

BIOGRAPHICAL MEMOIR

OF

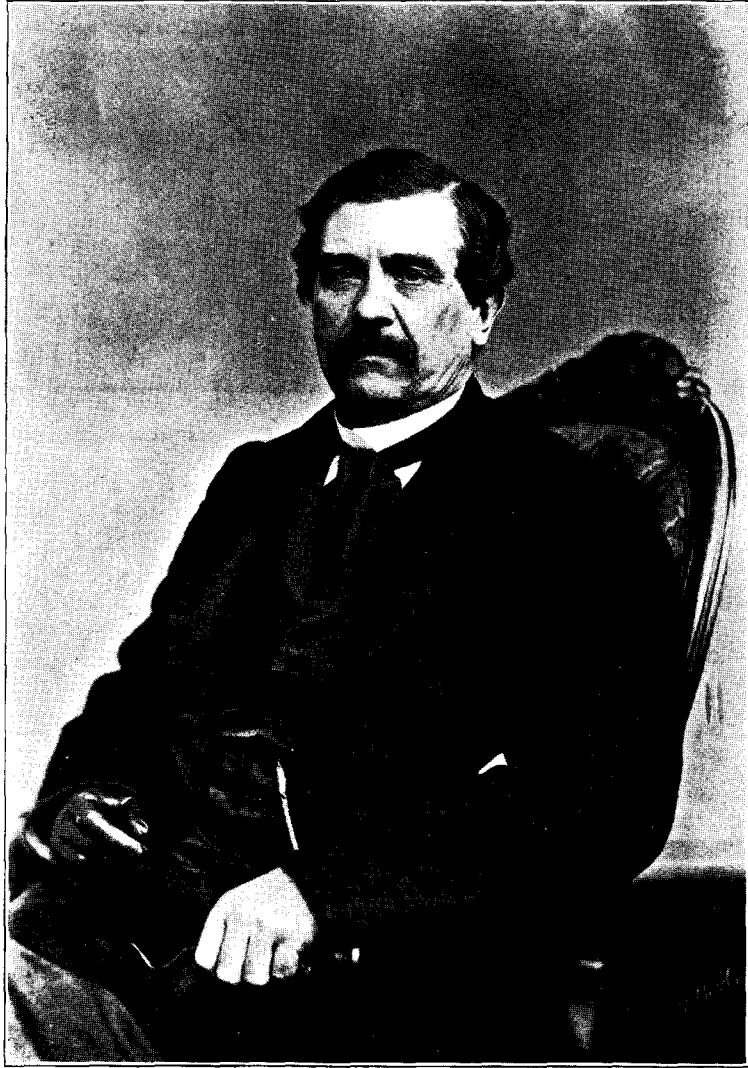
ROBERT EMPIE ROGERS,

1813-1884.

BY

EDGAR FAHS SMITH.

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R. E. Rogers

BIOGRAPHICAL MEMOIR OF ROBERT EMPIE ROGERS.

In 1798 there landed in Philadelphia, directly from the Emerald Isle, one Patrick Kerr Rogers. He had received, through private tutors, a liberal and broad training. The hope had been entertained by some of his family that he would take orders, which he, however, was unwilling to do because of innate and strong opinions, "not rigidly orthodox;" hence he drifted into commercial pursuits. His appearance in this country was in large measure due to the fact that just prior to the outbreak of the Irish rebellion in May, 1798, he had spread abroad, through newspapers, declarations hostile to his government, and his friends, fearing dire consequences for him, made haste and prevailed upon him to emigrate to a more congenial clime. In 1799 he served as tutor in the college of the University of Pennsylvania, beginning at the same time the study of medicine under the preceptorship of Dr. Benjamin Smith Barton. His medical degree from the University of Pennsylvania was received in June, 1802, and in the city directory for that year it is stated that Rogers lived at 55 Lombard Street, where he had presumably established a home shortly after his marriage to Hannah Blythe, "an intelligent woman, a year older than himself, endowed with a cheerful and affectionate disposition," who had come from Londonderry in 1794.

For ten years this excellent couple continued their home in the City of Brotherly Love. The husband practiced his profession, but devoted much time and energy to public lectures on botany and scientific subjects in general, seeking to popularize them, and it is recorded that at last he gave himself entirely to chemistry, "upon which he delivered, it is supposed, the first complete series of popular lectures ever given in this city (Philadelphia) or in the country." At the close of the year 1812 the family moved to Baltimore, where the father worked zealously on, amid very discouraging circumstances, until 1819, when his ability and efforts were recognized by his selection as the successor of Dr. Robert Hare to the chair of natural philosophy and mathematics in the College of William and Mary. "Dr. Rogers was soon settled in the Brofferton house, on the college

campus, with his wife and four sons. He made all the apparatus required to illustrate his lectures. In this making and mending he was habitually attended by his sons, who thus acquired unusual facility in the use of tools for working wood and metals. He also prepared and printed a syllabus of his course of instruction." His surroundings were most congenial and stimulating. The future looked bright and rich in results, but in the midst of this happiness there came all too soon the grim messenger, claiming for his own the mother, who in the summer of 1820 succumbed to a severe fever, leaving to the care of their father her four boys—James Blythe Rogers, William Barton Rogers, Henry Darwin Rogers, and Robert Empie Rogers—the eldest in his eighteenth year and the youngest in his seventh. So strongly had Rogers and his family entrenched themselves in the hearts of their associates at Williamsburg in the brief space of a year, that the boys became "almost foster children in the families of the professors." A brief interim, during which the ties of affection between father and sons became closer and more profound, and the family circle was again severed—the father, the beloved companion, surrounded by his little band of disconsolate sons, died a victim of malarial fever August 1, 1828, in his fifty-second year.

The gift of Patrick Kerr Rogers and his wife Hannah to the upbuilding and progress of science in America was indeed munificent:

JAMES BLYTHE ROGERS, chemical manufacturer, geologist, teacher (the successor in 1847 of Robert Hare as professor of chemistry in the University of Pennsylvania);

WILLIAM BARTON ROGERS, geologist, a founder and first president of the Massachusetts Institute of Technology;

HENRY DARWIN ROGERS, professor in Dickinson College, in the University of Pennsylvania, geologist of the first Geological Survey of Pennsylvania, professor in the University of Glasgow; and

ROBERT EMPIE ROGERS, who was born on March 29, 1813, in Baltimore.

The latter, the subject of the present sketch, was directed by the father in his early educational efforts, and upon his death this charge was assumed by James and William. It was a labor of love, for "their tastes and pursuits were similar." The

middle name Empie was assumed by Robert "as a lasting token of his grateful appreciation of parental care bestowed upon him at William and Mary College after the death of his mother * * * by the Rev. Dr. Adam P. Empie and his wife."

Growing up, then, as Robert did, under the most favorable influences and assisted in every way by devoted and loyal brothers, inheriting, too, an affectionate disposition, it is not in the least surprising to fall upon lines filled with the tenderness expressed in the following postscript of a letter to his brother William :

"What can be more grateful to an affectionate heart than to find in others a sympathy and reciprocation of the same warm feelings it proffers. How doubly blessed I consider myself when I feel that in my brothers I have found such beings."

After due preparation a life career had, of course, to be chosen. There was uncertainty, as in the case of almost every lad, although it appears that the general opinion among the brothers was that Robert should become a civil engineer, and, acting no doubt in accordance with this wish, he really placed himself with a surveying party; but how long he remained with it is uncertain, for the work proved uncongenial to him and was abandoned; whereupon he wrote to William :

"In a letter to Henry, some time since, I stated, as I have before done to you, that my favorite desire always has been, and I thought always would be, to follow, if possible, in your career, to become an instructor; and as preparatory to some higher station, I thought I should like to have charge of a school, either of my own or become teacher in some flourishing establishment of the kind. Such an occupation, I think, would be a useful schooling for myself, for I conceive that at no time could I learn so fast as when teaching, for then I should be making practical application of what I would be myself acquiring, and while occupied I would have also a portion of time altogether apart to myself to devote in my own way to my own improvement."

Thus he wrote at twenty, and continuing his study of botany, geology, and mineralogy he later began medical studies and became a pupil of Robert Hare, in whose laboratory he worked most diligently till the completion of his course. In March, 1836, he received his medical degree from the University of Pennsylvania. The title of his graduating thesis was "Experi-

ments on the blood, together with some new facts in regard to animal and vegetable structure illustrative of many of the most important phenomena of organic life, among them respiration, animal heat, venous circulation, secretion, and nutrition." It appeared in the "American Journal of the Medical Sciences" (vol. 18, p. 277). It was very fully illustrated by wood cuts of apparatus devised and constructed by the author. Most attention was given the phenomena of respiration. In the course of his discussion he remarked: "Experiment leads one to the belief that all the alkalinity beyond that originally found when blood is fresh is in consequence of the formation of a portion of ammonia. In all instances where I have witnessed an increase of *alkaline* reaction, I have detected the most unequivocal indications of *ammonia*," and then he proceeded to establish conclusive evidence of its elaboration from the blood by decomposition. Again: "I am led to the conclusion that the presence of coloring matter in the blood is always accompanied by that of the saline substances. * * * I am almost induced to believe that there is not in the blood any independent proximate principle whose *exclusive* province is to give color, but that the presence of some salt is essential to this result. * * * The statements of Macaire and Marcet that the *color* of the *coloring* matter of arterial and venous blood differs, and that the former is not so dark as the latter, as it proceeds upon the assumption that they succeeded in insulating the coloring matter, is obviously liable to objection. * * * In some experiments upon venous blood and arterial blood, made with the view of determining the relative amount of saline matter present in the colored washings obtained from the clots of each, I found that the incinerated residuum procured from the arterial clot was always richer in this ingredient than the other." He then considered the gas evolved from blood introduced into a vacuum before it had coagulated. Some supposed it to be carbonic acid, others that it was nitrogen. "My own experiments," he observed, "conducted with all possible precaution, have always failed in detecting this gas (carbonic acid) in venous blood, either during coagulation or subsequently."

In that section of the thesis relating to the action of animal and vegetable tissues we read:

"My first object of attention has been to find whether or not there is a disparity in the rate of passage of gases through dif-

ferent structures. For this purpose four short tubes were chosen, equal in length and diameter. A portion of fresh cuticle recently separated from the *cutis vera* was tied across one end of the first. Over the second was fastened a portion of peritoneum, over the third was a piece of mucous membrane, and over the fourth a very thin section of liver. These tubes being thus prepared and arranged over a mercurial trough, an equal measure of carbonic acid was passed up into each; a glass vessel was inverted over each of the tubes and filled with oxygen six times in volume of the carbonic acid in each tube. The opposite sides of the organic structures were thus in contact with different gaseous atmospheres. A rise of the mercury in each of the tubes was soon perceived, and the rate of movement was seen to be distinctly different in each. At the end of thirty minutes the experiment was suspended, being deemed satisfactory, and the mercury in the several tubes stood nearly as represented in the figure. We here perceive that from the third tube, where the mucous membrane was used, was the largest escape of the contained carbonic acid; a less proportion passed through the cuticle, a less share still through the peritoneum, and the least of all through the section of liver. * * * These inquiries were repeated and extended to other membranes with similar results. * * * As a deduction of the preceding determination, it seemed highly probable that by the use of certain tissues we might effect a separation of a particular gas from a mixture of two or more, so that by varying the tissue we might eliminate any gas at will, performing a species of proximate analysis. To test the truth of such an inference, two tubes were taken, and being bent into a rectangular elbow, one extremity of each was closed by a plate of metal perforated by a small round hole, corresponding to the caliber of the tube. A membrane being placed between the plates, they were then tightly clamped together. Thus arranged, I introduced into the leg of one of the tubes a measure of carbonic acid, a measure of oxygen, and a measure of hydrogen; and four measures of nitrogen were made to enter the other. The tissue employed in the first instance was mucous membrane. In fifteen minutes the mercury stood elevated in the first tube and depressed in the second; and the experiment being stopped, the contents of the latter were examined. It was found that nearly the whole augmentation of volume in this

tube was due to carbonic acid. Cellular tissue was now substituted in place of the mucous membrane, and after a longer time than in the previous case, when a similar change had arisen in the volume of gas in the two tubes, the contents of that tube which previously held the nitrogen were inspected, and were found to consist of some carbonic acid, a still greater proportion of oxygen, and all the nitrogen previously present. These experiments were extended to vegetable tissues * * * and always the general results were analogous to those above in showing a diversity of action according to the particular tissue and gases employed."

This story of the diffusion of gases through membranes naturally suggested an extension of these laws of action to liquids. This was done, and by a unique series of experiments, involving the use of most diverse apparatus, he obtained the most convincing evidence of "the existence of an agency controlling the transmission of certain fluids in preference to others." "Perceiving that in many instances the liquids performed their movements in opposition to gravity, I was curious to ascertain if they would be able to overcome a greater mechanical resistance." The result of his experiments led him to say that "the force of transmission in this case (potassium sulphate) could not have been less than four atmospheres, and we are entitled to conclude that it would have been still greater had the membrane withstood the pressure. * * * The laws of the transmission of fluids through organic structures are exhibited in results which are equivalent to a species of chemical decomposition." He next by use of membranes proceeded to separate gold, silver, and several other metals from their solutions, and was "led irresistibly to attribute an important office to the membrane itself."

The remainder of the investigation is marked by the same leaning toward experimentation, preferring rather that experimental results should guide in deducing his theoretical observations than mere uncertain speculation. This first product of Robert Rogers' venture into the field of investigation shows great manipulative skill and the true spirit of a researcher. Whether the hand of the master, Robert Hare, was in any manner concerned in the progress of the study is not indicated. It seems to be an entirely independent contribution, and well deserved

the recognition it received from the faculty to which it was presented.

The attainment of the doctorate accomplished, it would be but natural to look among those engaged in the practice of medicine to learn how the young physician was progressing away from the academic atmosphere—from the guiding influence of his brothers. Such a search would have failed to discover the doctor where one would imagine him to be, for the practice of his profession was not to his taste. He gave himself wholly to chemistry; so that it was not a surprise to learn that from 1836 to 1842 he served as chemist to the first Geological Survey of Pennsylvania, his brother Henry being the head of that survey. The only independent chemical study conducted in these years by Dr. Rogers related to the analysis of limestones (Journal Franklin Institute, vol. xxv, p. 158), and more especially to the separation of calcium from magnesium. The method adopted was the addition of sulphuric acid followed by alcohol. Martin H. Boyé was associated with him in this work. In March of 1842 he was chosen professor of general and applied chemistry in the University of Virginia. At last he had attained his heart's wish. He could now teach, which he did with signal ability. It was during this period also that investigation in the field of pure chemistry occupied his attention. In 1846, in conjunction with his brother William, he communicated to Silliman's Journal, 1, 428, a "new process for obtaining pure chlorine gas," which consisted in heating potassium bichromate with hydrochloric acid. The reaction was found to be quantitative in its yield of chlorine. It is a method of the text-books of the present day. In the same year the brothers published "On a New Process for obtaining Formic Acid, and on the Preparation of Aldehyde and Acetic Acid by the Use of the Bichromate of Potassa" (Silliman's Journal, vol. 2, 1846, pp. 18-24). The method generally in use at that time for the preparation of formic acid consisted in distilling a mixture of manganese dioxide, dilute sulphuric acid, and starch or sugar. The yield of formic acid by this method was inconsiderable; it was also largely admixed with numerous other products. The substitute offered by the brothers was to introduce into a retort of one quart capacity 800 grains of potassium bichromate and 10 cubic inches of water. The mixture was gently heated. Three hundred

grains of powdered white sugar were then introduced and about one cubic inch of sulphuric acid injected upon the mixture. This addition of acid was made from time to time with care. The yield of formic acid was most satisfactory, and the authors remark: "On comparing this process with that commonly employed we are convinced of its superiority, first, on account of the exemption of the product from SO_2 , and in a great degree from other impurities; second, from the much larger amount of formic acid obtained by it from an equal weight of the oxidizing material, sulphuric acid and starch or sugar; and third, from the ease with which the action is controlled. * * * By the new process, we procure about nine times as much formic acid from the same weight of the three reacting materials, as by that hitherto in use."

In making aldehyde they applied a mixture of bichromate of potash and sulphuric acid upon alcohol. In this use of bichromate they had been anticipated by Kane. Their method of procedure, however, contained many details of value. For instance, they observed: "We found that when alcohol is added in small quantities at a time to a mixture of the bichromate and sulphuric acid the distilled product is almost pure acetic acid, but when sulphuric acid is slowly dropped into a mixture of the salt and alcohol the liquid which passes over contains little else than aldehyde."

The next subject to engage their attention was "On the Volatility of Potassa and Soda and their Carbonates" (Proc. Am. Asso. Adv. Science, 1848). Numerous experiments were made "proving that these materials have a much higher volatility than hitherto recognized by chemists. * * * Reference was made to the bearings of this determination upon chemical analysis, first, as furnishing the means of recognizing the presence of the alkalies and the alkaline earths in mineral substances, such as the feldspars, hornblendes, epidotes, &c.; and, secondly, as indicating the probable large loss of the alkalies of vegetable matters through the intense heat used in converting them into ashes. Allusion was made, also, to the almost entire absence of the alkalies in the ashes of anthracite and other coals as dependent upon the intense heat operating in their combustion, and experiments were adduced to show that the coal, prior to the combustion, contained alkaline matter in a marked quantity.

The volatility of magnesia as compared with lime was spoken of as useful in distinguishing between magnesian and calcareous minerals." They also presented a communication to the American Association (1848) "On the Decomposition of Rocks by Meteoric Water," in which "the fact was stated that only one or two observations have hitherto been made by chemists to test in a direct and conclusive manner the power of water at ordinary temperatures to decompose rocky substances. * * * Experiments were accordingly applied to all the principal crystalline minerals containing alkalis and alkaline earths. They were of two kinds with each specimen, the one with pure distilled water, the other with water charged with carbonic acid." The difference in behavior was shown to be capable of furnishing a useful auxiliary means of extemporaneous qualitative analysis. "Experiments were also cited disproving the opinion, which appears to be received among chemists, that the feldspars, hornblendes, &c., are entirely unacted upon by sulphuric or hydrochloric acids." Evidence was adduced (Proc. Am. Asso., p. 95, 1848) that magnesium carbonate is more soluble than calcium carbonate in water impregnated with carbon dioxide.

In Silliman's Journal, volume 5, page 352, 1848, under the title "New Method of Determining the Carbon in Native and Artificial Graphites," the brothers allude to the difficulty usually encountered in oxidizing native graphite and the graphite in cast iron, and then proceed to say that their new method gave uniform and accurate results; hence they regarded it as worthy of the attention of analytical chemists. They say: "As a means of comparing the purity of the different varieties of native graphite we have found it entirely satisfactory. As applied to the still more important purpose of determining the entire amount of carbon in the several kinds of iron and steel, our experiments have not yet been sufficiently numerous to enable us to announce confidently upon its accuracy, but we are not without hopes of making it available also for this object." The oxidizing mixture in the method consisted of potassium bichromate and sulphuric acid. The apparatus used by the brothers was singularly like that used today in the wet determination of carbon. The communication is instructive and suggestive. It evinces thought and nicety in analysis.

At the time when these studies were being conducted it was customary in analyzing the diamond to burn the "gem either in the open air, in oxygen gas, or in some substances rich in oxygen, as nitrate of potassa." High temperatures were also required. Their experience with graphite induced the brothers to extend the same treatment to this more precious form of carbon, with the result, in their language, "that the diamond may be converted into carbonic acid in the liquid way and at a moderate heat by the reaction of a mixture of bichromate of potassa and sulphuric acid—in other words, by the oxidating power of chromic acid" (*Am. Jour. Sci. and Arts*, vol. 6, p. 110, 1848). The apparatus was almost identical with that used in the analysis of graphite, but precautions were necessary "to correct a slight error arising from the evolution of a minute amount of carbonic acid from the bichromate and sulphuric acid caused by the presence of a trace of organic matter or of carbonate in the former."

Another topic of extreme interest to our investigators was the absorption of carbonic acid by various liquids. The results were embodied in communications to the *American Journal of Science and Arts*, volume 5, page 114; volume 6, page 96, and *Proceedings of the American Association for the Advancement of Science*, 1850, page 298. The conclusions were, briefly, these: Thirty-three substances, including acids and salts, were tested as to their absorptive power. Among the results of interest may be noted "that sulphuric acid of the ordinary density absorbs at 60 degrees, under common pressure, about 94 per cent of its volume of carbon dioxide and Nordhausen sulphuric acid 125, the absorption by pure water at the same temperature and pressure being 98." The authors comment on what takes place by virtue of the absorption of this large volume of gas to what occurs in the drying apartment of the apparatus of Will and Fresenius. They declare that in using this instrument an error of from 3 to 4 per cent might readily arise. They enter like objections to processes of determining carbon dioxide as used by Boussingault and Lewy, Le Blanc, Orfila, and others. The absorption of carbonic acid by water was made for temperatures ranging from 32 degrees to 100 degrees "and a curve constructed representing the law of absorption as dependent on temperature." This was believed by the investigators to be a pioneer study upon the influence of temperature on gas absorption.

A problem confronting analysts of their day in examining mineral waters was the determination of the sulphur content present in many of the waters in the form of hydrogen sulphide, and a sulphide either of an alkali metal or of magnesium or calcium. The brothers had experienced difficulties in this problem. They gave it thought and then said:

"Suppose the mineral water to contain free hydrosulphuric acid, together with sulphides, say of potassium and magnesium, we may proceed as follows:"

1. Determine the total sulphur for a given volume of water by precipitation with cupric chloride or silver nitrate.

2. Conduct hydrogen gas (carefully purified) through an equal volume of water, and then pass the mixed gases into a silver nitrate or arsenious solution. The precipitate will contain the sulphur of the free hydrosulphuric acid in the mineral water.

3. Heat the flask containing the water through which hydrogen is passed, so that its contents boil gently. Supply the upper space of the flask with a strong stream of hydrogen. Under the boiling point the hydrogen which issues will contain no hydrogen sulphide, but when the liquid boils, the stream of vapor and hydrogen will show the presence of this substance, evolved by the decomposition of the sulphide of magnesium or calcium.

4. The only sulphur compound left in the water is the alkaline sulphide. Therefore add to its solution copper chloride or an arsenious compound. "The sum of this and the sulphur of the free hydrosulphuric acid subtracted from the total quantity of sulphur will give that of the sulphide of magnesium."

Carbonic acid was found to expel hydrogen sulphide much more rapidly than hydrogen. "Twenty-five cubic inches of Blue Lick (Ky.) water contained in a narrow-necked bottle were subjected to the washing action of a brisk stream of carbonic acid gas, previously purified by transmission through water. * * * In twenty minutes not a vestige of hydrosulphuric acid could be detected." Our authors therefore recommended this course when the mineral water was known to contain hydrogen sulphide only in the free state, for carbonic acid was capable of decomposing the sulphide present in such a water.

The details of the many experiments were incorporated in a communication to Silliman's Journal, volume 18, page 213, under

the title "On the Use of Hydrogen Gas and Carbonic Acid Gas, to displace the Sulphuretted Hydrogen in the Analysis of Mineral Waters, &c."

At the session of the American Association for the Advancement of Science held in 1848, Dr. Rogers with his brother James contributed a paper entitled "On the alleged Insolubility of Copper in Hydrochloric Acid, with an Examination of Fuchs' Method for analyzing Iron Ores, Metallic Iron, &c.," in which it was demonstrated, *contrary to the general view, that copper would dissolve in the acid in the absence of oxygen.* The solution took place in the presence of hydrogen and also in carbonic acid. The metal dissolved in marked quantity to cupric chloride. There is no evidence of the freedom of the gases employed from air. It was assumed.

It was in conjunction with James that Dr. Robert Rogers compiled from the works of Turner and Gregory a volume designed to be a text-book on chemistry. It appeared in 1846. It included both inorganic and organic chemistry.

The time given to the laboratory, to his literary work, and to teaching made the period of Dr. Rogers' service in the University of Virginia truly most active. It must, too, have been most congenial, working as he did, now with one and then with another of his brothers, upon problems alike interesting to all. In studying the publications to which reference has been made in the preceding paragraphs one can not well determine the special work of each brother. Their problems were very probably the subject of frequent discussion among themselves, and the suggestions of one became the property of all. As another writer has so beautifully remarked, "Each followed his routine course, but often they engaged jointly in one investigation, so that the public sometimes confounded their labors and gave credit to one which truly belonged to another. Their works were frequently mentioned at home and abroad as of 'the brothers Rogers,' and always in respectful and kindly terms. Mistakes of the sort never disturbed the perfect harmony that always existed between them, as they might have done had the brothers been rivals or competitors for reputation."

This most interesting group of brothers, working thus in the spirit of the father, with the affection for one another inherited from the mother, received its first shock in the way of dissolu-

tion in 1852, when James, then professor of chemistry in the University of Pennsylvania, closed his eyes upon the scenes of this world. But his work was to be transmitted to a brother, for in August of that same year Robert was chosen to fill his place, and a few years later (1856) became the dean of the medical faculty. The entrance into this broader field brought to Dr. Rogers a greater variety of opportunities for the display of his mental powers. The most diverse problems presented themselves for solution.

In 1855 he gave to his students and the public his American edition of Lehmann's monumental work on Physiological Chemistry. In the years immediately following he was engaged in expert work of various kinds, in executing the trusts of the various societies with which he was a member, and in caring for the many duties which devolved upon him as an assistant surgeon in the Military Hospital (1863), where he sustained the loss of his right hand while showing to a woman the dangers which beset her in feeding a steam mangle. He speedily learned, however, "to write with his left hand and to use the right arm, beneath the shoulder, in prehension with notable skill in his experiments while lecturing." A deeper sorrow came to him about this time through the death of his wife, Fanny Montgomery, who had been for twenty years his true helpmate.

His venture into petroleum speculations in 1864 cost him great pecuniary losses. In 1872 he was called to render public service, being appointed, together with Dr. H. R. Linderman, to investigate the waste of silver in the mint of Philadelphia. It became necessary in this work to improve old and devise new methods of refining precious metals. Many of these were later adopted with profit. In the report of the Director of the Mint for 1875 that official in writing of the mint of San Francisco proceeds:

"The arranging of the plan of the refinery and its equipment was intrusted to Robert E. Rogers, professor of chemistry in the University of Pennsylvania, whose eminent qualifications as a chemist and metallurgist rendered him peculiarly qualified for this service, and who performed the duty assigned him in an entirely satisfactory manner."

His report upon the consolidated Virginia and California mine in Nevada entailed much perplexing study until he was enabled to give a fair estimate of its value.

While these and other claims occupied much of his time he was more or less active in opposing certain proposed movements of the trustees of the university, begun not long after the removal of that institution to the west of the Schuylkill River. The old medical curriculum covered two years. Now it was proposed to lengthen the course. It was not done at once. Much discussion prevailed. The trustees also maintained that the division of students' fees should be abolished, and that the professors should be the recipients of stated salaries, regardless of the numbers in attendance. There was more or less discontent, and Dr. Rogers, after serving for a period of a quarter of a century, quietly accepted in 1877 an election to a similar chair in Jefferson Medical College, where he was most cordially welcomed by a great class of medical students. This position he held until 1884, when he became emeritus professor, but died shortly after, in the same year, September 6, aged nearly 72 years. His second wife, Delia Saunders, whom he married in 1866, had passed away in 1883.

In 1837 Dr. Rogers became a member of the Academy of Natural Sciences and was most active in its affairs. He participated in the organization of the Association of American Geologists and Naturalists in 1840, which in 1847 changed its name to the American Association for the Advancement of Science. He was also a member of the American Medical Association (1852); the American Philosophical Society (1855), being in regular attendance at its sessions and serving in the council; of the College of Physicians (1857); chemist to the gas trust of Philadelphia from 1872-1884; member of the annual Assay Commission (United States) from 1874-1879, both years included; member of the Franklin Institute, and its president from 1875-1879. He was active on the committee which reported (1878) to the institute on the efficiency of dynamo machines and the dangers of electric lighting (1881).

In addition to his scientific investigations, his literary contributions, membership in various scientific organizations, all indicating a man of ability, Dr. Rogers was also "author of many inventions, notable among them the Rogers and Black steam boiler, and of several modifications and improvements of electric apparatus."

ROBERT EMPIE ROGERS.

To some of these the following letter, addressed to Dr. Persifor Frazer, no doubt refers :

UNIVERSITY OF PENNSYLVANIA,
MEDICAL DEPARTMENT,
PHILADELPHIA, *August 10, 1872.*

MY DEAR SIR : Owing to my absence from the city at intervals and your letter of —— having been forwarded after me, it has been delayed in coming to hand.

In reply to your inquiry in reference to having constructed a battery upon the plan I described at the American Philosophical Society, I would say that under any other circumstances I should not only not object, but, on the contrary, be much gratified to see you in possession of one in good working condition. If, however, it will not put you to inconvenience to delay a little in ordering it, I would prefer that you would do so that I may have an opportunity of publishing its construction in one of the journals.

You are aware that the fire in Jayne's building on Dock Street destroyed much of the material going through the press for the Philosophical Society. My own recent contributions were among those consumed, and unfortunately, not suspecting such an accident, I failed to preserve any copy of the one in question. I shall therefore be compelled to make fresh drawings and rewrite the article, which I shall do so soon as I can get through with the press of work now upon me.

Were an instrument-maker to furnish you the battery in the present posture of things, he might perhaps consider it so much his own construction, and possibly give to it publicity, which, among scientific men, would not be regarded as doing justice to the originator.

Feeling quite assured that you appreciate my motive in suggesting a delay in ordering the apparatus, I am,

Yours very truly,

R. E. ROGERS.

In 1883 Dickinson College (Pennsylvania) bestowed upon him its honorary degree of Doctor of Laws.

He was one of the original members of the National Academy of Sciences.

Dr. Rogers was popular among men. He was considerate of others. He had an intense interest in the welfare of his fellow-beings, and throughout his life always "had several decent poor people, old or enfeebled, depending upon his bounty, whom he cheered by familiar counsels and substantial gifts—little stipends to eke out their meager earnings." He was a man of courage,

ever ready to serve in any emergency, and it is no little matter to know that three times in his life he rescued, at imminent peril to himself, from certain death persons wholly unknown to him. Two of these were snatched from a watery grave at Long Branch.

As a teacher he was beloved by his students. His lecture-room was always crowded. His gift of diction and his dexterity in experiment were very superior attractions, and, what is more, he constantly manifested a deep, sincere, personal interest in the every-day life and conduct of those whom he taught.

What another has said of the brothers Rogers may well conclude this sketch :

“ Few have wrought more acceptably or more usefully.”

“ Who kindly shows a wanderer his way,
Lights, as it were, his torch from his own torch—
In kindling others' light, no less he shines.”

BIBLIOGRAPHY OF R. E. ROGERS.

1. On the Alleged Insolubility of Copper in Hydrochloric Acid, etc. *Am. Jour. Sci. and Arts*, second series, vol. vi (1848), p. 395.
2. On the Absorption of Carbonic Acid Gas by Sulphuric Acid. *Chem. Gazette*, vol. vi, p. 477.
3. On the Volatility of Potassa and Soda and their Carbonates. *Proc. Am. Assoc. Adv. of Sci.* (1848), p. 36.
4. On the Decomposition of Rocks by Meteoric Agents, etc. *Am. Jour. Sci. and Arts*, second series, vol. v, p. 401.
5. On the Absorption of Carbonic Acid by Liebig's Dilute Solution of Phosphate of Soda. *Proc. Am. Assoc. Adv. of Sci.* (1848), p. 62.
6. On the Comparative Solubility of Carbonate of Lime, etc. *Proc. Am. Assoc. Adv. of Sci.* (1848), p. 95.
7. On the Absorption of Carbonic Acid by Acids and Saline Substances. *Proc. Am. Assoc. Adv. of Sci.* (1850), p. 298.
8. Experiments on the Blood, etc. *Am. Jour. Med. Sci.*, vol. xviii, p. 277.
9. On a New Process for Obtaining Pure Chlorine Gas. *Am. Jour. Sci. and Arts*, second series, vol. i (1846), p. 428.
10. Report on the Consolidated Virginia and California Mines. In *Annual Report of the Director of the Mint* (1875), p. 81.
11. Report on the Equipment of the New Refinery in the Mint at San Francisco. *Annual Report of the Director of the Mint* (1875), p. 83.
12. On a New Process for Obtaining Formic Acid, etc. *Am. Jour. Sci. and Arts*, second series, vol. ii (1846), p. 18.
13. On a New Process for Analyzing Graphite, etc. *Am. Jour. Sci. and Arts*, second series, vol. v (1848), p. 352.
14. Oxidation of the Diamond in the Liquid Way. *Am. Jour. Sci. and Arts*, second series, vol. vi (1848), p. 110.
15. On the Decomposition and Partial Solution of Minerals, etc., by Pure Water. *Am. Jour. Sci. and Arts*, second series, vol. v (1848), p. 401.
16. On the Use of Hydrogen Gas to Displace Sulphuretted Hydrogen in the Analysis of Mineral Waters. *Am. Jour. Sci. and Arts*, second series, vol. xviii (1854), p. 213.
17. On the Analysis of Limestones, etc. *Jour. Franklin Inst.*, vol. xxv (1840), p. 158.
18. Report upon the Wastage of Silver Bullion, etc. *Gov. Printing Office*, 1872.
19. Report on Dynamo-electric Machines. *Jour. Franklin Inst.*, third series, vol. lxxv (1878), p. 289.
20. Report of the Committee on the Precautions to be Taken to Obviate the Dangers of Electric Lighting. *Jour. Franklin Inst.*, third series, vol. lxxxii (1881), p. 401.