its carbon left free. This, as Professor Stokes suggested to the author, may be explained by the discovery of Professors Liveing and Dewar, that hydrogen has, at very high temperatures, a very strong affinity for certain metals, notably magnesium, forming extremely stable compounds therewith.

When the carbon is set free from the hydrocarbon in presence of a stable compound containing nitrogen, the whole being near a red heat, and under a very high pressure, the carbon is so acted upon by the nitrogen compound that it is obtained in the clear, transparent form of the diamond. The great difficulty lies in the construction of an inclosing vessel strong enough to withstand the enormous pressure and high temperature;

tubes constructed on the gun-barrel principle (with a wrought iron coil), of only half an inch bore and four inches external diameter, being torn open in nine cases out of ten.

The carbon obtained in the successful experiments is as hard as natural diamond, scratching all other crystals, and it does not affect polarised light. Mr. Hannay obtained crystals with curved faces belonging to the octahedral form, and diamond is the only substance crystallising in this manner. The crystals burn easily on thin platinum-foil over a good blow pipe, and leave no residue, and after two days' immersion in hydrofluoric acid they show no sign of dissolving, even when boiled. On heating a splinter in the electric arc, it turned black—a very characteristic reaction of diamond.

Lastly, a little apparatus was constructed for effecting a combustion of the crystals, and determining their composition. The ordinary organic analysis method was used, but the diamond crystals were laid on a thin piece of platinum-foil, and this was ignited by an electric current, and the combustion conducted in pure oxygen. The result obtained was, that the sample (14 mgrms.) contained 97·85 per cent. of carbon, a very close approximation, considering the small quantity at the experimenter's disposal. The author proposes to describe fully the apparatus and all analyses in a future paper.

Mr. Hannay wrote, subsequently to sending in his paper:—"I forgot, in the preliminary notice, to mention that the specific gravity of the diamond I have obtained ranges as high as 3·5; this being determined by flotation, using a mixture of bromide and fluoride of arsenic."

Messrs. Jonas Brothers, having written respecting the statement in Mr. Maskelyne's letter, that the process is "hardly less momentous to the arts than to the possessors of a wealth of jewellery" (see *Journal*, February 27th, 1880, p. 289). Mr. Hannay sent them the following answer, which has been printed in the *Times*:—"I do not in the least expect that my discovery will have any effect upon your business, as the cost of producing very small quantities of substance like boart is so great as to relegate the process to a mere laboratory experiment."

ON SILK-PRODUCING BOMBYCES AND OTHER LEPIDOPTERA.

By Alfred Wailly

(Membre Lauréat de la Société d'Acclimatation de France).

(Continued from page 232).

III.—NOTICE ON ATTICUS MYLITTA, ANTHERŒA PAPHIA-THE TUSSER, TUSSUR, TUSSEH, TUSSAH* SILKWORM.

The *Mylitta*, or Tasar silkworm, which is found all over India, and also in Ceylon, is the most valuable of the Indian wild silk-producing Bombyces, and it is extremely polyphagous. In India, it feeds on *Terminalea tomentosa*, *Zizyphus jujuba*, *Lagerstræmia indica*, *Ficus benjamina*, *Carissa*, *Guidia*, and other trees. Last year, in England (where I introduced it for the first time), and also in France and Germany, it has been reared on oak, and, by Mr. P. H. Gosse, on horn-beam.

The various races of *Mylitta* vary considerably in size, according to the different localities where they are found. The cocoons are oval and silvery-white, or yellowish. Some are 2 in. long and 1½ in. in diameter, and even more; others, only about 1 in. in length. The difference in size of the various races of the same species is very likely due to the quality of the foliage they feed upon.

In the forests of the Himalaya and other parts, where the foliage is abundant and keeps fresh, the worms grow to a considerable size; but, in localities where the weather is hot and dry, the foliage withering in a short time, the worms undergo their changes in a shorter time, and, in consequence, form much smaller cocoons.

This, of course, refers to worms living in a wild state; but, should they be reared on trees properly attended to, and kept in good condition, it is possible that the worms of the various races would all produce large cocoons. As a proof of this assertion, I may mention the success obtained in a part of the Bombay Presidency, where the climate is hotter than in the Himalaya Mountains, by Major G. Coussmaker, who, for several years, has reared this species, and obtained cocoons equal in size to those I received last year from Calcutta, and which came from the Himalaya.

The Himalaya race of *mylitta* is *uni-voltine* (single brooded), the moths emerging about the beginning of July; the races from the south of India and Ceylon, like all species of tropical insects, are *poly-voltines* (many-brooded). One of my correspondents in Colombo, to whom I had written for cocoons, in a letter dated 16th January, 1879, says:—"I have some cocoons of *mylitta*, but the moths are emerging."

At the end of June, 1879, I received from Calcutta a small case containing 55 cocoons of the Himalaya race of *Attacus mylitta*, which is one of the largest. The cocoons having been sent too late, the moths emerged on the way, but a few cocoons escaped, from which, in a few days, emerged large and magnificent moths. From the two first couples I obtained two pairings; the other moths were all females.

The couples were placed in small separate cages, and in the open air, under a roof. The first male and female moths, born in the evening, the 6th of July, paired in the night of the 7th, the pairing lasting 42 hours. The pairing of the second couple, which took place the following night, lasted 48 hours. I never had any species of moths the pairing of which lasted so long. I was so anxious about the success of my first experiment with this species that I paid a visit to the first couple in the middle of the night, when I was agreeably surprised to see that success had been obtained, and that in spite of the rather unfavourable weather.

I was afraid of failure after reading a description of *mylitta* in vol. xxxii. of the "Naturalist's Library," edited by Sir William Jardine, in which the writer of the memoir on *mylitta* says that this species cannot be domesticated. This evidently refers to a race of *mylitta* with habits very different to those of the Himalaya race, as it is further stated "this species cannot be confined, for, as soon as the moth pierces the cocoon, it gets away, and the people add that it is impossible to keep it by any precaution whatever." In another part of the memoir, the following extraordinary statement is made:—"I have frequently endeavoured to detain the males of the Jarroo species, and have kept them locked up in a box for that purpose; but, whether they did not like to make free with their female relations, or from what other cause I know not, but I never could obtain a breed in the domestic state; and the efforts of the male to escape were wonderful, and, at last, always effectual." The Jarroo species alluded to is that from which the cocoons are obtained during the coldest month of the year—January.

Although I could not take the above statements in a literal sense, I feared it was impossible, or at least difficult, to cause the Mylitta moths to pair in captivity. Fortunately, the moths of this great and valuable species paired readily, and for a considerable time (a most important thing), and the females laid their eggs for several days without even damaging their wings. Contrary to some small species of *mylitta*, which are restless, the moths of this large race were extremely quiet; they could be taken by the hand and placed anywhere without letting themselves fall. The male moths must have been as quiet as the female, as they were, after the pairings had taken place, as fresh as they were after emerging from the cocoons.

* From the Hindostani *tussurie*, which means shuttle.

The two female *mylitta* laid about 450 ova, all together. These eggs are of a whitish colour, round, rather compressed, generally with two lines encircling them; they are somewhat larger than the eggs of *Yama-mai* and *Pernyi*. Some of the ova are smaller than the others, and very likely they produce the male larvæ.

The hatching of the ova commenced on the 2nd of August. The smaller larvæ, in the first stage, and when just hatched, were light-brown or buff, the larger ones of a greenish tint. In a few days, they all became of a more uniform colour. Round each segment there is a black line. The head and legs of the larvæ are black, and there are black spots on the body.

The second stage commenced on the 10th of August. The larva was then yellow-green; no black lines round the segments; the head and legs, as in the first stage, black or blackish brown; black spots as before.

The third stage commenced on the 17th of August. Larva, fine green; head and legs, as before, black. Dark spines, with base of a brilliant metallic copper colour.

The fourth stage commenced on the 29th of August. From that date, I regret to say, I was obliged to discontinue my rough descriptions of the larvæ, which, up to that time, after thriving admirably without a single fatality, commenced to die, two, three, or more every day, till all were gone within about 12 days—about 60 worms in all. They were fed on oak.

The death of the *mylitta* larvæ I attribute to several causes. The cold weather compelled me to rear them in a room, and I kept them too long under bell-glasses; perhaps they had not a sufficient amount of fresh air, although the large glasses were raised to renew it. After the first stage, it would have been best to rear them entirely uncovered, on oak branches plunged in water, as they did not much wander then. I rear successfully many species under glass, but some of the larger species do best uncovered, with a free ventilation, and better still in the open air.

I fed my larvæ like *Yama-mai* and *Pernyi*, with hard leaves on old oak branches, and, from what I subsequently learnt from Herr Huesmann, it would seem they prefer young and tender leaves, such as those produced by suckers or shoots of the year; but experience alone will teach us the best method of rearing this valuable species. My impression now is that, the foliage being too hard, the worms could not eat sufficiently, and that they were gradually starved.

Mr. P. H. Gosse, writing to me on September 12th, 1879, says:—"My two *mylitta* larvæ are about 3½ in. in length and $\frac{5}{10}$ths in depth. Fine apple green, with a yellow line on each side; upper tubercles, burnished copper; middle and lower tubercles, purple; spiracles, orange; face, dark brown. I have fed them, as many others, on horn-beam (a valuable discovery of mine)."

In a subsequent communication, dated September 30th, 1879, which Mr. Gosse was kind enough to send me, he says, "In reply to your questions, the *mylitta* larvæ I described in the fifth stage, when full-grown. Both have since died. Fatality has attended almost all my species (*pyri*, *cecropia*, *promethea*, *cynthia*, *selene*) except *Hyperchiria io*, which has done very well."

Major G. Coussmaker, in his "Memoir on *Mylitta*," published in 1873, says the larvæ moult five times. From this we must conclude that Mr. Gosse's larvæ were in the last stage but one. Two larvæ I received from Herr Huesmann, on the 29th of October, in the sixth and last stage, were of an enormous size.

Lord Walsingham, to whom I sent them for preservation, kindly wrote to me on October 31st:—"I am much obliged for the two larvæ of *mylitta*. I am sorry to say that I have failed to preserve them satisfactorily, their brilliant pale-green colour being quite impossible to retain, and their size rendering them very difficult subjects."

The larva in its sixth stage was this:—On the back, 18 brilliant copper tubercles, and two rows of small purple spines on each side; a yellow, lateral stripe on each side; head, dark brown.

Major Coussmaker, in the description of his *mylitta* larva says that, "when hatched, it is blackish-brown, with a shining black head, and that, as it increases in size, the colour of the body turns yellow. After the first moult, the head becomes of a blood-red colour; the colour of the body is of a greenish tint, and after each moult it becomes greener." Major Coussmaker adds, "When full-grown, a fine specimen is, at least, 7 in. long and 1 in. in diameter. I have weighed one of these dimensions when 45 days old, and found it to be 371 grains."

From what has been said, it will be seen that the rearing of *mylitta* last year was of very long duration, from the beginning of August till the end of October; therefore, in England, and other northern countries, artificial heat will be required to bring the larvæ to the formation of their cocoons. No success could be obtained in the open air.

But, in southern European countries, such as Spain, for instance, where the *Yama-mai* and *pernyi* oak silkworms are already thoroughly acclimatised and reared in immense quantities, it is to be hoped the *mylitta* will be equally successful.

In August last, I received a letter, dated 27th July, 1879, from Major Coussmaker, from which I shall quote the following passage:—"My system of rearing is very simple and methodical. I keep all my seed-cocoons in a basket, with the pedicles uppermost. At intervals, between 6 and 11 p.m., I look at them, and if I see any moist at the top, I tie them on to a branch of any tree or shrub in my garden, and at daylight I find that the females are paired in the vicinity of their cocoons, while the males have gone away to seek for mates.

"They are left in that condition all day, and at sunset, or when I am going out for a walk, I take the females, let the males fly, and put the females to lay their eggs. The next morning I take the eggs away, and put them into a small box, or something of the kind, safe from rats, mice, and ants.

"In nine days they hatch out, and I put them on to shrubs, over which I put screens of split bamboo. As the worms grow, they eat the shrubs quite bare, while I move the screens as necessary. To facilitate this moving, I have planted my shrubs in hedges, and now it is only a matter of the food and number of worms.

"From a month to six weeks, according to the moisture and luxuriance of the foliage, the worms take to make their cocoons, and, as far as I can see, success seems certain. The plants I use are the varieties of *lagerstræmia*, *Zizyphus*, *terminalia*, and *carissa*. I am not aware as to whether any of these trees can be obtainable in England, or whether the worms will hatch out there. The moths paired and laid eggs in 1874, but did not hatch. I hope that you will be more successful."

To conclude, I will now quote a few short passages from Herr Huesmann's letters to me:—October 15, 1879—"My *mylitta* larvæ are doing very well, but are growing very slowly; up to this day, only four have formed their cocoons, but these are fully as large as the imported ones. Please to consider that my *mylitta* larvæ are exactly the same age as my *selene*, which partly are moths to-day." October 22—"The first *mylitta* larvæ hatched on July the 31st, and commenced to spin on October the 2nd, about half of this long time having been spent in the last stage. I never bred *mylitta* larvæ before, but have seen them reared in Bremen two years ago. The larvæ I saw in Bremen were a good deal smaller than mine, and their cocoons, of which I had some in my possession afterwards, produced very small and mean-looking moths. I fed my larvæ on the common oak, but always picked out young sprigs with large and succulent leaves."

At the end of October the larvæ had not all formed their cocoons.

A. Wailly.

119, Clapham-road, London, S.W.

CULTIVATION OF OLIVE, CAROB, AND MULBERRY TREES IN CYPRUS.

Olive groves in Cyprus are not so numerous as they might be; but isolated trees are frequently to be seen scattered, with carob trees, on the hills adjoining the two great mountain ranges of the island. On the spurs of the Troodos range, and in the northern slope of the range of Kerynia, they almost form a zone, at a height varying from 400 to 700 feet above the level of the sea; and though that locality appears the best suited for them, they are frequently seen also in the plains as well as the sea-shore. Many years must elapse before olive and carob trees yield any considerable profit to planters. But if, for other reasons, as for instance to promote rain, and to improve the climate, it be decided to plant more trees, olive and carob should, by no means, be lost sight of. They thrive well, and grow almost, as it were, spontaneously, in the island, and would yield, in course of time, a fair profit.

Dr. Schmas and Mr. Galizin mention in their report that the inhabitants do not appear to take much care of the existing olive and carob groves. The fruit of the olive is very small, which induces the belief that they are not properly grafted. The inhabitants of the northern slopes of the mountain range of Kerynia seem to bestow a little more care on their olives. In gathering their olives they take at least the pains of shaking, instead of striking, the branches of the trees, as is practiced in Baffo. The only reason that can be assigned for this rough usage is, that the country people of the south are compelled to gather the olives before maturity, fearing that they would be carried away by thieves, and when yet purple, shaking alone is sufficient to make them fall to the ground. It is difficult, however, to find any excuse for the setting on fire, without any apparent reason, olive and carob trees, as witnessed on more than one occasion. The art of extracting oil from olives is far from being fully developed in Cyprus; but even if some better method were introduced, good oil could never be obtained from olives artificially ripened by baking, as practised in Baffo. This branch of agriculture in Cyprus is capable of great improvement. Neither the quality nor the quantity of the oil now taken is such as to admit of exportation; the whole produce, a short time back, was only 103,114 gallons.

The carobs of Baffo are, unlike the olives, better than those of Kerynia, the former having sugar round the seed, and keeping better than the latter, which have but honey. Cyprus is renowned for its carob groves. The tree, unlike that of Malta, has the trunk straight, and is not so knobby. Not being sheltered, winds damage it to such an extent, that in several parts of the island, especially near the sea coast, the bending of the trunks of the trees is taken to indicate the direction of the prevailing winds. The carob of Kerynia is subject to a disease which reduces the inside of the pod to dust. It appears that it attacks, also, the carob on the seashore. Unlike the olive, the carob bears the heat wonderfully, and this accounts for the greater number of carob than of olive groves. Its cultivation, however, bears no proportion to the vast extent of the island, and to the climate, which is so favourable to its growth. The largest production of carobs is in the districts of Limassol, Karpas, and Kerynia. The whole of the produce of the island some years ago was about 5,000 tons, of which about 1,500 tons were exported.

Mulberry-trees are generally cultivated in proximity to villages, for the leaf, which is the food of the silkworm. They thrive well. At Famagusta, or rather at Varoscia, where mulberries are extensively cultivated, it is calculated that a scala yields food for silkworms, producing from 12 to 16 okes of silk a year (from 33 to 44 lbs.). The silk trade, at present, is not in a very flourishing condition, owing to a disease of the silkworm, from the effects of which the island has been suffering for the last 20 years, notwithstanding the change of seed. Cyprus produced formerly between 70,000 and 80,000 lbs. of silk, whilst at present the yearly produce is estimated at from 5,600 to 8,400 lbs. It is for the most part produced in the districts of Famagusta, Baffo, Larnaka, and Karpas. Kythrea also gives a good supply of silk, but of an inferior quality. It is calculated that 10 okes of cocoons give one oke of silk thread.

FISHERIES OF THE ISLE OF MAN.

The Commissioners of Fisheries—Messrs. Buckland and Spencer Walpole—mention that as so much interest attaches to, and so little is known of, the fisheries of the Isle of Man, they think it right to append a particular reference to them in their report upon the Sea Fisheries of England and Wales. With regard to the inland fisheries, the Isle of Man is watered by several rivers, the greatest and most important being the Sulby, a river which rises near the the centre of the island, and flows into the sea at Ramsey. The second most important watershed is drained by the town rivers, the Dhoo, or the Black River, and the Glass, or the Clear River, which unite their waters near Douglas, and give their united names to the thriving capital of the island. The third river of importance is the Neb, which enters the sea at Peel, and the fourth is the Laxey. Other smaller streams drain other parts of the island.

There is no doubt, whatever, that all these streams were, at a comparatively recent period, productive salmon and sea trout rivers. The Laxey owes its name, like the Lax weir, at Limerick, to the salmon with which it abounded; and the Douglas is situated in the parish of Braddan, a word derived from the Gaelic for a salmon. Men who are still alive recollect the period when the salmon fishery of the island was a profitable business. Of recent years this has been in a very unsatisfactory condition. The fishery of the Laxey has been practically destroyed by the well-known mine which takes its name from the river. The fishery of the Neb has also been destroyed by a mine, while the Douglas river is injured by the gas water of the town of Douglas. Pollution makes it impossible to hope that the salmon fisheries will ever recover their former condition. But in addition to the injury done to these fisheries by pollution, they are also suffering from the consequences of unfair fishing. The fisheries are now regulated by an old Act, passed about forty years ago. The Act provides a close time for salmon; it prohibits the use of certain instruments; and it professes to prevent the pollution of rivers. The authorities of the island, however, doubt the possibility of enforcing its provisions, while, in any case, the Act must be a failure, now that there is no machinery for enforcing them. Analogous machinery, however, to that which is provided with the same object in England, might be easily applied to the Isle of Man.

The sea fisheries are also of importance. Peel, the chief fishing port, is one of the principal stations of the herring fishery. It has a fine fleet of first-class fishing-boats, which frequent many of the principal Irish, Scotch, and English fisheries. The boats are fast, handsome, and large, and it is difficult to see a finer sight than the fleet standing out to sea on a summer's evening. The fleet usually repair in the spring of the year to Kinsale, for mackerel fishing. In the summer and autumn the herrings come into the Manx and Irish seas. The fishery is in a satisfactory condition, and there is an almost universal agreement among the fisherman that only one regulation is required, which, however, is of very great importance. A custom has arisen, of late years, for the fishermen to shoot their nets before sunset. The fish, scared by the early shooting of the nets, frequently sink, and the night's fishing

is, in consequence, lost. In addition to the summer fishery for herrings, there used to be a considerable autumn fishery for spawning herrings off the east coast of the Isle of Man. A large so-called coral bank, many miles in length, extends from a spot off Mangold Head, to a spot off Douglas Head, in which the herrings undoubtedly spawn. There used to be a very considerable fishery for these spawning fish. The fishery has now ceased, as the nets used in it are broken by the vast shoals of dog-fish preying on the spawning fisheries. The fishermen declare that in the olden times the shoal of herrings was much larger than it is now, and that, as the dog-fish were always on the outside, they could drift for some miles through the herrings without coming on the dog-fish. They declare that now the shoal is so much smaller that they come more quickly on the dog-fish, and that the nets are then broken. The Commissioners incline to think that the nets are broken, not because the shoal of spawning fish is smaller, but because the nets, which are now made of cotton, are much weaker than the old nets, which used to be made of hemp. On the other hand, it is only right to say that dog-fish, like other fish, are migratory in their movements, and that it is possible that they visit a place for some years, and then leave it altogether. This view is partly confirmed by a tradition in the Isle of Man, that a special prayer was once put up in all the parish churches against dog-fish. It was not possible to obtain a copy of the prayer, but its existence was stated on good authority. If such a prayer was raised in olden times, it is a fair inference that the present plague is not unprecedented. In addition to the herring fishery, which is chiefly carried on from Peel, there is an important hook-and-line fishery for cod conducted chiefly from Ramsey. The Liverpool trawlers fish the great breeding banks of the island, and the bays are fished by small-meshed drift nets, and by fixed trammel-nets. In the island itself the long-line fishing is regarded as the most important of these industries, and the majority of people in the island are prepared to sacrifice all the other kinds of fishing for the sake of the long-line and herring fisheries.

PROVINCE OF THE DOBRUDSCHA.

As the province of Dobrudscha—ceded to Roumania in exchange for Bessarabia—is likely to increase in importance, and, in time, become a valuable acquisition to Roumania, Vice-Consul Stokes gives a short summary of its principal towns and districts, their population and productions. The town of Tultcha and its suburbs contains a population of about 43,000 souls; the surrounding district is exceedingly fertile, producing grain of an excellent quality, but, owing to its limited cultivation and meagre population, only in small quantities. Its other products consist of wool (of a very superior quality), cheese, caviare, and skins; also wine. Its principal imports are rice, coffee, sugar, oil, spirits, cotton goods, glass ware, iron, and tobacco, but all on a limited scale (barely sufficient to meet the requirements of its population), and are principally imported from France and Austria.

The town of Babadagh and its surrounding district contains a population of about 41,000 souls, and possesses an excellent climate and a rich soil, and is supposed to be rich in mineral resources, which are, as yet, totally undeveloped.

Kustendji is divided into three districts, viz., Kustendji, Mangalia, and Hirsova, and the population of the three districts may be computed at about 23,320 souls, composed of Greeks, Tartars, Bulgarians, Roumanians, Armenians, and Turks, who are chiefly engaged in agricultural pursuits. Kustendji possesses a good harbour, and has the advantage of being the depôt of the Rustchuk and Varna Railway, which greatly facilitates the transportation of grain from the interior of the port. The town of Matchin and its suburbs has a population of about 2,200 souls, and it is a good grain-producing district. Medjidie and Cernavoda have a small population of about 8,000 souls, and are, like the others, grain-producing districts. Sulina, situated at the mouth of the Danube, derives its chief importance from the establishment of the offices of the European Commission of the Danube; it also serves as a depôt for a large quantity of grain, which is brought down from the up-river ports for transhipment on board of the larger class of steamers frequenting the port, whose heavy draught of water prevents them from ascending the river. The importance of the trade of the place depends in a great measure upon the depth of the water in the river, as when it is low, say 14 feet, a much larger number of vessels are loaded in the port. It is found more economical, under these circumstances, to send the grain down from the up-river port in lighters, for transhipment, thereby saving the expense of pilotage up and down, and also avoiding the risk of getting ships aground, which frequently occurs when the river is low, and this entails an expense of at least £500 to refloat a ship. As the incoming and outgoing of the whole trade of the Lower Danube, Sulina is a most important transit station, but nothing more; exports of its own produce it has none, and its imports are confined to the strict necessaries of life, for a population consisting principally of the labouring classes, who find their livelihood by loading and unloading ships. The population may be estimated at about 6,000 souls, chiefly Greeks.

The whole of the province of the Dobrudscha may be pronounced fertile, and possessing many resources, that would, under a good administration—which up to the present time it has never had—be sure in a short time to develop themselves, and amply repay Roumania for the exchange of Bessarabia to Russia.

THE WIRE BOOK-SEWING MACHINE.*

The most important step forward that has lately been made in bookbinding is, undoubtedly, the substitution of wire for thread. A machine for sewing books with wire was recently exhibited at a meeting of the Franklin Institute, where several books were sewed before the audience.

The principle of this machine consists in producing a number of U-shaped wire staples, which are driven from the inside of each section of the book through the back, and through one wide or several narrow bands of a strong linen or cotton fabric, whereupon the ends projecting through the back are clenched over, and thus a firm connection between the sheets of the section themselves and the band, or bands, covering the back of the book, is produced. The machine fastens a section at each revolution of the main-shaft, and can be run at 40 to 43 revolutions per minute. The book sections are fed by the operator, partly opened, upon a table, which, by an oscillating motion, brings the sheet in position to be sewed. By an adjustable downward feed of the table on which the book is sewed, the section can be sewed tight or loose, to suit the degree of "backing" in the subsequent forwarding of the book. The principal merits of this mode of binding books are, strength, durability, and flexibility, besides the saving of labour, as an operator can turn out as much work on one of these machines as from five to eight operators can do by hand. Greater strength is given by the several sheets of each section being clamped firmly between the back and the clenched legs of the wire staple, while the thread in thread-sewed books holds the centre sheet only by the edges of the cuts through which the thread passes. If the inner sheet of any section of a thread-

* A paper, by H. Bilgram, read before the Franklin Institute, Philadelphia, October 15th, 1879.

bound book be torn out by force, the thread cuts its way through the fold of the sheet, while in a wire-sewed book the sheet will tear in a double line, leaving a small strip of paper underneath the wire staple. This simple test proves at once the superior strength of a wire-sewed book.

The firmness of a wire-sewed book is not so much dependent on the glueing of the back as is the case with a thread-bound book. The inner sheet of any thread-bound book is held in position by the glue in the several saw-cuts; for, if this connection is carefully severed without injuring the thread connection, the sheet can be moved up and down as much as the thirty-second of an inch, while nothing short of actual tearing of the paper can make the corresponding sheet of a wire-sewed book move through the same distance. Rusting of the iron wire is effectually guarded against by tinning it. Increased flexibility is insured by the diminished thickness of the flexible back of the book. In the old way of binding, the flexible connection of the several sections of the book is represented by two or more comparatively thick strands laid in the saw-cuts on the back of the book, and held there by the threads passing round them; while on the wire-sewed books the corresponding connection extends over the greater part of the back, and is not only much thinner and more flexible, but also much stronger. The book opens very freely indeed.

In binding the first books sewed with wire, some difficulty was experienced in the wires thickening the back of the book so much that, in pressing it for the purpose of cutting, the paper was crushed by the wire just where it should have been strongest. This defect has been overcome by inserting the staples in a zigzag line, so that there appear two or three times as many rows of staples on the back, as there are staples in each section.

CORRESPONDENCE.

ARMENIAN LIBRARY, SMYRNA.

In consequence of late events in Asia Minor, the study of the English language has been taken up with more vigour, and an appeal for the contribution of English books is made on behalf of the Armenian Reading-room and Library, in Smyrna, established in 1869. Books, journals, and newspapers, may be sent to Captain Stab, Corresponding Member of the Society of Arts, Smyrna, or to Mr. H. Papa Sian, Smyrna. The postage is cheap, as Smyrna is within the Postal Union. I beg strongly to urge this application, as the members of the library have already 2,000 volumes, many of which are English. Hyde Clarke.

32, St. George's-square, S.W.

DOMESTIC POISONS.

In the *Journal of the Society of Arts* for the 23rd Jan., and in the latter part of the paper on "Our Domestic Poisons," by Mr. Carr, we find a paragraph on tapestry carpeting (vol. 28, p. 157).

No one acquainted with carpet manufacture could be misled by the observations contained in the paragraph; but, for obvious reasons, we are compelled to notice the same, and, for the information of those not so familiar, we feel called upon to give the following facts:—

It is perfectly true that the so-called stuffer or material used to give substance to the tapestry carpet fabric is sized, but the size used for the purpose by the chief makers is perfectly inodorous, being entirely flour.

It is absolutely incorrect that size is required or used to keep the wool surface in place.

Except by great care in preparing the size necessarily used in the manufacture of all carpeting wherein linen weft is used, unpleasant smell will temporarily pervade a carpet when first laid down. This statement is based upon an experience of over 40 years, and before tapestry carpeting was manufactured to any extent, if at all.

There is nothing different in the manufacture of Brussels and tapestry carpeting that one should be more liable to smell than the other; either is liable to smell in the absence of the most scrupulous care and attention in their manufacture.

The manufacture of tapestry carpeting dates from 30 to 40 years back, and has been steadily progressive, which would not have been the case had the statement referred to been correct.

We trust you will give the same publicity to this letter as you have given to the paragraph alluded to.

Edward Crossley & Sons.

Dean Clough Mills, Halifax,
February 27th, 1880.

GENERAL NOTES.

Population of the Globe.—The population of the globe has been roughly calculated at 1,421,000,000, giving the following numbers for the chief divisions:—Europe, 309,000,000; Asia, 824,000,000: Africa, 199,000,000; Oceania, 4,000,000; America, 85,000,000. The annual number of deaths throughout the world is put at 35,693,350, or 97,790 persons each day. The balance of population is, however, more than kept up by births at the rate of 104,300 per day.

The French Wine Trade.—It appears that the value of wines exported from France is annually decreasing, while that of wines imported into the country is increasing. The following figures given in the *Times* represent the value of the imports and exports during the past ten years:—

	Value of Imports.	Value of Exports.
1869	£565,640	£10,441,520
1870	196,160	8,921,200
1871	267,120	9,402,560
1872	775,080	10,939,800
1873	1,150,720	11,250,000
1874	1,189,840	9,170,320
1875	551,300	9,899,240
1876	1,010,680	8,464,120
1877	1,178,560	8,430,440
1878	2,509,920	8,320,040

The balance of trade has turned against France to the value of about £4,000,000 in ten years. The imported wines have been chiefly from Spain, but a large quantity are Italian wines. This serious diminution in the viticultural produce of France has been chiefly owing to the ravages of phylloxera.

MEETINGS OF THE SOCIETY

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock:—

March 10.—"Recent Advances in the Production of Lambeth Art Pottery." By John Sparkes. Sir Philip Cunliffe Owen, C.B., K.C.M.G., will preside.

March 17.—"The Art of the Silversmith." By W. Herbert Singer. A. J. Mundella, M.P., will preside.

April 7.—"Buildings for Secondary Educational Purposes." By E. C. Robins, F.S.A., F.R.I.B.A.

April 14.—"The History of the Art of Book-binding." By Henry B. Wheatley, F.S.A.

APRIL 21.—"The Present System of Obtaining Materials in use by Artist Painters, as compared with that of the Old Masters." By W. HOLMAN HUNT.

APRIL 28.—"Recent Improvements in Gas Furnaces for Domestic and Lavatory Purposes." By THOMAS FLETCHER.

MAY 5.—"On the last Forty Years of Agricultural Experience." By JOHN C. MORTON.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

APRIL 2.—"The Best Route for a Line of Railway to India." By B. HAUGHTON, C.E.

APRIL 16.—"Russia's Influence over the Inhabitants of Central Asia during the last Ten Years." By Prof. VAMBÉRY.

MAY 7.—"The Present Condition and Prospects of Agriculture in South India." By W. ROBERTSON, M.R.C.A., Superintendent of the Government Farms in the Madras Presidency.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at eight o'clock:—

MARCH 16.—"Transport and Trading Centres for Eastern Equatorial Africa." By Captain C. E. FOOT, R.N.

APRIL 6.—"Art in Japan." By C. PFOUNDES.

APRIL 27.—"Iceland and its Resources." By C. G. W. LOCK.

MAY 18.—"The Arts, Manufactures, and Prospects of Madagascar." By the Rev. JAMES SIBREE, jun., F.R.G.S.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at eight o'clock:—

MARCH 11.—"Balmain's Luminous Paint." By C. W. HEATON, F.C S. Professor H. E. ROSCOE, F.R.S., will preside.

APRIL 8.—"On Recent Improvements in Benzine Colours." By F. J. FRISWELL, F.C.S.

APRIL 22.—"On Some Recent Advances in the Science of Photography." By Captain ABNEY, R.E., F.R.S.

MAY 13.—"On some Physical Applications of Light." By Prof. W. G. ADAMS, F.R.S.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

The Second Course, "On the Manufacture of India-rubber and Gutta-percha," by THOMAS BOLAS, F.C.S.

LECTURE VI.—MARCH 8.

Gutta-percha. Sources. Chemical nature and physical properties. Purification. Applications in connection with the industrial arts. Vulcanisation of gutta-percha.

The Third Course will be by Mr. R. W. EDIS, F.S.A., on "Art Decoration and Furniture." It will consist of six lectures, to be given on the following dates:—April 5, 12, 19, 26; May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 8TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "The Manufacture of India-Rubber and Gutta-Percha." (Lecture VI.)
London and Middlesex Archæological, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. F. J. Hilton Price, "Notes on Excavations at Temple-bar." 2. Rev. R. Hawley Cluttebuck, "A Londoner's Trip to a Country Cousin's in 1773."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Lieut. G. T. Temple, "An Autumn and Winter Yacht Voyage along the Coasts of Norway and Lapland."
British Architects, 9, Conduit-street, W., 8 p.m. Special General Meeting.
Medical, 11, Chandos-street, W., 8½ p.m. Annual Meeting.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. F. J. Palmer, "Life-saving Apparatus."

TUESDAY, MARCH 9TH...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Schäfer, "Physiology of Muscle." (Lecture IX.)
Metropolitan Scientific Association, 13, Blomfield-street, E.C., 7 p.m.
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. H. E. Jones, "The Purification of Gas."
Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. Francis Galton, "Visualised Numerals, and other Forms of Mental Imagery." 2. Mr. C. H. E. Carmichael, "Notes on Prehistoric Discoveries in Central Russia."
Royal Horticultural, South Kensington, S.W., 1 p.m.
Folk Lore, 22, Albemarle-street, 8 p.m. 1. Mr. J. S. Udal, "Dorsetshire Mummery Plays." 2. Mr. Alfred Nutt, "Critical Notes on Celtic Folk-tales and Heldensage."

WEDNESDAY, MARCH 10TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. John Sparkes, "Recent Advances in the Production of Lambeth Art Pottery."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) Dr. Cayley, "Some Points in the Pathology and Treatment of Typhoid Fever." (Lecture III.)
Geological, Burlington-house, W., 8 p.m. 1. Prof. E. Hull, "The Rocks of the South of Ireland and North Devon." 2. Mr. G. R. Vine, "A Review of the Family Diastoporidæ for the Purpose of Classification." 3. Mr. W. H. Twelvetrees, "A New Theriodont Reptile (*Cleiorhizodon orenburgensis*, Twelvetr.), from the Upper Permian Cupriferous Sandstones of Kargalinsk, near Orenburg, in South-Eastern Russia."
Graphic, University College, W.C., 8 p.m.
Microscopical, King's College, W.C., 8 p.m.
Royal Literary Fund, 10, John-st., Adelphi, W.C., 3 p.m. Annual Meeting.
Telegraph Engineers, 25, Great George-street, Westminster S.W., 8 p.m. Mr. Alexander Siemens, "Some Recent Improvements in Electric Light Apparatus."

THURSDAY, MARCH 11TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Prof. C. W. Heaton, "Balmain's Luminous Paint."
Royal, Burlington-house, W., 8½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. W. H. Monk, "Some Predecessors of Bach and Handel."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Miss Edith Heraud, "Tennyson."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Recent Chemical Progress." (Lecture VII.)
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MARCH 12TH...Royal United Service Inst., Whitehall-yard, 3 p.m. Rear-Admiral C. Murray Aynesley, "The Preservation of Boilers."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Dr. C. W. Siemens, "The Dynamic Electric Current and Some of its Applications."
Astronomical, Burlington-house, W., 8 p.m.
Royal College of Physicians. (Lumleian Lectures.) Dr. W. Roberts, "Researches on the Digestive Ferments and the Preparation and Use of Artificially Digested Food." (Lecture I.)
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
New Shakespeare, University College, W.C., 8 p.m. Paper by Mr. T. Alfred Spalding.

SATURDAY, MARCH 13TH...Trades Guild of Learning (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Lecture by Prof. Hales.
Physical Science Schools, South Kensington, S.W., 3 p.m.
Royal Botanic, Inner-circle, Regent's-park, N.W., 3½ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. George Saintsbury, "Dryden and his Period." (Lecture III.)

ERRATA.—Page 280, line 33, *for* "boys should be trained," *read* "bogs should be drained." Line 46, *for* 20, *read* 200.

DORÉ GALLERY, 35, NEW BOND-STREET.

"Ecce Homo," "The Ascension," "Christ leaving the Prætorium," "Entry into Jerusalem," "Brazen Serpent," "Dream of Pilate's Wife," "House of Caiaphas," "Night of the Crucifixion," "Massacre of the Innocents," &c. 10 to 6. Admission 1s.

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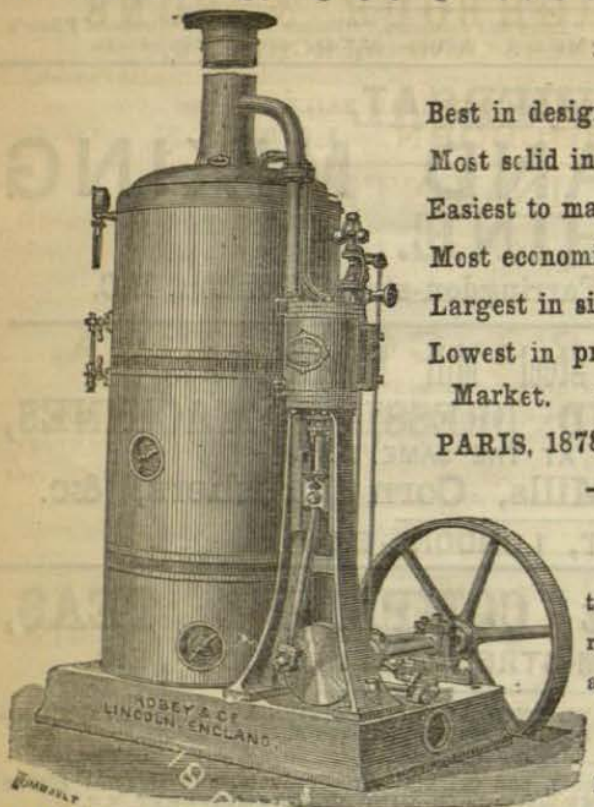

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Best in design,
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Easiest to manage,
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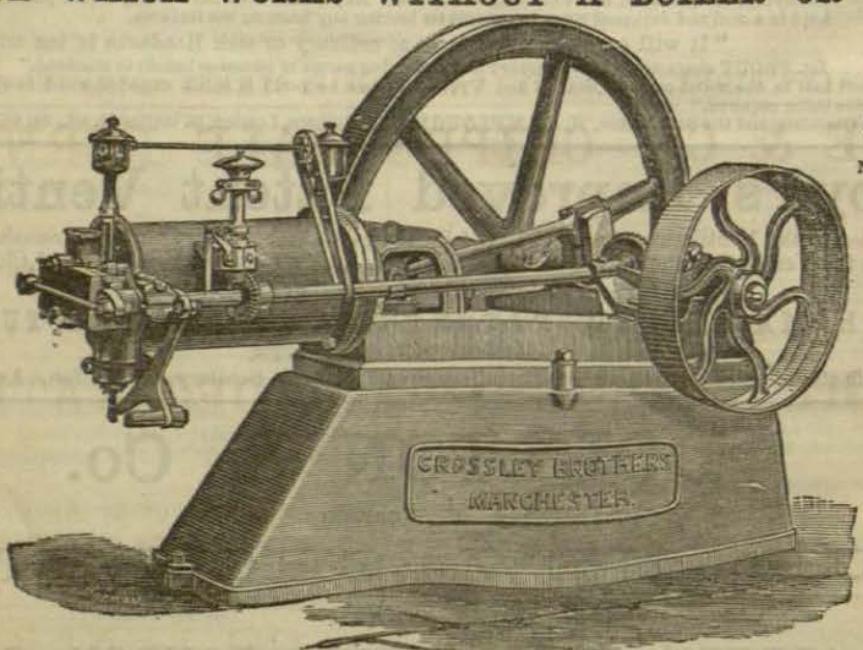
Cases not charged IF returned free.



Sizes offered.

Nominal Horse Power.		Maximum Horse Power.
½	=	¾
1	=	1½
2	=	2½
3½	=	4
6	=	9
8	=	12
12	=	18
16	=	24

The durability of these Engines is now established by experience, one of them having run night and day at the Hinckley Gas Works or over twelve months without any expenditure for repair; this being equal to about 2½ years average work. Over 1,600 already delivered. Very numerous Testimonials from Users, including Engineers, Men of Science, and others, on application to the Makers. No trouble with Coal, Ashes, Smoke, Insurance, Water, or constant attendance. No glands to pack, or Water Gauges and Steam Gauges to watch.

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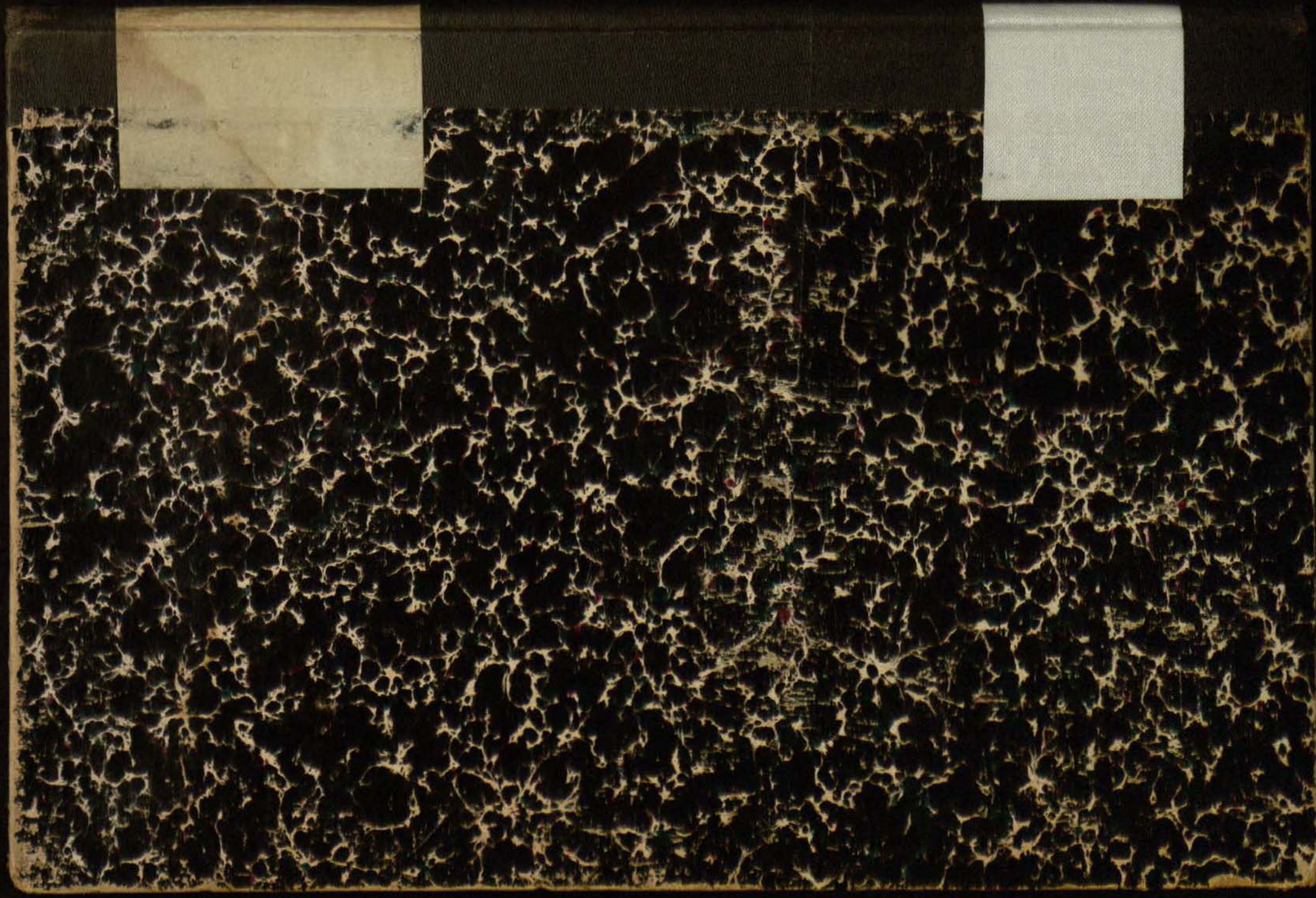

APRIL 21.—"The Present System of Obtaining Materials in use by Artist Painters, as compared with that of the Old Masters." By W. HOLMAN HUNT.

APRIL 28.—"Recent Improvements in Gas Furnaces for Domestic and Lavatory Purposes." By THOMAS FLETCHER.

MAY 5.—"On the last Forty Years of Agricultural Experience." By JOHN C. MORTON.

INDIAN SECTION.

Friday Evenings, at Eight o'clock:—

APRIL 2.—"The Best Route for a Line of Railway to India." By B. HAUGHTON, C.E.

APRIL 16.—"Russia's Influence over the Inhabitants of Central Asia during the last Ten Years." By Prof. VAMBÉRY.

MAY 7.—"The Present Condition and Prospects of Agriculture in South India." By W. ROBERTSON, M.R.C.A., Superintendent of the Government Farms in the Madras Presidency.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at eight o'clock:—

MARCH 16.—"Transport and Trading Centres for Eastern Equatorial Africa." By Captain C. E. FOOT, R.N.

APRIL 6.—"Art in Japan." By C. PFOUNDES.

APRIL 27.—"Iceland and its Resources." By C. G. W. LOCK.

MAY 18.—"The Arts, Manufactures, and Prospects of Madagascar." By the Rev. JAMES SIBREE, jun., F.R.G.S.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday Evenings, at eight o'clock:—

MARCH 11.—"Balmain's Luminous Paint." By C. W. HEATON, F.C S. Professor H. E. ROSCOE, F.R.S., will preside.

APRIL 8.—"On Recent Improvements in Benzine Colours." By F. J. FRISWELL, F.C.S.

APRIL 22.—"On Some Recent Advances in the Science of Photography." By Captain ABNEY, R.E., F.R.S.

MAY 13.—"On some Physical Applications of Light." By Prof. W. G. ADAMS, F.R.S.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

The Second Course, "On the Manufacture of India-rubber and Gutta-percha," by THOMAS BOLAS, F.C.S.

LECTURE VI.—MARCH 8.

Gutta-percha. Sources. Chemical nature and physical properties. Purification. Applications in connection with the industrial arts. Vulcanisation of gutta-percha.

The Third Course will be by Mr. R. W. EDIS, F.S.A., on "Art Decoration and Furniture." It will consist of six lectures, to be given on the following dates:—April 5, 12, 19, 26; May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 8TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "The Manufacture of India-Rubber and Gutta-Percha." (Lecture VI.)
London and Middlesex Archæological, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. F. J. Hilton Price, "Notes on Excavations at Temple-bar." 2. Rev. R. Hawley Cuttebuck, "A Londoner's Trip to a Country Cousin's in 1773."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Lieut. G. T. Temple, "An Autumn and Winter Yacht Voyage along the Coasts of Norway and Lapland."
British Architects, 9, Conduit-street, W., 8 p.m. Special General Meeting.
Medical, 11, Chandos-street, W., 8½ p.m. Annual Meeting.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. F. J. Palmer, "Life-saving Apparatus."
TUESDAY, MARCH 9TH...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Schäfer, "Physiology of Muscle." (Lecture IX.)
Metropolitan Scientific Association, 13, Blomfield-street, E.C., 7 p.m.
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. H. E. Jones, "The Purification of Gas."
Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. Francis Galton, "Visualised Numerals, and other Forms of Mental Imagery." 2. Mr. C. H. E. Carmichael, "Notes on Prehistoric Discoveries in Central Russia."
Royal Horticultural, South Kensington, S.W., 1 p.m.
Folk Lore, 22, Albemarle-street, 8 p.m. 1. Mr. J. S. Udal, "Dorsetshire Mummery Plays." 2. Mr. Alfred Nutt, "Critical Notes on Celtic Folk-tales and Heldensage."
WEDNESDAY, MARCH 10TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. John Sparkes, "Recent Advances in the Production of Lambeth Art Pottery."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) Dr. Cayley, "Some Points in the Pathology and Treatment of Typhoid Fever." (Lecture III.)
Geological, Burlington-house, W., 8 p.m. 1. Prof. E. Hull, "The Rocks of the South of Ireland and North Devon." 2. Mr. G. R. Vine, "A Review of the Family Diastoporidæ for the Purpose of Classification." 3. Mr. W. H. Twelvetrees, "A New Theriodont Reptile (*Cleiorhizodon orenburgensis*, Twelvetr.), from the Upper Permian Cupriferous Sandstones of Kargalinsk, near Orenburg, in South-Eastern Russia."
Graphic, University College, W.C., 8 p.m.
Microscopical, King's College, W.C., 8 p.m.
Royal Literary Fund, 10, John-st., Adelphi, W.C., 3 p.m. Annual Meeting.
Telegraph Engineers, 25, Great George-street, Westminster S.W., 8 p.m. Mr. Alexander Siemens, "Some Recent Improvements in Electric Light Apparatus."
THURSDAY, MARCH 11TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Prof. C. W. Heaton, "Balmain's Luminous Paint."
Royal, Burlington-house, W., 8½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. W. H. Monk, "Some Predecessors of Bach and

