100 ft., and that with a cloudy sky it is only half what it is with a clear sky. These results were from the mean of his observations; under exceptional circumstances the variations were both greater and less. It is hence shown that rays of sound otherwise horizontal would be bent upwards in the form of circles, the radii of which with a clear sky are 110,000 ft., and with a cloudy sky 220,000 ft., so that the refraction is double as great on bright hot days as it is when the sky is cloudy, and still more under exceptional circumstances, and comparing day with night.

It is then shown by calculation that the greatest refraction—110,000 ft. radius—is sufficient to render sound from a cliff 235 ft. high inaudible on a ship's deck 20 ft. high at 1¾ miles, except such sound as might reach the observer by divergence from the waves above, whereas when the refraction is least—220,000 ft. radius—or where the sky is cloudy, the range would be extended at 2½ miles with a similar extension for the diverging waves. It is hence inferred that the phenomenon which Prof. Tyndall observed on July 3, and other days—namely that when the air was still and the sun was hot he could not hear guns and sounds from the cliffs of South Foreland, 235 ft. high, for more than two miles, whereas when the sky clouded, the range immediately extended to three miles, and as evening approached much farther,—was due, not so much to stoppage or to reflection of the sound by invisible vapour as Prof. Tyndall has supposed, but to the sounds being lifted over his head in the manner described; and that had he been able to ascend 30 ft. up the mast, he might at any time have extended the range of the sound by a quarter of a mile at least. Or had the instruments on the top of the cliff been compared with similar instruments at the bottom, a very marked difference would have been found in the distances at which they could be heard.

It seems that there were instruments at the bottom, and it is singular that throughout his report Prof. Tyndall makes no comment on their performance, unless they were at once found to be so inferior to those at the top that no further notice was taken of them; this seems possible, since beyond mentioning that they were there, Prof. Tyndall throughout his report never refers to them.

It also seems that besides those results of Prof. Tyndall's experiments, there are many other phenomena connected with sound, of which this refraction affords an explanation, such as the very great distances to which the sound of meteors has been heard as well as the distinctness of distant thunder. When near, guns make a louder and more distinctive sound than thunder, although thunder is usually heard to much greater distances. In hilly countries, or under exceptional circumstances, sounds are sometimes heard at surprising distances. When the Naval Review was at Portsmouth, the volleys of artillery were very generally heard in Suffolk, a distance of 150 miles. The explanation being that owing to refraction (as well as to the other causes) it is only under exceptional circumstances that distant sounds originating low down are heard near the ground with anything like their full distinctness, and that any elevation either of the observer or of the source of sound above the intervening ground causes a corresponding increase in the distance at which the sound can be heard.

SCIENTIFIC SERIALS

Memorie della Societa degli Spectroscopisti Italiani, February.—Father Secchi contributes a paper On his Observations of Solar Prominences from April 23 to October 2, 1873. From his tables it appears that the sun was observed on 127 days, when 1,052 prominences were seen, being more than 8 a day, the maximum number visible on any one day was 13, and the minimum 2. The greatest number of prominences over 64″ high occurred in lat. 30° 40′ N. and 20° 30′ S. The greatest number of prominences of all kinds were in lat. 20° 30′ N. and 10° 20′ S. The same author also makes some remarks on the spectroscopic observations of the transit of Venus.

Astronomische Nachrichten, Nos. 1,980–1,981.—These numbers contain a large quantity of observations of positions of the minor planets and comets made in 1873 by Leopold Schulhof. He also gives the positions of more than 100 variable stars, with remarks on a new variable position for 1850, RA 23° 10′ 35″ Dec. − 19° 39′·7. Prof. Peters gives the position of Planet 135, Feb. 18, 1874, at 14h. 37m. 40s., Hamilton College, M.T., RA 11h. 19m. 42·7s. Dec. + 4° 25′ 5″·11 mag. G. Spoerer gives the positions of spots and prominences for February last. J. Palisa gives the position of the planet discovered by him on March 18, 4h. 46m. 39s. RA 12h. 22m. 2·12s. Dec. − 3° 19′ 33″·4.

No. 1,982 contains a long paper On a Method of Computing Absolute Perturbation, being in great measure similar to that of Laplace.

Journal of the Franklin Institute, March.—This number contains an account, by Mr. Crew, of the "prismoidal" one-rail railway (of his invention), of which he has made two years' trial in Alabama, with encouraging results. The cars are kept securely on the prismoidal track by a combination of wheels; a centre one, at either end, on the rail, kept on the track by revolving flanged wheels at either side; and wheels on the sides of the prismoid, with strong wrought-iron bars to the side of the car; these keep the car upright. One proposed application of the system is that of elevated rapid transit by steam through crowded streets in populous cities. As to speed, Mr. Crew thinks even 100 miles an hour would be possible; there is no oscillation through lateral motion.—Mr. Richards continues his Principles of Shop Manipulation for Engineering Apprentices; treating of belts, gearing, hydraulic and pneumatic apparatus as means of transmitting power, and of "machinery of application" of power.—Mr. Isherwood points out a method of ascertaining what portion of the feed-water admitted to a boiler is entrained in the form of spray by the escaping steam.—Details with reference to the Girard Avenue Bridge (which will form the chief entrance to the West Park, at Philadelphia), are furnished by Mr. Hering.—Prof. Thurston claims for Count Rumford a higher place in connection with thermo-dynamics than has hitherto been assigned to him; affirming that he first, and half a century before Joule, determined with almost perfect accuracy the mechanical equivalent of heat, while the sole credit of discovering the true nature of heat is due to him.—We may note, in addition, a paper On Railway Crossings and Turnouts, by Mr. Evans, and one On the Sanitary Care and Utilisation of Refuse in Cities, by Dr. Leas, who describes, more especially, the system followed in Baltimore.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 23.—On some points connected with the Circulation of the Blood, arrived at from a study of the Sphygmograph Trace, by A. H. Garrod, B.A., Fellow of St. John's College, Cambridge.

The author commences by giving a table containing a fresh series of measurements of the ratio borne by the cardiosystole * to its component beat in the cardiograph trace. These tend strongly to substantiate the law previously published by him, viz., that the length of the cardiosystole is constant for any given pulse-rate, and that varies as the square root of the length of the pulse-beat only, being found from the equation $xy = 20\sqrt{x}$ when x = the pulse-rate and y = the ratio borne by the cardiosystole to the whole beat.

A similar series of fresh measurements are given in proof of the law previously published by him, that in the sphygmograph trace from the radial artery at the wrist, the length of the sphygmosystole † is constant for any given pulse-rate, but varies as the cube-root of the length of the pulse-beat, it being found from the equation $xy' = 47\sqrt[3]{x}$, where x = the pulse-rate, and y' = the ratio borne by the sphygmosystole to the whole beat.

By measurement of sphygmograph tracings from the carotid in the neck and posterior tibial artery at the ankle, it is then shown that the length of the sphygmograph in those arteries is exactly *the same* as in the radial; so that the above-stated law as to the length of the sphygmosystole in the latter applies to them also, and must therefore equally apply to the pulse in the aorta.

Such being the case, by comparing the equations for finding the length of the cardiosystole with that for finding the aortic sphygmosystole, the relation between the whole cardiac systolic act and the time during which the aortic valve remains open can be estimated with facility; for by subtracting the shorter sphygmosystole from the longer cardiosystole a remainder is obtained which can be nothing else than the expression of the

* The *cardiosystole* is the interval between the commencement of the systole and the closure of the aortic valve in each revolution.

† The *sphygmosystole* is the interval between the opening and closure of the aortic valve in each cardiac revolution.

time occupied by the ventricle at the commencement of its systole in raising its internal pressure to that of the blood in the aorta, which must occur before the aortic valve can open up. This interval is named the *syspasis*. Its length is found to decrease very rapidly with increase in the pulse-rate, and to become *nil* at a pulse-rate of 170 a minute. An attempt is made to explain these phenomena.

If the above considerations are correct, certain independently obtained measurements ought on comparison to correspond; for by reference to one of the papers in the Society's Proceedings it is shown that the length of the there-termed second cardio-arterial interval (which may be called the second cardio-radial interval, as the artery under consideration was the radial), can only represent the time taken by the second or dicrotic wave of the pulse in travelling from the aortic valve to the wrist. This being so, there is every *à priori* reason in favour of the earlier primary wave taking the same time in going the same distance; which can be expressed in other terms by saying that the length of the first cardio-radial interval, from which that of the syspasis has been subtracted, ought to be exactly the same as that of the second cardio-radial interval. That such is the case is proved by the two measurements, which have been arrived at independently, agreeing in all cases *to three places of decimals*, which is great evidence in favour of the accuracy of the methods and arguments employed.

The latter part of the paper is occupied with the description of and the results obtained by the employment of a double-sphygmograph, by means of which simultaneous tracings are taken from two arteries at very different distances from the heart. The arteries experimented on are the radial at the wrist and the posterior tibial behind the ankle, 29 and 52½ inches respectively from the aortic valves. From the resulting traces the time occupied by the pulse-wave in travelling the difference of distance—(52·5 - 29) = 23·5 inches is given—is found to be 0·0012 of a minute in a pulse of 75 a minute, and it is shown that this varies very little with difference in pulse-rate, as other considerations would lead us to expect; it is also proved that *there is a marked acceleration of the pulse-wave as it gets further from the heart*.

By superposing the simultaneous trace from the wrist on that from the ankle, direct verification is obtained of the earlier proposition, that the sphygmosystole at the wrist and at the ankle are of exactly similar duration. The peculiarities of the ankle trace are also referred to.

Geological Society, April 15.—John Evans, F.R.S., president, in the chair.—The following communications were read: About Polar Glaciation, by J. F. Campbell. The author commenced by referring to a reported statement of Prof. Agassiz, to the effect that he supposed the northern hemisphere to have been covered in glacial times from the pole to the equator by a solid cap of ice. He described his observations made during thirty-three years, and especially those of last summer, when he travelled from England past the North Cape to Archangel, and thence by land to the Caucasus, Crimea, Greece, and the south of Europe. His principal results were as follows:—In advancing southwards through Russia a range of low drift hills occurs about 60° N. lat., which may perhaps form part of a circular terminal moraine left by a retreating polar ice-cap; large grooved and polished stones of northern origin reach 55° N. lat. at Nijni Novgorod, but further east and south no such stones could be seen. The highest drift beds along the whole course of the Volga seem to have been arranged by water moving southwards. In America northern boulders are lost about 39°, in Germany about 55°, and in Eastern Russia about 56° N. lat., where the trains end and fine gravel and sand cover the solid rocks. Ice-action, in the form either of glaciers or of icebergs, is necessary to account for the transport of large stones over the plains, and the action of moving water to account for drift carried farther south. There are no indications of a continuous solid ice-cap flowing southward over plains in Europe and America to, or nearly to, the equator; but a great deal was to be found on shore to prove ancient ocean circulation of equatorial and polar currents, like those which now move in the Atlantic, and much to prove the former existence of very large local ice-systems in places where no glaciers now exist.—Note regarding the Occurrence of Jade in the Karakash Valley, on the southern borders of Turkestan, by Dr. Ferdinand Stoliczka, Naturalist attached to the Yarkund Mission. In this paper the author described the jade-mines on the right bank of the Karakash river formerly worked by the Chinese. There are about 120 holes in the side of the hill, and these at a little distance look like pigeon-holes. The rocks are a thin-bedded, rather sandy syenitic gneiss, mica- and hornblende-schists, traversed by veins of a white mineral, apparently zeolitic, which in turn are traversed by veins of jade.

Zoological Society, April 21.—Viscount Walden, F.R.S., president, in the chair.—The secretary read a report on the additions that had been made to the Society's Menagerie during the month of March 1874. Amongst these particular attention was called to a scarce Parrot (*Chrysotis finschi*), of which a specimen had been presented by Mrs. Chivers.—A communication was read from Mr. Morton Allport On the capture of a Grilse in the River Derwent, in Tasmania, showing that the salmon had really been successfully introduced into the colony.—Communications were read from Dr. J. E. Gray, F.R.S., On the very young of the Jaguar, *Felis* (*Leopardus*) *onca*; On the short-tailed Armadillo, *Mulelia septemcincta*; On the young of the Bosch Vark, *Patomochærus africanus*, from Madagascar; and On the Skulls of the Leopard in the British Museum.—A communication was read from Dr. O. Finsch, containing the description of a new species of Penguin, from New Zealand, which he proposed to call *Eudyptula albosignata*.—Mr. Edwin Ward exhibited the skull and horns of a fine specimen of the Persian Stag (*Cervus maral*) from the Crimea.—A communication was read from Capt. W. H. Unwin, containing an account of the breeding of the Golden Eagle (*Aquila chrysaetos*) in North-Western India.—Mr. J. E. Harting read a paper On a new species of *Tringa*, from St. Paul's Island, Alaska, which he proposed to name *Tringa gracilis*.—A communication was read from Lieut. R. Wardlaw Ramsay, giving the description of an apparently new species of Woodpecker, which he had obtained in a teak-forest, about six miles to the north of Tanghoo in British Burmah. Mr. Ramsay proposed to name it *Gecinus erythropygius*.—Messrs. W. T. Blanford and H. E. Dresser read a monograph of the genus *Saxicola*, Beechstein, being an attempt to reduce into some order the excessively confused nomenclature of the species composing this genus.

Royal Horticultural Society, April 15.—Scientific Committee.—M. T. Masters, M.D., F.R.S., in the chair.—Mr. Worthington Smith exhibited a drawing of a very curious fasciation in the aërial roots of *Aerides crispum*, in which the roots presented the curious flattened appearance so often met with in the branches of the ash, the shoots of asparagus, &c.—Mr. W. G. Smith also showed a drawing of the very rare *Angræcum ellisii*, from the collection of Mr. Day, of Tottenham. Mr. Smith remarked that the flowers turn brown when bruised.—Mr. Smith also showed a wood-engraving made on the wood of green ebony, *Brya ebenus*. Mr. Smith reported that for engraving purposes this was as good as bad box.—Prof. Thiselton Dyer showed dried specimens of a variety of *Hibiscus rosa-sinensis* from Zanzibar, where it was found wild by Dr. Kirk. The petals are palmately cut, as in *Clarkia*, *Schizopetalum*, &c. Dr. Masters made some remarks on the analogy the divided petals of this plant presented with the stamens of mallows, which it is now supposed consist of five primary organs, subsequently dividing into numerous anther-bearing filaments. It is doubtful whether *Hibiscus rosa-sinensis* has been heretofore observed in a truly wild condition. The discovery of the plant in east tropical Africa is therefore particularly interesting. It is possible, however, that it may prove a distinct species.—Prof. Thiselton Dyer also showed an elegant white fungus, having the appearance of lace, from Santarem. The Rev. M. J. Berkeley considered it probable that it was the fungus published by Kunze as *Rhizomorpha corynephora*.—Mr. Andrew Murray exhibited a fungoid production existing on trees over a considerable space in the Yosemite Valley, in California. Mr. Berkeley considered it near to the fungus called *Dothidea morbosa*, but there was also a gall on the same shoot.—Mr. Murray exhibited larvæ of a beetle closely allied to *Hammaticherus heros*, a beetle very destructive to timber in Germany, found feeding on the roots of fir near Enfield. Specimens of the perfect living insect have from time to time been found in the gun-stocks of walnut wood in the small-arms factory. It seems, therefore, a fair inference that the insects had escaped thence, and may perhaps have become naturalised—a most undesirable thing, for the larva is very destructive to timber. Mr. Blenkins remarked that he was familiar with the insect in the Crimea.

General Meeting.—H. Little in the chair.—The Rev. M. J. Berkeley commented on the plants exhibited. *Arthropodium cirrhatum* was an interesting plant of striking habit from New Zealand. When first introduced into this country, some years ago, it was supposed to have come from New Holland.

Physical Society, April 18.—Dr. Gladstone, F.R.S., in the chair.—Dr. W. H. Stone read a paper On Wind Pressures in the human chest during performance on wind instruments. The author's object was to ascertain (1) what was the extreme height of a column of water which could be supported by the muscular act of expiration transmitted by the lips: this was found to be about 6 ft.; and (2) what was the actual pressure corresponding to the full production of a note on each of the principal wind instruments. It was found that with the majority of wind instruments the pressure required for the high notes is considerably greater than that required for the low notes, each instrument having a pressure-ratio of its own. The clarinet is an exception to the rule.—Mr. Tribe illustrated by experiments the action of hydrogen upon finely divided metals, such as are produced by precipitation.

EDINBURGH

Royal Physical Society, April 22.—R. Scot Skirving, president, in the chair.—Recent Modes of determining the Impurity of Milk, by J. Falconer King, City Analyst. The only sure way to determine the quality of milk is to make a proper and careful chemical analysis of it.—Additional Note on the Suspension of Clay in Water, by Wm. Durham. Finely-powdered silica was found to behave in a manner generally similar to clay. Experiments seem to show that each solution has a specific capacity of sustaining clay, and also that this capacity varies in a specific manner according to the strength of the solution.—Note on the Formation of Boulder Clay, by D. J. Brown. Mr. Brown advocated that the usually accepted theory of the land origin of boulder clay would not explain the nature of this remarkable deposit, and considered that it was formed at the line of junction of the Arctic glacier with the sea.—On Fused Stones, showing Columnar Structure from a Pictish Tower, by the Rev. Jas. M. Joass, Golspie. These stones, in their columnar structure, illustrate, though on a small scale, an important geological phenomenon. The instance usually cited in illustration of the development of columnar structure in a melted mass is that of grain-tin, which forms rude columns on cooling. The author ventures to think that these fused stones afford a new and rather better illustration of the geological phenomenon, more closely analogous to the case of lavas, inasmuch as we have, in fact, a fused silicate, an artificial lava, forming columns the same in character as those of the Giant's Causeway, Samson's Ribs, or the pillars of Fingal's far-famed cave.

PARIS

Academy of Sciences, April 20.—M. Bertrand in the chair.—The following communications were read:—Letter relating to a calculation, by Pouillet, on the cooling of the sun's mass, by M. Faye. The author showed that Pouillet's calculation tacitly implied that the sun's mass was not susceptible of contraction, and again restated his belief that solar radiation is not maintained by external causes, but is to be looked for in the formation of the sun itself, and in the enormity of its mass.—Observations concerning a communication, by M. Crocé Spinelli, on the lines of aqueous vapour in the solar spectrum, a letter from P. Secchi to the perpetual secretary. The author stated, that although the elements of water would be dissociated at the high temperature of the sun, their combination might take place in the ascending currents accompanying spots and eruptions owing to the lowering of temperature in these currents produced by expansion.—Tenth memoir on the formation of various crystalline substances in capillary spaces, by M. Becquerel.—New researches on the cyanogen series, by M. Berthelot. A continuation of this author's valuable researches in thermo-chemistry.—Heat of formation of the Cyanogen compounds, by M. Berthelot.—On Phylloxera and the American vines at Roquemaure (Gard), a note by M. J. E. Planchon.—Collimating level and its employment for foggy horizons, by M. G. M. Goulier.—On Orometric dials, specially applicable to pocket barometers, by the same author.—On partial differential equations which can be integrated without arbitrary functions, by M. de Pistoye.—On the "singular points" of algebraical plane curves, by Mr. Halphen.—On the rôle of salts in the action of potable waters on lead, by M. Fordos. The author recommended, as the results of his experiments, the filtration of all water issuing from leaden conduits.—Mode of preservation of the wood employed in large manufactures and in railways, by M. Hubert. The preservative is hydrated ferric oxide.—On the absorption of oxygen and the emission of carbonic acid by leaves kept in darkness, by MM. P. P. Dehérain and H. Moissan. The authors have proved that leaves kept in the dark give off a quantity of CO_2 increasing with the temperature, that the quantity of CO_2 given off is comparable to that given off by cold-blooded animals, that the leaves absorb more oxygen than they give off CO_2, and that they continue to evolve CO_2 in an atmosphere deprived of oxygen.—Facts concerning the vibration of the air in sonorous pipes, by M. E. Gripon.—On a new thermo-electric pile, by M. C. C. Clamond.—On a volume regulator for gas currents, by M. H. Giroud.—On tetra-iodide of carbon, by M. G. Gustavson. This substance has been obtained by the action of tetrachloride of carbon upon di-aluminic hexiodide, according to the equation $3Cl_4 + 2Al_2I_6 = 3CI_4 + 2Al_2Cl_6$; the two substances being dissolved in carbon disulphide. It was described as a red crystalline substance decomposed by heating in the air into CO_2 and free iodine.—New researches on black phosphorus, by M. Blondlot.—Action of pure hydrogen on silver nitrate, by M. H. Pellet. The author stated that a neutral or slightly acid solution of the salt is not reduced in the cold by pure hydrogen, and that an alkaline solution is reduced in the cold to an extent proportional to its alkalinity, elevation of temperature increasing the reducing action.—Researches on soluble phosphates used in agriculture, by M. A. Millot.—On the direct determination of the degree of intensity of explosive mixtures: application of the method to gunpowders, by M. Chabrier.—Action of bromine on dibromsuccinic acid; tribromsuccinic acid, by M. E. Jungfleisch. The following substances are obtained by the action of bromine and water on the acid: tribromsuccinic and dibrom-maleic acids and dibrominated ethylene dibromide.—On the alcohols contained in the acid liquors of starch manufactories and in the products of the butyric fermentation of glucose, by M. G. Bouchardat. These are ethylic, normal propylic, and butylic alcohols.—On the determination of alcohol in water, wines and saccharine liquors, by M. Salleron.—General method for the transformation of alcohols into nitric ethers, by M. P. Champion. The reagent employed is nitro-sulphuric acid.—On phenyl-allyl, by M. B. Radziszewski.—On pyrogallol in presence of iron salts, by M. E. Jacquemin.—On the colouring matter of wine, by M. E. Duclaux.—On the volatile acids of wine, by the same author.—Movements excited in the stamens of *Mahonia* and *Berberis*; anatomical conditions of this movement, by M. E. Heckel.—On the direction of the wind in the high and low (atmospheric) regions during the storm of April 13, 1874, by M. Chapelas.—During the meeting a commission was appointed to prepare a list of candidates for the vacancy of foreign associate caused by the death of M. De la Rive.

BOOKS RECEIVED

ENGLISH.—Handbook of Practical Telegraphy. 6th edit.: R. S. Culley (Longmans).—Mental Physiology: W. B. Carpenter (H. S. King & Co.).—The Design and Construction of Harbours: Thos. Stevenson (A. & C. Black).—Our Inheritance in the Great Pyramid: C. Piazzi Smyth (Isbister & Co.).—Longevity: John Gardner (H. S. King & Co.).—The New Chemistry: Josiah P. Cooke (H. S. King & Co.).—Hydrostatics and Pneumatics: Lardner and Loewy (Lockwood).—Geology of Suffolk: J. R. Taylor (White).—The Universe and the Coming Transits: R. A. Proctor (Longmans).—Haydn's Dictionary of Dates. 14th edit.: B. Vincent (Moxon).

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