CHAPTER XX.

NOTES OF LIFE FROM 1864 TO 1867.

PHILOSOPHY consists not
In airy schemes or idle speculations;
The rule and conduct of all social life
Is her great province. Not in lonely cells
Obscure she lurks, but holds her heavenly light
To senators and to kings, to guide their councils,
And teach them to reform and bless mankind.

THOMSON.

FULL many a storm on this grey head has beat;
And now, on my high station do I stand,
Like the tired watchman in his air-rock'd tower,
Who looketh for the hour of his release.
I'm sick of worldly broils, and fain would rest
With those who war no more.

JOANNA BAILLIE.

IN 1864 Sir David Brewster was appointed President of the Royal Society of Edinburgh, and on taking the chair he delivered an address, in which he gave some details of the earlier history of the Society, which were probably unknown to some of the members, who belonged to a more recent generation than their venerable President; and which included recollections of early friends and scientific correspondents, whose letters still remain for future use. I give a few extracts :—

"In the closing years of the last and in the first decade of the present century, the Society was in a very languid condition. In each of the years 1799, 1802, 1803, 1808, and 1809, only one of the papers read at its

meetings was published in the Transactions; while our Transactions were thus scantily supplied with papers, those actually read were few in number, and often too abstruse to excite a general interest."

It was the storm of geological controversy which was raised between the followers of Dr. Hutton and his Theory of the Earth, and the Wernerian school of Geology, which brought new life and animation into the declining Society. "The rival theories of fire and water were discussed with all the warmth, I may even say the bitterness, of political or theological controversy. Vanquished by the superior science of their opponents, the Wernerians quitted the field, and the Huttonian theory, illustrated by the eloquence of Professor Playfair, attracted to its study the most distinguished geologists of other lands, and took a high place among the natural sciences. . . . If geology, as a science, drew its first breath within our walls, by the active labours of our colleagues, the kindred science of mineralogy was, at the same time, earnestly studied and greatly advanced. Mr. Thomas Allan, who possessed one of the finest collections in Scotland, spared no expense in enriching it with new and rare minerals. In 1808, a Danish vessel, brought into Leith as a prize, was found to contain a small collection of minerals, which was purchased by Mr. Allan, and Colonel Imrie, a Fellow of this Society, and a contributor to its Transactions. Among these minerals they found a large quantity of cryolite, a substance so rare that at the market price it would have brought £5000. They found also crystals of gadolinite, sodalite, and a new mineral, to which Dr. Thomson, who analysed it, gave the name of Allanite.

"These interesting minerals had been collected in Greenland by Mr. (afterwards Sir Charles) Giesecké, during the mineralogical survey which he had made of that country between 1805 and 1813, and were shipped by him for Copenhagen in 1808. Upon his arrival at Hull in 1813, with another and more valuable collection, he learned the fate of his former specimens, and immediately proceeded to Edinburgh, where he was hospitably received by Mr. Allan, Sir George Mackenzie, and other members of this Society. During his residence here he contributed papers to our Transactions, and acquired so high a reputation as a mineralogist, that, through the interest of his friends here, he was appointed to the Chair of Mineralogy in the Royal Dublin Society.

"While the study of mineralogy was thus greatly promoted by the labours and liberality of Mr. Allan, he had the good fortune, at a later period, to bring to Edinburgh, and receive under his roof for nearly four years, a young German mineralogist of very uncommon acquirements. William Haidinger, a native of Vienna, who had studied mineralogy at Gratz, under the celebrated Frederick Mohs, came to Edinburgh in 1823, and resided with Mr. Allan till 1826, when he returned to Austria, where he prosecuted with ardour his geological and mineralogical studies, and where he now occupies a high place in the scientific institutions of Vienna. During his residence in Edinburgh he published several valuable papers in our Transactions, and delivered a course of lectures on Crystallography, at which Dr. Edward Turner and other two friends were the audience. In claiming to have been one of his pupils at these lectures, I cannot resist the gratification

of claiming him as a pupil in that branch of optics, connected with mineralogy, which was then ardently studied in every part of Europe. When Mr. Haidinger returned to Vienna, he prosecuted the study of physical optics with great zeal and success, and had the good fortune to discover one of the most beautiful facts in that branch of science. He was the first who observed that curious property of the eye by which it discovers polarised light, and even the plane of its polarisation, without any instrument whatever. The cause of this remarkable phenomenon, called 'Haidinger's brushes,' has not been discovered; but there is reason to believe that it is produced by a structure in the retina, immediately behind the *foramen centrale.*"

Sir David either delivered or had read for him an address each of the few years that he held his post, and the latter part of each contained very interesting biographical notices of the members of the Society deceased during the past year. He frequently communicated papers, many of them on subjects connected with the labours and discoveries of long past years. A few of these which are before me embrace such topics as "the Action of Uncrystallized Films upon Common and Polarised Light;"—"On the Radiant Spectrum," the phenomena of which he discovered and described to the Society in 1814;—"Observations on the Polarisation of the Atmosphere," and "Additional Observations," which were made at St. Andrews between 1841-45, where, from some of the experiments in which he so delighted, made in "a long dark passage running north and south," he discovered a new "point or spot in which there is no polarisation," and to which the French gave the name of "Brewster's neutral point;"

"Report of hourly Meteorological Register, kept at Leith Fort, in the years 1826-27;"—"On the Pressure Cavities in Topaz, Beryl, and Diamond, and their bearing on Geological Theories;"—"On the Structure and Optical Phenomena of Ancient Decomposed Glass"—one of the beautiful and popular subjects of investigation which many will recollect enjoying with him; this paper is beautifully illustrated by the late Mrs. Ward, whose name has been already mentioned as a kind assistant with her most ready and intelligent pencil. Her charming drawings, correct and beautiful as they are, cannot do full justice to the strange filmy beauty which clothes this substance only in decay and death. Afterwards there is a paper upon the "Motion and Colours of Films of Alcohol, Volatile Oils, and other Fluids,"—two papers on his favourite study, the "Liquid Films of Soap-bubbles," and many others.

During my father's visit to Parkhill in 1866, an epidemic of whooping-cough was in the neighbourhood, and two cases occurred in the house; his distress and anxiety lest his little girl should take the infection were very great, and a strict quarantine was established. It never struck any one that, while she was to escape, he himself was to be smitten down,—but so it was; a few days after his arrival at Belleville, so severe and prostrating a cough began to tear his delicate frame, that it was quite clear that he must either have caught real or sympathetic whooping-cough, a complaint which it turned out he had never had in earlier years. He was very ill, and Lady Brewster and I were both sent for from different directions. With the knowledge of the presence of long-standing organic heart-disease, it seemed as if every paroxysm of coughing must be his last, and

slender were our hopes of his rallying, while he himself was sure that the end was near. The occasional extreme lowness of pulse, exhaustion, and abhorrence of the necessary food and stimulants, were most alarming, but his submissive efforts to take the nourishment on which his life depended were very touching, and were, under God, the means of his ultimate recovery. During one day, when he was at the worst, and occupation was impossible, from the almost unceasing violence of the cough, it was curious to see how his active mind employed itself in "examining" the laws of the malady, which was so severe upon him that he would rather, as he said, with his quaint force of expression, "have been sentenced to ten years of penal servitude;" he counted the seconds of intermission, calculated the approach and duration of the fits of coughing, described clearly his symptoms, and anxiously inquired into the sensations of one or two other friends who in other parts of the country had been prostrated in ripe years by apparently the same juvenile complaint. Just before, he had received the sad intelligence of the death of his beloved daughter-in-law, Mrs. James Brewster, who sank under protracted sufferings, borne with the beautiful patience of those who know and love the skilful Hand which smites and heals.

Notwithstanding these depressing circumstances, my father's mind was never brighter, clearer, or more active. A favourite young scientific friend, Mr. Francis Deas, was staying in the house at the time, and after hours of fatigue and suffering, it was positive enjoyment to the invalid to make the little preparations for his visit, which was quite the event of the day. Believing himself a fast dying man, he left many instructions with

Mr. Deas as to the arrangement of his scientific instruments, etc., and two years afterwards, when the call really came, it was to this gentleman that he confided the finishing and reading of a paper for the Royal Society which weakness prevented him from completing. It was "On the Motion, Equilibrium, and Forms of Liquid Films."[1]

Mr. Deas writes thus to Mrs. Macpherson :—

"EDINBURGH, 22*d June* 1869.

"MY DEAR FRIEND,—I most gladly comply with your request to send you what reminiscences I have of Sir David during the three weeks that I spent with him at Belleville in September 1866.

"He had been ailing for some days, and, as I well remember, he sent for me to see him in his bedroom the very night I arrived. I found him dressed, sitting at the table, busy experimenting on a subject which had recently attracted his attention, and which formed one of the principal matters of scientific interest with him from that time till his death, viz., the phenomena displayed by liquid films without sensible gravity. The subject had been shortly before brought under his notice by an account published in the Transactions of the Belgian Royal Academy of some experiments of Professor Plateau. Sir David, while repeating these experiments, had been led to question the commonly received theory of the cause of the colours of the soap-bubble. Sir Isaac Newton's calculations for the various orders of the colour bands proceeded upon the supposition that the colours were due to the interference of the rays reflected

[1] This paper, with several others, was beautifully illustrated by Miss Dickenson, then residing at Friar's Hall.

from the surfaces of the film itself. Sir David made the discovery (which, although I believe it has been questioned, has certainly not been refuted) that the colours originated in minute particles of oily matter floating freely upon the surface of the film. These experiments engrossed almost his whole time while he was at Belleville, and formed the substance of three papers which were afterwards read before the Royal Society of Edinburgh (*vide Transactions*, vol. xxiv. part 3, and vol. xxv. part 1). His illness, you know, took the form of a harassing cough, which at his great age of course severely taxed his strength; but his spirit seemed to defy any such restraint, and I think there was scarcely a day that he was not at his work. I saw him, you will remember, almost daily, and had a great deal of talk with him, both on various scientific subjects and those of everyday interest, and I remember I was struck, more than I ever had been before, by what I think was so remarkable a part of his character, and doubtless one cause of his eminent success as a discoverer of truth,—I mean the marvellously keen interest he showed in every possible thing. I daresay you remember remarking the same to me long ago, that in driving or walking with him every few yards of the road presented either something he wished to look at or had something to tell about.

"I was probably more struck with this peculiarity of his during that visit than I had been before, because I saw more of him, and tried to amuse him during his confinement with any subject for talk I could think of. Anyway, I well remember thinking what a sight it was to see the grand old philosopher, who had in the truest sense *lived* through wellnigh a century, during which

he had so diligently and so lovingly gathered in and employed, to the glory of God and the weal of man, the truth and the beauty which, though lying all around, it needs the seer's eye to see, sitting there still at his work, with all his faculties as perfect as ever, his memory as clear, and his interest as keen. And touching too, was it not, that at the close of his long life he should be admiring with the eye of the philosopher those very beauties of the fleeting soap-bubble which doubtless he had so long before delighted in with a different but not less intense interest as a child—as grieved as ever when the poor bubble broke and scattered its glories just as they reached perfection.

"Another matter of a somewhat different kind which greatly interested him at that time was the Newton and Pascal correspondence. You may remember that I remarked to you at the time that I was amazed at the ability with which he sifted the evidence on that subject, and struck home at the weak points in his opponent's armour. It was more like the way an accomplished lawyer might have been expected to deal with it than one who had never devoted himself to the art of debating.

"Two little incidents also occur to my recollection which I may mention, as I think they were both very characteristic of Sir David. One was his wakening Lady Brewster, as he afterwards told me, to look at the changes on a gorgeous film he had been watching for hours. His whole heart was so in the pursuit of the knowledge of God's works that he seemed never for a moment to doubt that any one could but go into raptures like himself over a thing of beauty, even at untimely seasons.

"The other incident was no less like his own kind

beautiful self. I had let a box of microscopic objects, which had taken me months to prepare, fall downstairs, to their utter ruin. He spoke to me so kindly and sympathizingly, saying it was like the story of Newton's papers being burnt by the upsetting of the candle, and so encouraged me that I set to work that very day to repair the loss.

"If you think this letter can be of any service to Mrs. Gordon, please send it to her; and if I can contribute anything more that may be thought of interest about one who always showed such a kindly and considerate interest in me, it will afford me the greatest pleasure to do so. I owe him at least this debt of gratitude, that I believe, but for the kindly encouragement and assistance that—prince of philosophers as he was—he always condescended to give me in scientific subjects, much of the interest I have in those things to which he so ardently and lovingly devoted his life might have lain dormant.—Believe me, ever most truly yours, FRANCIS DEAS."

The complaint gradually subsided, and when he was able to return home it was with little apparent mischief, except an increased delicacy of the bronchial tubes.

There was one subject which loomed through half a century of Brewster's life, and which to its last months caused him so much overwhelming anxiety and distress, that it would be impossible to write any sort of faithful memoir of him without at least alluding to it. I refer to what is called "the Lighthouse Controversy." For obvious reasons my sketch of it shall be as uncontroversial as possible.[1]

[1] I have taken the leading dates from a statement of Dr. J. H. Gladstone, Ph.D., F.R.S., which, it was well known, my father did not consider a favourable one.

There has seldom if ever lived an inventor who stood quite alone in his invention. One man has generally laid the unseen foundation, another builded thereupon, while perchance a third has put on the pyramidal headstone which crowned it with use and glory. Nay, as the builder builds, it is not always with his own materials. The blessing upon the inventor is still due to him who in building the edifice of his invention, has the adaptive genius to utilize the stone, the lime, the lintel, and the beam of some former edifice scattered unused and uselessly around.

In 1811 Dr. Brewster had busied himself in experimenting upon a form of lens which was not at that time known in England. This was called Buffon's lens, invented by that philosopher while making experiments with the burning mirror of Archimedes. It consisted "of one piece, in which all the glass was ground away which was not necessary either for converging rays to a focus, or throwing them from a focus into a parallel beam." In 1788, Condorcet, in his "Éloge de Buffon," suggested the important improvement upon his lens of making it of several zones or circles of glass instead of one, or to use his own words:—"On pourrait même composer de plusieurs pièces ces loupes à échelons; on y gagnerait plus de facilité dans la construction, une grande diminution de dépense, l'avantage de pouvoir leur donner plus d'étendue, et celui d'employer, suivant le bésoin, un nombre de cercles plus ou moins grand, et d'obtenir ainsi d'un même instrument différents dégrès de force."[1]

[1] "Eloge de Buffon," by Condorcet, quoted in *Rudimentary Treatise on the History, Construction, and Illumination of Lighthouses*, by Alan Stevenson, C.E.

Buffon's lens was intended for the purposes of heat. It was useless for the practical purposes of illumination, because "the thickness of the glass at its central part was so great as either to absorb the light by its colour, or refract it irregularly by its want of homogeneity;" and if bad for light, it was still worse for heat. Condorcet's "circles" possessed the same disadvantage, though to a lesser degree, and neither form of lens was ever executed on a large scale. In 1789 there was, however, an attempt made to apply lenses combined with mirrors for illuminating the Lower Lighthouse in the Isle of Portland, which completely failed; and why? Simply because the invention of a lens fit for practical purposes had not then been made.

In 1811, Dr. Brewster, during the course of experiments to which I have alluded, invented a lens which he called the "built-up lens." It was constructed in zones or "circles," which, it is true, was suggested by Condorcet;—although, being unknown to Brewster, even this step was an independent discovery. But it did not stop there,—each zone of Brewster's lens was formed or "built up" of separate segments, and hence it received the name of the polyzonal lens,—a most important improvement for obviating the great practical difficulty in the use of lenses for illumination, which was that of obtaining pure and homogeneous glass in masses sufficiently large. In order to give increased power to his new form of lens, Dr. Brewster connected it with "an entirely new lenticular apparatus, consisting of small lenses and concave and plane reflectors, for concentrating in one point or focus the light of the sun, or for throwing into one parallel beam all the rays of light that diverged from that focus, as represented by a lamp."

Both of these inventions were intended at the time solely for the purposes of combustion. They were described and published, with clear and correct engravings, in 1812, in the article "Burning Instruments" in the *Encyclopædia*, copies of which were sent to the library of the French Institute and to M. Biot in 1815. The laws of heat and light being identical, it would have been passing strange if the easy application of the new lens and its companion apparatus to illumination, had not soon occurred to the fertile and practical mind of Brewster. That it did so, and as early as 1816, when, by his own recollections, he made the proposal of so using it to Mr. Robert Stevenson, the Engineer of the Scotch Lighthouse Board, is therefore extremely probable, but as there are no documents *directly* establishing this earlier period, it is best to waive it and the following periods of 1818-19, when, as many believe, he also pressed it upon the engineer's attention. There is no doubt, however, that in 1820 he actually proposed this application of it to Mr. Stevenson. Mr. Alan Stevenson, the son of the engineer, himself gives this decided date in a pamphlet published in 1833, in which he says, in reference to lighthouses, "that on the subject of polyzonal lenses, Doctor, now Sir David, Brewster, the inventor, was consulted in 1820," while a statement in a letter from Sir David Brewster to the chairman of the Board, that he had had frequent communication on this subject with their engineer in 1820, is recorded in their minutes uncontradicted.

We are told that at this time "every lighthouse in Europe was fitted up with hammered parabolic reflectors of plated copper, or with little squares of silvered glass, combined so as to form the segment of a sphere or a

paraboloid. When a lamp was placed in the focus of these reflectors, its light was thrown into a widely diverging beam—so attenuated by its divergence, and by the imperfection of the surfaces which reflected it, that it ceased to be visible at great distances, and was incapable of penetrating the fogs so prevalent at sea." Very different from the "full swelling beam of light" that might be cast upon the waters by the polyzonal lens and its "whole light" apparatus. Mr. Stevenson, however, did not feel convinced by the inventor's arguments, and again and again his proposals fell to the ground.

In the meantime an important life of science was springing up in France. On the 10th of May 1796, Augustin Jean Fresnel was born at Broglie in Normandy. He was the son of an architect, and he was educated as a civil engineer. In 1814, at the age of eighteen, he is recorded to have asked his uncle the meaning of the words "Polarisation of Light,"—the explanation struck his vivid mind, and from thenceforward he made the rapid progress in scientific attainments which often marks the men of short career. In 1817 he was much engaged in experiments upon Light; in 1819 he was put upon the French Lighthouse Committee, and turned his attention to improvements in illumination; experiments on these were made in 1821, and in 1822 he read before the Academy of Sciences a memoir on "A New Method of Illuminating Lighthouses," describing as inventions of his own not only a polyzonal lens, but, as it was afterwards called, a holophote or "whole light" apparatus of lenses and mirrors, to be connected with it, so identically the same as those described and engraved in the *Encyclopædia*, that it is

difficult to believe that he had not seen the article on Burning Glasses, which had been in the library of the Institute for six years. That he was an independent inventor, however, is universally believed, and my father wrote as follows of him:—

"I have always considered that distinguished philosopher as an independent inventor of the built-up lens and its relative apparatus, as described by himself, though I preceded him by many years; and if his friends shall think it just to assign to him a higher place than mine, it will be done with the delicacy and tenderness which honourable men feel to a rival, and with that love of truth which his colleagues and mine in the Imperial Institute of France will not fail to cherish and observe."

M. Fresnel sent copies of his memoir to Sir David Brewster and Mr. Stevenson. His invention possessed one great advantage,—it was made in a country where the clairvoyance necessary for a foresight of success is not only possessed in a peculiar degree, but is always promptly acted upon. In 1822, therefore, M. Fresnel was made secretary of the French Lighthouse Board, and in the same year the Tour de Corduan, at the mouth of the Garonne, was lighted by the polyzonal lens and its attendant apparatus,—while before his death in 1827, M. Fresnel was a man whom his nation delighted to honour as the inventor of the life-saving instruments which guard the rocks and the reefs of the whole French coast. It was otherwise in England. In 1820 at the latest, the Dioptric apparatus, as the process of illumination by lenses is called, in distinction to the Catoptric or reflector system, was proposed for lighthouses by Sir David Brewster, being exactly

the reverse arrangement of the same invention for heat. From that time, on to 1822, when the success of the same system was shown in France,—on through fifteen years, while precious lives were being saved in France, Germany, Russia, and Holland, precious lives were being lost in Great Britain by the unaccountable dilatoriness of officials, and the dislike of the nation to "any new thing." Month after month, year after year, Sir David Brewster threw himself into the cause with the ardour and singular persistency of his nature, only to be baffled and buffeted. The history of these singular and unwearied efforts will still, it is hoped, be presented to the public, so that it is unnecessary to say more than that they were not crowned by success until 1835, when the new lighthouse of Inchkeith was illuminated by the Dioptric lights; and their triumphant superiority so completely manifested, that since then all the new lighthouses of Scotland, England, and Ireland have been fitted up with the lenticular apparatus, although lighthouses erected previous to 1835 still send out their old feeble lights, ships struggling beyond their limited gleams still break upon the rocks, and lives still go down into the great deep. Sir David Brewster wrote:—

"If the security of life and property at sea is a subject of national concern, the expense of substituting a combination of lenses and mirrors in place of reflectors does not merit a moment's consideration. The saving of oil and other materials would go a certain length in defraying it, and the reflectors themselves might find an appropriate application to various purposes on our coasts, or on ships at sea. Who can look at the Bell-Rock Lighthouse, erected at the expense of £61,231,

without lamenting that so noble a watch-tower should be still lighted by hammered reflectors, and with a distinguishing light which science and common sense have equally condemned? An expenditure of little more than £1000 would make the lighthouse a rival of the Great Corduan on the coast of France, and carry its distinctive character over a much wider range of the German Ocean. What would be said of a great railway company, if, when safer locomotives, stronger carriages, superior brakes, and surer signals have been invented and in use, they should introduce them only into their new lines of railway, and allow the passengers on the old lines to run all the risks of imperfect and antiquated machinery?"

Still it was much to accomplish, and the proved superiority of the new to the old system caused bursts of enthusiastic appreciation even from those whose prescience had been at fault for so many years. A word of gratitude from his country might therefore have been expected to the man who invented, proposed, and almost forced the adoption of the system; but the new mode of illumination was and is called the "French system," the lens impressed with the name of "Fresnel," and the Holophote with that of Stevenson. That during the years before and after the tardy adoption of the Dioptric lights, there was much of acrimonious and personal spirit cannot be denied, and Brewster's undoubted share of the blame is deeply to be regretted, while those who loved him best would fain have to remember that he had calmly submitted to want of justice rather than that he failed in the application for it. But the desire for a recognition of his services in this noble cause by his country appeared

almost as if it were engraven on his heart, like the name of Calais on the queenly heart of old. His own intense dread of some day perishing in the wild waters probably made him still more tenacious of his glory in being the undoubted means in some ways at least of a saving of life, the amount of which, though it might well be greater, will not be fully known till the seas of the past and the present give up their dead.[1] After many applications, it was not till August 1867 that the Government of Great Britain finally refused all recognition of his claims. Two circumstances are pleasing to recall,—one is, that in his obituary notice in 1866, before the Royal Society of Edinburgh, of Mr. Alan Stevenson, all painful recollections were cast to the winds. His eminent qualifications as civil engineer, author, and classical scholar, are given their due place, and his death mentioned as that "which a Christian should die." The other is that on the 17th of February 1868, the representative of the Stevenson family made before the Royal Society a few remarks prompted by good taste and feeling, in which he expressed his cordial sympathy with the recognition made of their late President's "numerous and valuable contributions to science and literature," and seconded the motion to this effect. When after his death the tardy recognition of his Lighthouse services was made in many of the newspapers, it was touching to hear the weeping remark made from sure knowledge of the hold it had upon his

[1] I cannot forbear quoting the following gratifying sentence from the eloquent Opening Address of Sir Alexander Grant, Bart., my father's successor as Principal and Vice-Chancellor of the University of Edinburgh, delivered Nov. 2, 1869:—"Every lighthouse that burns round the shores of the British empire is a shining witness to the usefulness of Brewster's life."

heart:—"O that he could have read that! How pleased he would have been!"

The names of many eminent men, and their opinions upon this subject, all favourable to my father's claims, are in print before me;[1] such as Sir William Snow Harris, Sir John Herschel, Sir William Thomson, Lord de Mauley, Professor Fuller, and others; and I may be forgiven for inserting the following valuable opinions, as well as an unpublished letter from Lord Brougham to Lord Palmerston:—

"*Opinion of* DR. LYON PLAYFAIR, C.B., F.R.S., *Professor of Chemistry in the University of Edinburgh; and* P. G. TAIT, M.A., F.R.S.E., etc., *Professor of Natural Philosophy in the University of Edinburgh.*[2]

"We have examined the written and printed documents (connected with Lighthouse Illumination) which you submitted to us, and we are of opinion that they completely justify the following statements:—

"1. That in 1812 you suggested an important improvement on the lens of Buffon and Condorcet, such as, in fact, rendered it (for the first time) capable of being constructed. Neither Buffon's original device, nor the farther improvement of Condorcet, could possibly have been executed on a large scale.

"2. That in the same year, you described the Dioptric Apparatus, by which the whole of a beam of light, parallel or diverging, can be thrown into a beam con-

[1] These form an appendix to Sir David Brewster's pamphlet entitled *The History of the Invention of the Dioptric Lights, and their Introduction into Great Britain.*

[2] Dr. Playfair and Professor Tait's statement was drawn up in the winter of 1863-64.

verging or parallel, constituting what has been called the Holophote.

"3. There is complete documentary evidence, that certainly in 1820, and probably even as early as 1816, you pressed on the Engineer of the Scottish Board the adoption of a Dioptric system, based on your new form of Polyzonal Lens. Fresnel's suggestion of the same improved form of lens, and of the same Holophote apparatus, did not appear till 1822.

"4. The more perfect form of Holophote is also your invention, and was not known to Fresnel.

"5. Apart altogether from the question of priority, there is no doubt whatever that it was by your persistent and unaided efforts (especially in obtaining, through Mr. Hume, a Committee of the House of Commons, after all other means had failed) that the Dioptric system was at last, in spite of long-continued opposition, tardily introduced in Britain.

"We have kept to the main facts, about which the evidence is so clear that we consider it scarcely possible for any candid mind, upon being made acquainted with it, to hesitate to give you, not only the full credit of long priority, but also the merit of having, as it were, forced this inestimable boon upon the country.

"LYON PLAYFAIR.
P. GUTHRIE TAIT.

"*To* SIR DAVID BREWSTER, K.H."

"At a Meeting of the Council of the Inventors' Institute, held on the 30th day of June 1864, PETER WILLIAM BARLOW, Esq., F.R.S., in the chair: After hearing a Report from a Committee appointed to investigate the evidence upon the subject, it was agreed—

"1. That in the year 1811 Sir David Brewster, adopting, as he admits, from Buffon a suggestion of a new form of lens, invented a mode of building up this lens in segments, which for the first time made it capable of construction.

"2. That in the years 1811 and 1812 Sir D. Brewster invented and described an apparatus for burning purposes, consisting of a combination of this built-up lens with a spherical reflector behind, and small lenses and plain mirrors distributed around the focus, by which the whole of a beam of light, parallel or diverging, can be thrown into a beam converging or parallel.

"3. That all men of science must have been fully aware, even at that time, of the identity of its effects when applied to rays of light instead of rays of heat.

"4. That this combination, afterwards called a Holophote, embodied the fundamental features and principles of the most perfect optical apparatus for lighthouses now in use.

"5. That the application of this combination, as peculiarly adapted for lighthouse purposes, was suggested by Sir D. Brewster to the Engineer of the Scottish Lighthouse Board as early as the year 1820, and probably much before that time.

"6. That in the year 1822 M. Fresnel applied the built-up lens of Sir D. Brewster in combination with plain mirrors to the construction of an apparatus for the illumination of one of the French lighthouses.

"7. That this apparatus of M. Fresnel did not involve the principle of the Holophote, nor was its application to it suggested by him.

"8. That from the year 1820, till its final adoption and completion in a Scottish lighthouse in 1836, Sir D.

Brewster, by his personal exertions and by his writings, laboured strenuously to obtain the introduction of the Holophotal system into British lighthouses, and that it was owing to his persevering efforts in the face of much opposition that its introduction was finally effected.

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Benj. Burleigh, C.E.	M.P."
Cornelius Varley.	

"I have not the books in which your invention was published, but I remember distinctly reading the article in the *Edinburgh Encyclopædia* when it appeared (1812), and appreciating at once its importance for lighthouses. I felt this the more strongly, because at that time there stood in Howth a lighthouse (now demolished) provided with solid lenses, which were so thick at the centre that they did not transmit one-half of the Incident light. This was a case that seemed to challenge the trial of your invention, for it would at once have removed that defect. That such trial was not made will surprise none who are familiar with the history of invention.—Believe me, etc., T. R. Robinson."

"Observatory, Armagh, *Feby.* 2, 1865."

"2 *August* 1859.

"My dear Palmerston,—As I expect to leave London to-morrow early, I have no prospect of seeing you before I go. But there is a subject on which we had so little time on Saturday, that I omitted to mention

it, though it is really one of importance and of interest to scientific men and to the public at large.

"I mean Sir David Brewster's great services, and the value to the country of his useful invention of Dioptric Lights, by which an incalculable number of lives have been saved in the prevention of shipwrecks. My opinion, very decidedly, is that the country which most properly showed its gratitude, and its sense of valuable services in the case of Sir William Snow Harris's conducting rods, would be most unjust were it to pass over Sir D. Brewster's.

"I need not remind you of the great scientific eminence of Sir D. B. He is, in fact, at the [head] of our men of science for the originality of his researches, and the importance of his discoveries. But the matter now under consideration refers to a happy and most successful invention in practice, though founded on scientific principles.—Believe me ever most truly yours,

"H. BROUGHAM."

In the meantime the strength of life was waning, though with a merciful and gentle decrease. In the spring of 1867, my father for the first time lost his consciousness in a fainting fit which came upon him when in a class-room of the University in Edinburgh; assistance was at hand, and he soon rallied, so much so that, when he came to see me half-an-hour after, he walked up-stairs as firmly and conversed as cheerfully as if nothing had happened. When with him at Belleville in September there seemed little change; and when he left it to go to the British Association at Dundee, it was with all the want of precaution of a young and strong man. No entreaty would make him attend

to the taking of food or rest, which might have helped him to undergo the journey more easily, and to have been more fit for the fatigues which awaited him. The heated and crowded assembly of 2000 persons, held in the Kinnaird Hall, was too much for him, almost immediately after the hurried journey. He fainted away again, and was longer in recovering than on the preceding occasion. Again he rallied, however, and was soon able to reassure Lady Brewster by writing a playful account of his horror when he became conscious of cold water, and hands kindly divesting him of his neckcloth. After a day or two of rest, under the kind care of Mr. and Mrs. Edward Baxter of Hazel Hall, whose guest he was, he recovered sufficiently to be present as usual at his own Section A (Mathematics and Physical Sciences), where he read papers on the Colours of Soap-bubbles, on the Radiant Spectrum, on Enamel Photography, and on the Alleged Correspondence between Pascal and Newton.

Professor Balfour, the eminent botanist, one of the Secretaries of the Royal Society of Edinburgh, and the son of an early friend of my father, gives me the following notes:—"We were glad to have Sir David Brewster at the Dundee meeting of the British Association, as a noble advocate of Bible truth in opposition to the scepticism of the men of science of the present day. To see a philosopher like him, of world-wide reputation, vindicating the inspiration of God's word, and humbly receiving the truth in the love of it, was most encouraging, though we did not know that it was to be his last appearance amongst us,—the meeting at Dundee having laid the foundation of his last illness. I was on the platform when Sir David came into the

crowded hall, after a most fatiguing journey, and sat down beside me. We shook hands and spoke as usual, but on looking at him shortly after I saw a change on his countenance and a shaking of the frame, which indicated faintness. He fell into my arms, and was gently laid down on the platform, means being used to revive him; he was then carried to a back room, where many of his Edinburgh friends (medical and others) rallied round him. He recovered gradually, and was glad to see so many known faces. When he had sufficiently recruited, he wished to go back to the room to hear the Duke of Buccleuch's address (as President), but his medical friends prevented him. After a time I got him conveyed in a cab to my friend Dr. Gibson's house, where I remained till I got him comfortably settled for the night. When sitting by him he pressed my hand, and expressed his thankfulness for the mercies he had experienced, and for the kind attentions paid to him. I committed him to Dr. Gibson, and, when departing for the night, I could not but remark the tender and affectionate manner in which he took leave of me. He thoughtfully sent me money to pay for the cab, which he refers to in the following brief but characteristic note:—

"'ALLERLY, *Sept.* 14, 1867.

"'DEAR PROFESSOR BALFOUR,—I enclose some stamps in return for a small part of my debt to you; but I know of no stamp or coin by which I can repay the great attention and kindness I received from you at Dundee.—I am, ever most truly yours,

'D. BREWSTER.'

"After the Dundee meeting, I spent a day at Rossie

Priory (Lord Kinnaird's) with some of the scientific men. Sir Charles Wheatstone was there, and told me that Sir David Brewster had gone up to him frankly at Dundee, saying, 'We have had much disagreeable discussion together, but I hope it is all forgotten now;' upon which they shook hands cordially. In repeating the anecdote to me, Sir Charles said, 'Do you really think he was sincere?' and I could not resist the prompt answer, 'You may trust Sir David for that.'

"Sir David afterwards proposed to the Council of the Royal Society of Edinburgh that Sir Charles should be elected an Honorary Fellow. His conduct in this instance contrasted well with his reluctance some years before with regard to another honour which was proposed (though not pressed) for Wheatstone, and showed a softening of the heart which was very marked, and which could only be traced to the power of the Spirit. —Believe me, yours most sincerely,

"J. H. BALFOUR."

"INVERLEITH ROW, *October* 27."

Although apparently well again, he was glad to give up other intended visits after the Association, and to hasten to his own home, which he never again left. It was not, however, to entire rest and quiet that he at first returned. One other public conflict begun before the Dundee meeting yet awaited him. I refer to the part he took about the forged correspondence between Pascal and Newton, which, if true, would have tarnished the fame of his noble and beloved master, and broken the shrine of seventy years' fervent admiration.

The discovery and establishment of the great law of universal gravitation, which was the foundation of the

celebrated *Principia*, were partly, it is true, suggested by other minds, especially by Hooke and Cassini, which Newton always frankly acknowledged; but these letters, if true, would have branded the noble-minded philosopher with having fraudulently concealed that these suggestions and others had been made to him long before by Pascal. "Newton(g) dépossédé" was the heading of the first announcement of this curious "fact," which, if a "stubborn" one, would have been highly gratifying to the French nation, one of whose scientific representatives[1] had frankly confessed "that no Frenchman can reflect without an aching heart on the small participation of his own country in the remarkable achievement of the discovery of universal gravitation."

The most noteworthy parts of these documents consisted in a French correspondence between Pascal and Newton, when the latter was a boy of twelve years old, in which the discovery of gravitation by Pascal is clearly announced. These were read before the Institute, and published in *Les Comptes Rendus* by M. Chasles, a French geometer and scientific historian of such undoubted character for rectitude, that even those who felt most sure of the forgery never attributed it to him. As the biographer of Newton, and the only living person who had examined his literary remains, it was natural and appropriate that Sir David Brewster should again come forward as the champion of the illustrious dead. That he did so with the zeal and the entireness of his character, and with the energy so seldom possessed at eighty-six, was only to be expected, and these qualities contrasted strongly but pleasantly with the flippancies which were opposed from unexpected quarters

[1] M. Arago.

to his intense earnestness. His acute discrimination seized at once on many points, which may be said to have proved the forgeries. Some of them may be stated thus :—

1. That there was no mention of Pascal in any correspondence of Newton.

2. So far from being a precocious boy, Newton was a juvenile idler, and when his mind did begin to work it was entirely on mechanical objects; he himself having recorded that his first and rather clumsy scientific experiment was made when he was sixteen, namely, jumping first in one direction and then in the other in a storm, and by the measurement of both leaps, which he compared with the same leap in a calm day, he computed the force of the gale.

3. That Newton never wrote in French—a not uncommon circumstance in the history of John Bull,—but wrote in Latin to foreign savans, while it also came out that he was unable to read French without a dictionary at the age of thirty-one.

4. That Newton's mother, whose maiden name was Hannah Ayscough, and who married Mr. Smith when her son was four years old, is represented as signing her name when he was twelve years of age as "Miss Anne Ascough Newton!"

5. That it would not have been like Newton's English mind and English pen to have professed himself "eternally grateful" even to Pascal for scientific favours, while another correspondent pointed out the amusing idea of an English boy writing of Sir Kenelm Digby as "le Chevalier D'Igby!"

6. That the handwriting of the MS., of which M. Chasles sent a photograph to Sir David, bore not the

least resemblance to the well-known autograph and mode of signature—specimens of which were sent by Lord Portsmouth and Lady Macclesfield for the purpose of comparison.

7. That Dr. Robertson, the Scotish Historian, who flourishes in the correspondence as having been in Paris, writing in excellent French and addressing his correspondent as "mon très Honorable," has not left a single document from which it could be gathered that he was ever out of Great Britain, could write a line of French, or was in the least interested in Newton.

One name that occurred frequently in connexion with these documents was that of M. Desmaizeaux, a contemporary of Newton, and a man of whose character for probity there seem certainly to have been two opinions; upon this man, in his eagerness to demonstrate the forgery, Sir David Brewster rather immaturely fixed as the forger, overlooking the obvious inference that a man who like Desmaizeaux was "half an Englishman," and who had lived fifty-three years in England, would never have committed or allowed to pass such obvious and ludicrous Gallicisms in letters professing to be written by English letter-writers in a difficult and foreign tongue.

As these and other arguments and attacks appeared in the public papers, other and more astonishing statements were successively produced. Galileo complains of "weak eyes" in a letter, purporting to be written by his own hand, three years after his total loss of sight. A correspondence, also in French, was brought forward, said to have passed between James II. and Newton, the object of the royal letters being entirely to extol Pascal, whose scientific discoveries made him oblivious of his

various heretical peccadilloes. One of these letters is written to Newton a few days after he left his throne, a fact announced in the meekest terms, adding that he forgets and forgives the behaviour of Newton and the rest of his rebellious subjects! Louis XVIII. and an English Queen or two also dash into the subject, but all unite in the scientific glorification of Pascal.

It will never be forgotten, in connection with this singular episode, how many distinguished Frenchmen came forward to rebut these accusations against Newton, especially M. Leverrier and M. Prosper Faugère, the latter of whom had in 1844 published in full the *Pensées* of Pascal; he demonstrated the want of scientific probability, inasmuch as Pascal had barely been convinced of the motion of the earth, and as one well qualified to judge of Pascal's handwriting, he pointed out the entire dissimilarity. Although this subject has been entirely dropped in England, it has been again and again mooted in France, and in its Institute, where M. Chasles still continued his singular refusal to give up the source of these documents, his belief in which was the only hold they had over the French mind. The conclusion of this story is now a matter of history. M. Chasles at last consented to disclose the name of the man from whom he had received the Pascal-Newton papers; and, as it now appears, of a large number of other MSS. of ancient personages of note,—amongst them Columbus, Joan of Arc, Petrarch, Charlemagne, Julius Cæsar, etc., etc., for which he had paid the enormous sum of £6000. The police watched this unfortunate individual, whose chief haunt turned out to be the Imperial Libraries, his chief occupation copying old MS., and the chief furniture in his room chemical compounds and brown and yellow dyes! He

made confession of his guilt, and is in prison awaiting his trial. And so ends this singular episode which caused much pain to Brewster, who to the very last was peculiarly one whose life was instinct with—

> "... the conscious nerve
> Within the human breast,
> That from the rash and careless hand
> Shrinks and retires distrest.
>
> The pressure rude, the touch severe,
> Will raise within the mind
> A nameless thrill, a secret tear,
> A torture undefined."

But it is pleasant to remember that he went straight from this controversy into the gathering Silences, from whose cool calm shades came the whisper, "I die at peace with all the world."