and from these springs is derived from atmospheric air, held in solution by the water, and deprived of the greater part of its oxygen by animal and vegetable putrefaction. He is disposed to ascribe the deficiency of oxygen to some process of combustion, during which it unites with some base, forming a compound not easily volatilized by heat; and to account for the presence of carbonic acid, by the calcination of earthy carbonates, rather than by the combustion of coal or bitumen.

The Society then adjourned over the Christmas Vacation, to meet again on the 9th of January.

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January 9, 1834.

BENJAMIN COLLINS BRODIE, Esq., Vice-President, in the Chair.

The Earl of Tyrconnel was elected a Fellow of the Society.

A paper was read, entitled, "On the empirical Laws of the Tides in the Port of London, with some Reflections on the Theory." By the Rev. William Whewell, M.A., F.R.S., Fellow and Tutor of Trinity College, Cambridge.

The present state of our knowledge of the tides is represented by the author as extremely imperfect, and at variance with the scientific character which Physical Astronomy is supposed to have attained ; for although it be the universally received opinion that they are the direct results of the law of gravitation, the exact laws by which the phenomena are actually regulated with regard to time and place have never been strictly deduced from this general principle. The tide tables that have been given to the world are calculated by empirical methods, which are frequently kept secret by those who employ them ; and the mathematical solutions of the problem hitherto attempted have been confessedly founded on hypotheses which are in reality very remote from the real facts; and accordingly it is doubtful whether they give even an approximation to the true result. The comparison of the results of theory with extensive series of observations had not been attempted previously to Mr. Lubbock's discussion of the tides of the port of London, recorded in the Philosophical Transactions for 1831. The establishment, on theoretical grounds, of rules for the calculation of tide tables, has been attempted by Bernoulli and by Laplace : the methods recommended by the former are probably the foundation of those at present used by the calculators of such tables, that of Laplace being complicated, and too laborious for practice. Original tide tables are very few ; none, with which the author is acquainted, deserving that title, except those which are published for Liverpool, and those for London. The former, which are calculated according to rules obtained from Mr. Holden, from the examination of five years of observations, made at the Liverpool docks by Mr. Hutchinson, at that time harbour-master, are remarkably

correct. Several tide tables for London are annually published; but they vary considerably from one another. The method generally practised in England for the construction of tide tables for other places, has been to add or subtract some constant quantity, according to the place, assuming as a basis the tide tables either of London or of Liverpool ; but this assumption of a constant difference is shown by the author to be, in various instances, incorrect. Much, therefore, remains to be done, before we can hope to arrive at a scientific solution of this problem.

The author then proceeds to examine the empirical laws of the tides of the port of London, deducible from the records of the nineteen years of observations which have been discussed by Mr. Dessiou, under the direction of Mr. Lubbock, and which include 13,073 observations. His first object is to determine the manner in which the time of high-water is affected by the following conditions, namely, the right ascensions, declinations and parallaxes of the sun and moon ; for which purpose he considers at some length, first, the establishment ; secondly, the semimenstrual inequality ; thirdly, the corrections for lunar parallax ; fourthly, the lunar declination ; and lastly, the solar parallax and declination. He next discusses the empirical laws of the height of high-water ; which he observes will be affected in the same manner as the periods of the tides, by a semimenstrual inequality, by corrections for lunar parallax and declination, and by a solar correction ; and concludes by giving a formula for computation which comprehends all these elements. He then enters into a comparison of the results thus obtained with the theory of Daniel Bernoulli, according to which the waters of the ocean assume nearly the form in which they would be in equilibrium under the actions of the sun and moon, on the supposition that the pole of the fluid spheroid follows the pole of the spheroid of equilibrium at a certain angular distance ; and that the equilibrium corresponds to the configuration of the sun and moon, not at the moment of the tide, but at a previous moment, at which the right ascension of the moon was less by a constant quantity. The author thinks, however, that it would not be safe to attempt to deduce from the preceding investigations any general views concerning the laws of the tides, for it is not likely that the discussion of observations at any one place should exhibit clearly the true principles of the theory, especially as, in the present case, it so happens that the phenomena of the tides at London are in some measure masked by a curious combination of circumstances, namely, by the mouth of its river being on the side of an island, turned away from that on which the tide comes, and so situated that the path of the tide round one end of the island is just twelve hours longer than round the other.

In consequence of the time required to transmit to any port the general effect of the tide-producing forces being different from the time required to transmit to the same port the effects of particular changes in these forces ; or, in other words, from the epochs of the changes due to parallax and declination being different from the epoch of the semimenstrual inequality, it follows that although the general

form of the terms, and the variable part of the arcs on which they depend, may be deduced from the theory of equilibrium, yet the constant epoch which occurs in each of these arcs, and which determines when the inequality vanishes, and reaches its maximum, will probably have to be determined, in all cases, by observation.

In conclusion, the author gives a statement of what appears to him to be the most important steps from which any great improvement to our knowledge on the subject of the tides may be hoped ; and recommends the discussion of extensive collections of observations made at a variety of places, in a manner similar to what has been done by Mr. Dessiou with regard to those at London ; and the comparison with one another of the empirical laws resulting from their separate investigation. Very valuable materials for this purpose, he expects, will hereafter be furnished by the observations now making, on a judicious system, at the St. Katharine's docks.

### January 16, 1834.

JOHN WILLIAM LUBBOCK, Esq., M.A., V.P. and Treasurer, in the Chair.

A paper was read, entitled, " On a new property of the Arcs of the Equilateral Hyperbola." By Henry Fox Talbot, Esq., M.P., F.R.S.

By an analytical process, the author arrives at the following theorem, namely, if three abscissæ of an equilateral hyperbola be materially dependent by reason of two assumed equations, which are symmetrical with respect to these three abscissæ, the sum of the arcs subtended by them is equal to three quarters of the product of the same abscissæ, or only differs therefrom by a constant quantity. In order to satisfy himself of the correctness of this theorem, the author calculated various numerical examples, which entirely confirmed it. This simple result is essentially a relation between three arcs of the equilateral hyperbola, and is by no means reducible to a relation between two ; and therefore is not reducible to the celebrated theorem of Fagnani, concerning the difference of two arcs of an ellipse or hyperbola, nor to any other known property of the curve.

The reading of Mr. Faraday's Sixth Series of Experimental Researches in Electricity was commenced.

### January 23, 1834.

FRANCIS BAILY, Esq., Vice-President, in the Chair.

A paper was read, entitled, " Appendix to a Memoir, lately read to the Society, on the Quality and Quantity of the Gases disengaged from the Hot Spring of the King's Bath, in the City of Bath." By Charles G. B. Daubeny, M.D., F.R.S.

The author has lately examined two tepid springs, which, since the setting in of the wet weather, have broken out at the foot of St.