

PROCEEDINGS
OF
THE ROYAL SOCIETY.

November 30, 1860.

ANNIVERSARY MEETING.

Major-General SABINE, R.A., Treasurer and Vice-President,
in the Chair.

Dr. Tyndall reported, on the part of the Auditors of the Treasurer's Accounts, that the total receipts during the past year, including a balance of £420 carried from the preceding year, amounted to £4745 7s. 8d.; and the total expenditure during the same period amounted to £4247 15s. 8d., leaving a balance in the hands of the Treasurer of £497 12s.

The thanks of the Society were voted to the Treasurer and Auditors.

The Secretary read the following lists:—

Fellows deceased.

Sir Charles Barry, R.A.
General Sir Thomas Brisbane.
Robert Edward Broughton, Esq.
George Buist, Esq., D.C.L.
John Frederick, Earl Cawdor.
Henry Drummond, Esq.
Sir Fortunatus Dwaris.
Sir William Browne Ffolkes, Bt.
Lieut.-Gen. Sir Robert Harvey.
Thomas Hoblyn, Esq.
Rev. David Laing.

Lieut.-Colonel Leake.
Joseph Locke, Esq.
The Right Hon. Lord Londesborough.
The Right Hon. Lord Macaulay.
Charles May, Esq.
Joseph Miller, Esq.
Major Moore.
M. César Moreau.
John Narrien, Esq.
Charles H. Parry, M.D.

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Rev. Baden Powell.
 Charles Gordon, Duke of Richmond.
 William Simms, Esq.
 Lieut.-Colonel Charles Smith.
 William Somerville, M.D.
 William Spence, Esq.

Sir John Edward Swinburne, Bart.
 Theophilus Thomson, M.D.
 Robert Bentley Todd, M.D.
 Rev. John Traherne.
 John Ashley Warre, Esq.
 Major-General Wavell.
 Horace Hayman Wilson, Esq.

On the Foreign List.

Louis Poinso.
 Heinrich Rathke.

Withdrawn.

George T. Doo, Esq.
 Samuel Peace Pratt, Esq.

Defaulter.

Robert William Sievier, Esq.

List of Fellows elected since the last Anniversary.

Frederick Augustus Abel, Esq.
 Thomas Baring, Esq., M.P.
 John Frederick Bateman, Esq.
 Right Hon. Edward, Lord Belper.
 Edward Brown-Séquard, M.D.
 Richard Christopher Carrington, Esq.
 Right Hon. Frederick, Earl De Grey and Ripon.
 Right Hon. Sir William Erle.
 Francis Galton, Esq.
 Joseph Henry Gilbert, Esq.
 Sir William Jardine, Bart.

Thomas Hewitt Key, Esq., M.A.
 Joseph Lister, Esq.
 Rev. Robert Main, M.A.
 Robert William Mylne, Esq.
 Roundell Palmer, Esq., Q.C.
 Right Hon. Sir Edward Ryan.
 John Thomas Quekett, Esq.
 Right Hon. George, Earl of Sheffield.
 Edward Smith, M.D.
 Rt. Hon. Edward, Lord Stanley.
 Right Hon. Spencer Horatio Walpole.

On the Foreign List.

Alexander Dallas Bache.
 Hermann Helmholtz.
 Albert Kölliker.
 Philippe Edouard Poullétier de Verneuil.

The Chairman then addressed the Society as follows :—

GENTLEMEN,

IT is known to you all that early in the summer our excellent President suffered from an affection of the eyes, which was partially relieved by an operation, and that he is now about to undergo a second operation for the removal of a cataract. Under these circumstances, Sir Benjamin Brodie, prompted by his well-known unwillingness to hold an office when temporarily disqualified for the fullest performance of its duties, signified, by letter to the Council towards the end of September, his desire to decline to be put in nomination for the Presidency at the ensuing (that is the present) election. The Council having duly considered Sir B. Brodie's letter, and looking forward with confident hope and expectation to the recovery of his sight by the impending operation, were unanimously of opinion that the interests of the Royal Society would be most effectually promoted by his allowing himself to be again put in nomination for the Presidency ; feeling assured also that his consenting to do so would be in accordance with the general wish of the Society. The Council further requested me, as the Treasurer of the Society, and in the absence of the President officiating as Chairman of the Council, to communicate personally with Sir Benjamin Brodie (then at Tunbridge Wells), and to convey the earnest hope of the Council that he would comply with their wishes. Thus solicited, Sir B. Brodie has consented to be again placed in nomination for the office of your President. In making this communication, it is fitting that I should add that, in the opinion of his medical advisers, the probability of the operation which he is about to undergo being successful in its issue is very strong, and that they have a confident hope that his sight will be sufficiently restored to enable him to reassume the duties in the spring, if it should now be your pleasure to re-elect him.

Sir B. Brodie has placed in my hands an Address, which, had he been able to have taken the Chair at this Anniversary Meeting, it was his intention to have delivered himself. This address he has requested me to read to you, which I shall proceed to do after I shall have briefly noticed some subjects which have occupied the attention of your Council in the past year, and on which it is desirable that the Society should be informed.

1. *Scientific Relief Fund.*—The intention of several Fellows of the Society to promote the establishment of a Permanent Fund, to be invested in the name of the Royal Society, the interest of which Fund should be applied (under the control of the Council) to the aid of such scientific men and their families as may from time to time require and deserve assistance, having been notified to the Council, accompanied by a list of several intended donations, the Council passed a resolution accepting the proposed Trust, and directing that all Donations on account thereof, paid to the Bankers of the Society, should be invested in Government Securities, and constitute a Fund to be named the “Scientific Relief Fund,” the interest of which should be at the disposal of the President and Council under the following conditions, viz. :—

“That the President and Council of the Royal Society have full power to appoint Committees, or to make such arrangements as they may, from time to time, consider most advantageous for the carrying out the objects of the Trust in the most liberal sense.

“That no application for relief be entertained except on the recommendation of the President of one of the following Chartered Societies :—The Astronomical, Chemical, Geographical, Geological, Linnean, or Royal Society ; it being understood that the several Presidents will consult their respective Councils as to the persons whom they intend to recommend for relief.

“That in each case in which assistance is granted, a record of the recommendation be entered on the Minutes of the Council of the Royal Society.

“That the amounts and particulars of the Fund, as invested, with the account of the receipts during the preceding year, the gross expenditure and disposable balance in hand, appear in the annual published Financial Statement of the Royal Society.”

The Council have made arrangements for the administration of the proceeds of this Trust-Fund in conformity with the above conditions. The sum invested in the New 3 per Cent. Annuities amounts at present to £4824 9s. 9d.

2. *Increased Gratuities to the Secretaries.*—The duties of the Secretaries having augmented greatly of late years, in consequence partly of the increased activity with which various branches of science are cultivated in this country and the greater number of papers

annually presented to the Society, and partly from new duties devolving on them, it appeared to the Council desirable to reconsider the amounts of the "honoraria" presented annually to those gentlemen as an acknowledgement, but by no means as a remuneration, of their services. As a preliminary step, a Committee* was appointed to inquire into and to report on the duties of the Secretaries at various times, and on the gratuities which have been awarded them, as well as on the present financial condition of the Society. With your permission I will read the Report of this Committee.

"Your Committee beg to report to the Council, that, in performing the task which was imposed upon them, they have inquired into the duties of the Secretaries at various times, the gratuities which have been awarded to them, and the financial condition of the Society.

"They have been favoured with valuable information and opinions by former Officers of the Royal Society,—Sir John Herschel, Mr. Brande, Dr. Roget, and Sir John Lubbock.

"Previous to the year 1720 no regular Salaries were assigned to the Secretaries, but it was customary to present them from time to time with sums varying from £10 to £20 under the name of 'Gratuities.'

"In 1720, on the motion of the President, Sir Isaac Newton, the Council directed that £50 should be paid to each of the two Secretaries annually. In 1732 this amount was increased to £60, and in 1760 to £70 10s. In November 1799, on the motion of the President, Sir Joseph Banks, the amount of the Salaries was reconsidered by the Council, and raised to *One Hundred Guineas* to each Secretary, at which amount they have remained from that time to the present.

"The office of 'Foreign Secretary' originated in a legacy of £500 bequeathed to the Society in 1719 by Mr. Robert Keck, for the express purpose of remunerating a person for carrying on foreign correspondence. In 1720 the first Foreign Secretary was appointed, with a Salary of £20 a year, which sum has been paid, without increase, from that time to the present.

"It is the concurrent opinion of all who have the best means of knowing, that since the gratuities were last fixed in 1799 the busi-

* Consisting of the President, the Treasurer, the Rev. J. Barlow, Mr. Bell, and Dr. W. Farr.

ness of the Society and the duties of the Secretaries have largely increased. The increase of Fellows and the larger income of the Society have enabled it to extend its operations. In the ten years 1790 to 1799, 319 papers were communicated to the Society; and in the ten years 1850 to 1859, the number of such papers was 672. Some of the communications are short notices for publication in the 'Proceedings,' and it is impossible to determine precisely in what ratio the work has increased; but your Committee are disposed to believe that it is represented approximately by the above figures. The Secretaries now edit the 'Transactions' and the 'Proceedings,' which are found so useful by the Fellows, and this latter duty has added considerably to their labour.

"The current revenue of the Society may be set down at about £3514, of which £1150 are derived from rents and dividends, and £517 from the Stevenson bequest. The latter sum, it is known, will increase as lives fall in. The annual subscriptions amount to £1126; the entry fees, estimated on an average of eleven years, will be about £170; the compositions £360; the 'Transactions' will yield £276; making the aggregate revenue under these heads £1932. Your Committee see no reason to believe that these sources of income are likely to fail.

"The current annual expenditure may be stated at about £2839; namely, £1177 on printing; £764 on gratuities, salaries and wages; £187 on books and binding; £511 on house expenses; £200 on Catalogue of Periodicals. These items necessarily fluctuate, and the printing bill last year exceeded considerably the above amount; but the amount just stated for printing is estimated from an average of the last eleven years. The income of the Society has thus for some years exceeded the expenditure by about £675.

"Looking at the duties which now devolve upon the Secretaries, of regularly attending Meetings, reading papers, editing the 'Transactions,' preparing the 'Proceedings' for publication, and other work,—looking also at the remuneration which it is found desirable to give gentlemen who discharge less onerous duties merely as editors of literary works in the present day,—your Committee are of opinion that the Council will be acting quite in conformity with the sound principles which were laid down in Sir Isaac Newton's presidency, and have been acted on since, by increasing the gratuity to each of

the two Secretaries. As the result of the inquiries made by your Committee, they would suggest that the addition should be £95, raising each gratuity from £105 to £200. This would involve an increase of £190 in the expenditure.

“The relations of the Society with foreign countries may be largely extended, and your Committee are of opinion that to accomplish this object £80 may be advantageously added to the £20 now voted, making the annual gratuity of the Foreign Secretary £100.

“The total augmentation of the expenditure under this arrangement would be £270, leaving a probable annual surplus of £400 to be devoted to the numerous purposes which fall naturally within the scope of the Society’s inquiries.

“Your Committee are of opinion that the offices efficiently discharged will still be to a great extent honorary ; and that so long as the Society is so fortunate as to have able, industrious, and eminent men as its Secretaries it will be still largely in their debt.

“Should the finances of the Society, through any unforeseen circumstance, require it, there would not, your Committee apprehend, be any difficulty in again revising the scale of gratuities which may be awarded.”

The recommendations of the Committee regarding the augmentation of the gratuities have been adopted by the Council ; and the view taken by the Committee of the financial condition of the Society has been thus far confirmed by an excess in the present year of income over expenditure (the increased gratuities being included in the latter) of £742 2s.

3. *Duties of the Foreign Secretary.*—The Council having thus augmented the honorarium of the Foreign Secretary, have had under their consideration the advantage which the Society might derive from an extension of the duties of the Foreign Secretary as hitherto defined by the Statutes, and have made additions to those duties under the three following heads, viz. :—

- “1. To prepare the Biographical Notices of deceased Foreign Members for publication in the ‘Proceedings.’
- “2. To collect such information respecting the labours and discoveries of Foreign Men of Science as may serve to aid the Council in the nomination of persons for election by the Society as Foreign Members, and in the award of the Copley and Rumford Medals.

“ 3. To furnish the Society, from time to time, with early notice of researches of special importance carried on abroad ; such notice to be drawn up in the form of a short communication, to be read as early as practicable at an evening Meeting of the Society, and published in the ‘ Proceedings.’ ”

These additions are to be regarded for the present simply in the light of *Regulations made under the authority of the Council*. They may hereafter be embodied in the Statutes, if after trial it shall appear desirable to do so, with any further additions or modifications which experience may point out.

I shall now proceed, with your permission, to read Sir Benjamin Brodie’s Address.

“ Since our last Anniversary, the Royal Society has continued to pursue its mission, and I hope that I may add, with no unsuccessful result. Papers of great importance have been given to the world in the last volume of the ‘Philosophical Transactions;’ and many others which are of much interest may be found in the lately published Numbers of our ‘Proceedings.’ This last publication has become a valuable addition to scientific literature, and, as such, has risen in estimation both in this and in foreign countries, beyond the expectation of those by whom it was originally suggested. The meetings of the Society have been fully attended ; and the occasional dryness of scientific details has been not unfrequently relieved by the display of new experiments, and by discussions in which many of our Fellows have taken part, uninfluenced by any other desire than that of mutually giving and receiving information. The increasing number of candidates for admission into the Royal Society sufficiently shows how highly that honour is appreciated by the public ; and I may take this opportunity of repeating an observation which I made formerly, namely, that this distinction, like those afforded by the Universities, is all the more valuable to those on whom it is conferred, inasmuch as it is one of the very few which cannot be obtained either by the favour of the great or through the partiality of friends. As the election of the Fellows is now conducted, it is barely possible that that honour should be on any occasion improperly bestowed. There can indeed be no doubt that the present mode of election has been a great improvement on that which had been adopted previously, and

that it has very much contributed to maintain the honour and dignity of our Institution. I make this acknowledgement the more readily, because I must own that I was not a convert to the new system in the first instance. It was perhaps because I had been intimate with the Royal Society from a very early period of my life, that, when the change was first suggested, I was led to believe, in common with my friend Robert Brown and some other of the older Fellows, that it would have been better for us *stare super antiquas vias*. Experience has altered my opinion on the subject.

“It would, however, be unworthy of us, as the living representatives of those great men by whom the Royal Society was founded, to consider the progress of the physical sciences only as it regards ourselves. Looking abroad into what is going on in general society, I am sure that there is no individual now present who is not gratified to find that there is a desire to become acquainted with natural phenomena and the laws which govern them, much beyond what existed even at the beginning of the present century ; and that the opportunity of satisfying that desire, to a certain extent, is afforded to persons of every class, not only in the metropolis, but also in the provincial towns, and sometimes even in our villages, by means of ‘Mechanics’ and Literary Institutions, and by occasional lectures where no such Institutions exist. As a part of the education of those who ought to be the best instructed members of the community, in our schools and colleges the study of the physical sciences has already taken root ; and there is every reason to believe that the tree will grow and flourish.

“In the address which I offered to you at our last Anniversary, I adverted to the influence which such studies must have in training some of the higher faculties of the mind ; and I also adverted to the effect which they have already produced in laying the foundation of a better method of investigation in other departments of knowledge. It is not my intention to trouble you with a repetition of these observations ; there are, however, some other points belonging to the same subject, to which I would willingly draw your attention.

“In holding the opinion that much advantage would arise from the study of the physical sciences being regarded as an essential part of a liberal education, I apprehend that it has never entered into the mind of any person who has seriously reflected on the subject, that it should

supersede those other studies which form the basis of such an education in this and others of the more highly civilized communities at the present day. One of these studies, indeed, namely mathematics, is necessary to the physical sciences themselves, there being no one of these sciences to which, under certain circumstances, mathematical reasoning may not be usefully applied ; whilst one especially, and that the foremost and grandest and most important of the whole, is so entirely founded upon it, that, if this were taken away, there would be very little of the science left. The languages of the ancient nations of Greece and Italy have no such direct relations to the physical sciences as mathematics ; but I know no better method than that which the study of them affords of training the mind, at an early period of life, to habits of thought and attention, and so of fitting it for other studies afterwards. There is another advantage to be derived from those pursuits which lead us to a knowledge of the Greek and Roman classics. Greek and Roman literature has been the foundation of the best literature of modern Europe ; and an acquaintance with it stores the mind of the youthful student with graceful recollections and noble thoughts, which may exercise a wholesome influence over him through all the rest of his life. Further, it may be observed that the study of the ancient languages is an excellent introduction to a knowledge of grammar, and of the use of language generally, and this knowledge is of a kind the importance of which cannot well be over-estimated ; not only as it is by means of language that we are enabled to communicate our thoughts to each other and hand them down to those who are to come after us, but because language is in itself an instrument of thought, without which the reasoning powers which God has given us could be turned only to a very small account.

“ There is indeed no sufficient reason why the instruction of youth should be limited to one of these subjects, to the exclusion of the other, there being “ ample room, and verge enough ” for both ; it being quite true, as has been lately observed in an address delivered at Edinburgh by a noble Lord, a Fellow of our Society, that what is wanted in education is not so much that a great deal should be learned of any one subject, as that whatever is learned should be learned thoroughly ; so that the student should acquire the habit, so important in after life, of undertaking nothing which he does not

undertake in earnest. One object of education undoubtedly is to furnish the mind with knowledge which may be turned to good account hereafter. But that is not the only object. And there is always danger that, in exercising the faculty of learning over much, the higher faculties of thought and observation may not be exercised sufficiently. There may indeed well be, for the higher order of minds, too much as well as too little of systematic education; and hence it is that for some of the greatest achievements in the way of scientific discovery, we are indebted to those who, like Sir Humphry Davy, were in a great degree self-educated.

“It is a poor pedantry that would exalt one kind of knowledge by disparaging others. Literature, the arts, the moral and the physical sciences, all of these in their respective ways have tended to elevate the condition of mankind. But it is by the union of the whole that the greatest results have been obtained. That union is indeed as necessary to the higher forms of civilization, as the combination of rays of different degrees of refrangibility is to the constitution of a beam of solar light.

“Of the physical sciences, it may, I apprehend, be truly asserted that they have an advantage over every other department of knowledge,—in this respect, that the field of inquiry is practically unlimited. The student may indeed meet with an impassable barrier in one direction, but in that case he has only to proceed in another. As he advances, the horizon which terminates his view recedes before him. He enters on fresh scenes, gathers in new knowledge; and every addition which he makes becomes the foundation of further knowledge, to be afterwards acquired; so that, at the end of a long life, he finds himself a learner still. In the meanwhile, under whatever circumstances he may be placed,—whether he be in the cultivated valley, on the glaciers of the Alps, on the wide sea, in the crowded city, in the busy factory, in the broad sunshine, or in the starlight night,—he has only to look around him to find objects which have to him a peculiar interest, exhibiting relations which are not perceptible to those whose minds have been otherwise engaged. While viewing the gorgeous sunset, he finds, in the changing colour of the clouds and in the dark blue sky above, illustrations of the phenomena and laws of light. The flashes of the aurora are to him not mere objects of

curiosity, but are associated with the magnetism of the earth,—with that mysterious force which, like the force of gravity, connects us with the sun, and probably with all the other heavenly bodies, even those which are at the greatest distance from us. In the tumultuous movements of the atmosphere, which tear up trees by their roots, and cause the destruction of life by shipwreck, he recognizes the law of storms, and is enabled to comprehend how the mariner, by steering his course in one direction, may avoid those dangers to which he would be exposed if he were to steer it in another. In this way it is plain that even a moderate acquaintance with the physical sciences cannot fail to add to the interest of life ; an advantage which, under occasional circumstances, may be extended even to the humbler classes of society. A professor of one of our ancient universities, and a distinguished Fellow of the Linnæan Society, does not consider it to be incompatible with his duties as a parish priest, nor beneath his dignity as a philosopher, to give such simple instructions in Botany to the girls of the village in which he resides as may enable them to understand the flora of the neighbouring district ; thus affording them not only a useful, but a cheerful occupation for hours which would otherwise be passed in idleness.

“ It was on the 28th of November, just now 200 years ago, that several eminent individuals, who had previously been in the habit of meeting for the purpose of communicating with each other on subjects of common interest, assembled in Gresham College, and agreed to form themselves into a Society, having for its object the prosecuting of physico-mathematical experimental learning. When they reassembled on the following week, it was reported to them that what they proposed was highly approved by the reigning Monarch ; who intimated at the same time his desire to do what lay in his power towards promoting so useful an undertaking. Accordingly steps were taken for the incorporation of the Society under a Royal Charter, that Charter being conferred on them in due form two years afterwards. Such was the origin of the Institution which I have now the honour to address ; and to which the world is indebted for the long series of scientific memoirs contained in the 150 volumes of the ‘ Philosophical Transactions.’ The publication of these ‘ Transactions,’

however, was not begun until the year 1665, and then only in the form of a few pages, produced at uncertain intervals, which, being collected, made a thin volume at the end of the year.

“Many years elapsed before the ‘Philosophical Transactions’ became of larger dimensions. But we are not therefore to suppose, because so little was done in the way of publication, that little was really done for the promotion of the objects which the Founders of the Royal Society had in view. At this time Lord Bacon had already pointed out the right method to be pursued for the advancement of learning; and the abstract science of Geometry, inherited from an ancient nation, had been partially applied in the investigation of the physical sciences. Nevertheless it cannot be said that these sciences were more than in an infant state; and some which are now among the greatest subjects of attention, for instance Chemistry and Geology, had barely been called into existence. There was indeed as yet no sufficient number of facts collected on which the superstructure of science could be raised. The Founders of the Royal Society well comprehended what was required. If I may be allowed to use a homely expression, they had the good sense to begin at the beginning; and their first endeavours were to collect a larger number of facts by a course of experimental inquiry. Dr. Birch’s ‘History,’ which occupies a period of twenty-seven years from the foundation of the Royal Society, furnishes us with a great deal of valuable information as to this part of their labours, and gives us a more just notion of what the Royal Society accomplished in those days, than can be obtained from the ‘Philosophical Transactions’ themselves. At the several Meetings experiments were suggested, which were afterwards carried into effect. Mr., afterwards Dr. Hooke, received a special appointment as experimentalist; for which office he was well qualified, not less by his practical skill, than by his great and discursive genius. The collection of the experiments proposed and made during the period which I have mentioned would of itself form an instructive volume. It might not indeed add much to our present knowledge, but it would show us in what manner much of that knowledge with which we are now familiar had its origin, and at the same time furnish a grand example of the caution and circumspection with which all experimental inquiries should be conducted.

“With the gradual extension of knowledge, the method of inquiry

necessarily became modified. The size of the volumes of the 'Philosophical Transactions' gradually increased, and longer and more elaborate memoirs superseded the brief notices of which the earlier volumes were composed.

"It is not for us to give nor even to form an opinion of what the Royal Society has done during the last few years; but we are at liberty to refer to what has been done by our predecessors; and with regard to them we are justified in the conclusion that they have well performed the task which they had undertaken. In adding to human knowledge, they have added to human happiness. Standing apart from politics, they have pursued an independent course, having no selfish objects in view, but acting harmoniously with the Government of the day, whatever it might be. I am sure that every existing Fellow of the Society will join with me in the desire that we and those who come after us may continue in the same path, so as to maintain the dignity of science, and do honour to our country:—

*'Alterum in lustrum meliusque semper
Proroget ævum.'*"

On the motion of Mr. Horner, seconded by Sir R. Murchison, it was resolved,—

"That the account of the proceedings of the Council communicated from the Chair, be printed and circulated among the Fellows.

"That the thanks of the Society be returned to the President for his Address, with the expression of sincere regret for the cause of his absence; and that he be requested to permit his Address to be printed."

The Chairman then announced the adjudication of the Medals, and presented them in the following terms.

The Copley Medal has been awarded to Professor Robert Wilhelm Bunsen, of Heidelberg, one of our Foreign Members, for his researches on Cacodyl, Gaseous Analysis, the Volcanic Phenomena of Iceland, and other researches.

For thirty years Professor Bunsen has been a most industrious and successful investigator of various subjects in the domain of chemistry. His researches on Cacodyl supplied the first instance of a compound radical, behaving through a complete series of reactions like an elementary body, and being prepared in the free state

by processes similar to those by which many metals are prepared from their compounds. Notwithstanding the extraordinary difficulties of the research, Professor Bunsen carried it through completely, and with such accuracy that every one of his results has stood the test of subsequent investigation, and not one of his formulæ has been altered. The difficulty and danger attending these manipulations with spontaneously inflammable, highly poisonous and volatile bodies, are quite unparalleled, and enhance our admiration of the singular perseverance with which the subject was followed out into its most minute ramifications. The importance of the results, and the value of the influence which they have exerted on the development of sound views in organic chemistry can scarcely be over-estimated. The most important investigations in subsequent years have been mainly applications of the theory of organic radicals to new bodies, or extensions of its use in cases in which it had been already applied.

Another most important service to science, was Professor Bunsen's invention of a simple and effective apparatus for analysing gases, with an accuracy previously unattained. His researches on this head may justly entitle him to be regarded as the founder of accurate gas-analysis,—a branch of quantitative analysis which now far excels all others in the perfection of its results.

His researches on the gases evolved from blast-furnaces consuming charcoal, coke and coal (the latter made in conjunction with Dr. Playfair), are models of experimental and analytical skill, and have led to important applications of the waste gases of such furnaces to useful purposes.

Professor Bunsen's researches on the volcanic phenomena of Iceland, besides being valuable contributions to mineral chemistry, exhibit a masterly application of chemistry and physics to geological phenomena.

It is proper to remark that the important researches in which Professor Bunsen is now engaged with Professor Kirchhoff, not being yet complete, do not form any part of the grounds on which the Medal has been awarded.

PROFESSOR MILLER,

In transmitting this Medal to Professor Bunsen, you will not fail

to convey to him the deep interest with which the Royal Society regards the progress of the very important researches, in which he is engaged in conjunction with Professor Kirchhoff.

A Royal Medal has been awarded to Mr. William Fairbairn, F.R.S., for his various Experimental Inquiries on the Properties of the Materials employed in Mechanical Construction, contained in the 'Philosophical Transactions' and in the publications of other Scientific Societies.

Mr. Fairbairn's first scientific publication was, I believe, a small volume published in 1831 on 'Canal Navigation,' illustrative of the advantage of the use of *Steam* as a moving power on canals. In this work he detailed the results of experiments made on the Forth and Clyde canal and on other canals in Scotland, and recorded experiments made about the same time by other parties as to the traction of light boats by horse-power at high velocities.

In 1837 he contributed his first paper to the Manchester Literary and Philosophical Society, being "An Experimental Inquiry into the Strength and other Properties of Cast Iron." This was the first of many valuable papers on the same and similar subjects which have been from time to time published in the 'Memoirs of the Manchester Society,' in those of the British Association and of the Institution of Civil Engineers, and in the 'Philosophical Transactions.' It is well known also, and has been warmly acknowledged by Mr. Eaton Hodgkinson, that Mr. Fairbairn rendered most valuable assistance to Mr. Hodgkinson in his experimental inquiries into the strength of iron (for which the Royal Medal was awarded in 1841), by placing at Mr. Hodgkinson's disposal his works at Manchester, in which the experiments were conducted free of cost.

In the Transactions of the Manchester Geological Society in 1841, there is a paper by Mr. Fairbairn on the economy of raising water from Coal Mines; and in Weale's Quarterly Papers on Engineering, an account of his "Ventilated Water-wheel," a very material improvement in the construction of water-wheels.

Since that time his experimental researches and his contributions to various scientific bodies have been very numerous and important. Amongst these I may specify Papers on Fire-proof Constructions—On the Strength of Iron and the best Form of Beams and Pillars—

On Boiler Explosions—On the Collapse of Tubes under Pressure—On the Density of Steam—On the principle of Construction of Iron Ships—and on other kindred subjects: many of these being within the period required by the terms of the award of the Royal Medal. Of separate works may be noticed a volume on the Conway and Britannia Tubular Bridges (1849), including his researches on the best form and strength of *wrought* iron beams. A work ‘On the Application of Cast and Wrought Iron to Building purposes’ (in 1854 and 1857), and a valuable compendium entitled “Useful Information for Engineers,” in 1856 and 1860.

Perhaps it may be said with truth that there is no single individual living who has done so much for practical science, who has made so many careful experimental inquiries on subjects of primary importance to the commercial and manufacturing interests of the country, or who has so liberally contributed them to the world.

MR. FAIRBAIRN,

In presenting this Medal to you from this Chair, I will venture to say that the award of the *Royal Medal*,—the Medal which Her Majesty the Queen has been graciously pleased to place at the disposal of the President and Council,—for scientific services such as yours, so eminently conducive as they have been to the *general* good, is even *peculiarly* appropriate.

A Royal Medal has been awarded to Dr. Augustus Waller, for his investigations into the Anatomy and Physiology of the Nervous System, and for the introduction of a valuable method of conducting such investigations.

Previously to Dr. Waller’s inquiries it was known that, when a nerve is cut across, the distal portion, severed from its central connexion, undergoes disorganization; but Dr. Waller was the first to conceive, or at least to make known the idea of employing the section and disorganization of a nerve as a means of tracing out its distribution. In the art of injection anatomists have long possessed a method of following even the finest branches of the blood-vessels; and in like manner the well-marked alteration in the aspect of a nerve consequent on its section and degeneration has been made available by Dr. Waller for identifying and following its ramifications and finest divi-

sions when mingled with other nerves distributed to the same organ, or for tracing its fibres with certainty through the intricacies of a plexus to which various nerves contribute. He has suggested, too, the employment of this method to determine the course and connexions of particular tracts of nervous fibres in the brain and spinal cord.

Dr. Waller has himself applied this method with much success in unravelling the ultimate distribution of the nerves of the tongue, and in investigating the constitution of the cervical part of the sympathetic nerve and its relation to the spinal cord ; and his process has also been successfully employed by others in similar inquiries.

But the application of Dr. Waller's process is not confined to anatomical investigation alone. He has shown how it may serve also to elucidate the functions of nerves. The disorganization of nerve-fibres consequent on their section involves the loss of their functional activity ; and, accordingly, when a nerve contains fibres derived from two or more sources and operates functionally on several different organs, its function may be analysed, as it were, by the separate section and disorganization of its different tributaries and consequent elimination of the special function of each from the general effect. In this way Dr. Waller has been able to show that the influence of the pneumogastric nerve over the motion of the heart, and in great part also its government of the motions of the larynx, depend on fibres which are contributed to that nerve by the spinal accessory.

Having once perceived that the changes consequent on the division of nerves might afford a valuable means of research, Dr. Waller was naturally led to study with care the progress and characteristic features of the disorganizing process, and the modifications of it depending on the nature of the animal subjected to experiment, on age, external temperature, and other circumstances. In the course of these investigations he found that, when the cut ends of a divided nerve are reunited by the healing process, the fibres of the distal or severed part first suffer atrophy throughout their whole length, and are then regenerated, or at least restored to their original integrity.

Another result of this inquiry was the discovery of an important relation between the ganglia of the spinal nerves and the nutrition of their sentient fibres. This fact, previously unknown, but now fully

established, may probably help to a further insight into the nature and office of nervous ganglia, a question in physiology on which our want of real knowledge has given scope to much profitless speculation; its discovery was deemed of sufficient importance by the French Academy of Sciences to entitle its author to the award of the Monthyon Prize in Physiology for the year 1856.

Besides these independent researches, Dr. Waller, in association with Professor Budge of Bonn, undertook an experimental inquiry into the influence of the sympathetic nerve on the motions of the iris, which resulted in showing the dependence of certain of these motions on a particular part of the spinal cord. For these researches the authors obtained the Monthyon Prize for 1852. Lastly, through his independent investigations, Dr. Waller had an important share in the discovery of the influence of the cervical part of the sympathetic nerve on the contractility of the blood-vessels of the head; and he first demonstrated, by positive experiment, the influence of the cilio-spinal region of the spinal cord over these vessels.

For these various merits the Council have adjudged to Dr. Waller a Royal Medal, but especially for having supplied a process of research, which, already successful in the hands of himself and other inquirers, promises to afford most effectual aid in the future study of the Nervous System.

DR. WALLER,

In presenting this Medal to you, I have to express the hope of the Council that it will operate as an encouragement to you to prosecute researches which are considered by your brother physiologists to have so high a value.

The Rumford Medal has been awarded to Professor James Clerk Maxwell, for his Researches on the Composition of Colours and other Optical Papers.

Professor Maxwell is the author of various remarkable papers on subjects of pure mathematics and physics, which cannot here be mentioned, besides his memoirs more immediately devoted to optics. In one of his earliest papers, he has connected, by rigorous calcula-

tion, the mechanical strains to which elastic solids are subjected under certain conditions with the coloured curves which those solids exhibit in polarized light. In a paper published in the 'Quarterly Journal of Mathematics,' he has treated in a very general manner the passage of rays of light through optical combinations.

The research specially mentioned in the award of the Rumford Medal, was commenced by him many years ago, and as early as 1852 he had made an instrument for examining the mixture of the colours of the spectrum; but the first paper which he published on the subject was read before the Royal Society of Edinburgh in 1855. Helmholtz had in the meantime published some important investigations on the composition of the colours of the spectrum; but as the main object of his research was merely to make out under what circumstances two colours of the spectrum could be combined so as to give white light, his results could not be applied to test quantitatively a mathematical theory of the composition of colours.

Such a theory is virtually contained in the empirical construction which Newton long ago gave for determining the effect of combining in any proportions the colours of the spectrum. Newton's construction appears, however, to have been based on estimation only; and even the mathematical theory involved in it does not seem to have been clearly pointed out; though it has long been known, or suspected, that colour depends in some way on three elements, whether the triplicity exist objectively in some quality of the light itself, or subjectively in our organization. In the paper already mentioned, Professor Maxwell has not only exhibited in its essential simplicity the theory involved in Newton's rule, but has put the theory to the test of exact quantitative experiments. The instrument which he devised for that purpose, and which he calls a 'colour-top,' enables the observer to establish an exact match between two different sets of coloured papers, the colours of which are mixed by rotation in proportions which can be read off by the graduation. Such a match can always be established between any four colours (including white as a colour), by properly varying their proportions. If we suppose (n) observations to have been taken with the instrument, establishing each a match between two groups made up of three standard colours, and a fourth colour different for each observation, the results may be regarded as expressing the (n) fourth colours as linear functions of the

standards. If, now, the theory be true, the new colour-equations which we should obtain from the former by mere algebraical elimination, ought to agree with the results of direct observation on the matches indicated thereby. Professor Maxwell has subjected the theory to this verification, and thereby raised the composition of colours to the rank of a branch of mathematical physics.

Not the least remarkable part of these researches consists in their application to the case of colour-blindness. All the phenomena of colour-matches, as seen by the colour-blind, can be represented quantitatively as well as qualitatively, as Professor Maxwell has shown, by supposing that, as seen by such persons, all colours may be expressed in a linear manner by means of two chosen at pleasure. The results, as he has pointed out, would seem to indicate that the normal-eyed have (as Young supposed) three primary colour-sensations, and the colour-blind but two.

These researches Professor Maxwell has recently completed, by a paper published in the first part of the 'Philosophical Transactions' for the present year.

The researches for which the Rumford Medal is awarded, lead to the remarkable result that, to a very near degree of approximation, all the colours of the spectrum, and therefore all colours in nature which are only mixtures of these, can be perfectly imitated by mixtures of three actually attainable colours, which are the red, green, and blue, belonging respectively to three particular points of the spectrum.

MR. PROFESSOR MAXWELL,

In presenting you with this Medal, I may express the pleasure with which the Council, and I may add, I am sure, the Fellows of the Society generally, have seen your recent removal to London; and their hope that the 'Transactions' may be frequently enriched by contributions from one who already, in this early part of his career, has attained so much distinction.

The Statutes relating to the election of Council and Officers having been read, and Mr. Glaisher and Mr. Smee having been, with the consent of the Society, nominated Scrutators, the votes of the Fellows present were collected.

The following Gentlemen were declared duly elected Council and Officers for the ensuing year :—

President.—Sir Benjamin Collins Brodie, Bart., D.C.L.

Treasurer.—Major-General Edward Sabine, R.A., D.C.L.

Secretaries.— $\left\{ \begin{array}{l} \text{William Sharpey, M.D., LL.D.} \\ \text{George Gabriel Stokes, Esq., M.A., D.C.L.} \end{array} \right.$

Foreign Secretary.—William Hallows Miller, Esq., M.A.

Other Members of the Council.—John Couch Adams, Esq.; Sir John Peter Boileau, Bart.; Arthur Cayley, Esq.; William Fairbairn, Esq., LL.D.; Hugh Falconer, M.D.; William Farr, M.D., D.C.L.; Thomas Graham, Esq., M.A., D.C.L.; Sir H. Holland, Bart., M.D., D.C.L.; Thomas Henry Huxley, Esq.; Sir J. G. Shaw Lefevre, M.A., D.C.L.; James Paget, Esq.; Joseph Prestwich, Esq.; William Spottiswoode, Esq., M.A.; John Tyndall, Ph.D.; Alex. William Williamson, Ph.D.; Col. Philip Yorke.

The following Table shows the progress and present state of the Society with respect to the number of Fellows :—

	Patron and Honorary.	Foreign.	Having com- pounded.	Paying £2 12s. annually.	Paying £4 annually.	Total.
December 1, 1859..	7	47	353	7	277	691
Since elected .....	.....	+4	+6	.....	+16	+26
Since deceased ....	.....	—2	—17	.....	—18	—37
Withdrawn .....	.....	.....	.....	.....	—2	— 2
Defaulter .....	.....	.....	.....	.....	—1	— 1
November 30, 1860	7	49	342	7	272	677

Receipts and Payments of the Royal Society between November 30, 1859, and December 1, 1860.

	£	s.	d.
Balance	420	0	0
Subscriptions and Compositions	1634	4	0
Rents	238	8	6
Dividends on Stock, including Trust Funds	1175	6	11
Sale of Transactions, Proceedings, &c.	380	8	0
Compensation for Rights of Common at Acton	41	2	10
Stevenson Bequest	783	18	5
Chemical Society, Subscription to 'Proceedings'	20	0	0
Ditto, Tea Expenses and Lighting	17	4	6
Linnean Society, Tea Expenses and Lighting	17	4	6
Geographical Society, Lighting Hall	13	10	0
Geological Society, ditto	4	0	0
<i>Estates and Property of the Royal Society, including Trust Funds.</i>			
Estate at Mablethorpe, Lincolnshire (55 A. 2 R. 2 P.), £116 16s. per annum.			
Estate at Acton, Middlesex (34 A. 3 R. 11 P.), £110 0s. 0d. per annum.			
Fee farm rent in Sussex, £19 4s. per annum.			
One-fifth of the clear rent of an estate at Lambeth Hill, from the College of Physicians, £3 per annum.			
£14,000 Reduced 3 per Cent. Annuities.			
£26,476 19s. 1d. Consolidated Bank Annuities.			
£513 9s. 8d. New 2½ per Cent. Stock.			
<i>Scientific Relief Fund.</i>			
Investments up to August 7th, 1860, New 3 per Cent. Annuities, £4824 9s. 9d.			

EDWARD SABINE,
Treasurer.

£4745 7 8

	£	s.	d.
Rev. T. Evans, Fairchild Lecture	2	16	3
Mr. Fairbairn, Bakerian Lecture	3	18	4
Mr. J. Pettigrew, Croonian Lecture	2	18	9
Salaries, Wages, and Pension	1033	0	0
Fire Insurance	42	1	6
Printing Transactions, Parts 1 & 2, 1859, and Part 1, 1860.	533	14	10
Ditto Proceedings and Miscellaneous	286	19	1
Engraving	267	3	1
Paper for Transactions and Proceedings	521	8	9
Binding Transactions	99	12	3
Books Purchased and Binding	260	19	0
Furniture	130	17	4
Stationery	21	18	1
Shipping Expenses	6	2	0
Fire and Lighting	108	17	4
House Expenses	63	4	6
Tea Expenses	58	13	11
Taxes	30	17	6
Donation Fund	232	2	6
Wolveringham Fund	35	5	0
Copley Medal Fund	4	17	7
Rumford Medal Fund	140	16	7
Catalogue of Scientific Periodicals	185	17	0
Postage, Miscellaneous and Petty Charges	83	8	0
Acton Estate Enclosure Expenses	69	6	6
Catalogue of Portraits	21	0	0
Balance at Bankers	497	12	0

£4745 7 8

Statement of Income and Expenditure (apart from Trust Funds) during the Year ending November 30, 1860.

	£	s.	d.		£	s.	d.
Annual Subscriptions	£1134	4	0	Salaries, Wages, and Pension			
Admission Fees	200	0	0	Fire Insurance	1033	0	0
Compositions	300	0	0	Printing Transactions, including Part 1, 1859	42	1	6
Rents				Ditto Proceedings and Miscellaneous	286	19	1
Dividends on Stock (exclusive of Trust Funds)				Engraving	267	3	1
Sale of Transactions, &c.				Paper for Transactions and Proceedings	521	8	9
Stevenson Bequest.—Portion of Residue and Income				Binding Transactions	99	12	3
Chemical Society, Subscription to 'Proceedings'				Books Purchased	194	12	2
R. Geographical Society, for Lighting of Hall				Binding Books	66	6	10
Linnean Society, Tea Expenses and Lighting				Furniture			
Chemical Society, ditto				Stationery			
Geological Society, Lighting Hall				Shipping Expenses			
Income available for the Year ending Nov. 30, 1860	4017	2	8	Fire and Lighting			
Expenses in the Year ending Nov. 30, 1860	3825	0	8	House Expenses			
Excess of Income over Expenditure in the Year ending	£192	2	0	Tea Expenses			
Nov. 30, 1860				Taxes			
				Catalogue of Scientific Periodicals			
				Catalogue of Portraits			
				Acton Estate Enclosure Expenses			
				Postage, Miscellaneous and Petty Charges			
					63	4	6
					58	13	11
					30	17	6
					185	17	0
					21	0	0
					69	6	6
					83	8	0
					£3825	0	8

In the similar account to the present, rendered Nov. 30, 1859, it was stated that the Society was liable for the Expenses of Printing, Paper, and Engraving the Transactions (Part 1, 1859). This liability, amounting to £550, has been paid off, and is included in the disbursements of the present year. In addition to Part 1, 1859, two Parts, viz. Part 2, 1859, and Part 1, 1860, have been printed and paid for in the current year. There is therefore now no liability; and the sum of £550, for which the Society was liable at the last Anniversary, though paid in the present year, does not properly form a part of its expenses, and being added to £192 2s., the excess of income over payments, makes £742 2s. as the true excess of Income over Expenditure in the year which is now closed.

EDWARD SABINE,

Treasurer.