WILLIAM FERREL.

The National Academy of Sciences has met with serious losses since its April meeting in Washington. Its deliberations had scarcely terminated when the news of the death of John Le Conte, who for so many years filled the chair of physics in the University of California, was announced. Also in the last days of April Joseph Leidy, the distinguished biologist and president of the Philadelphia Academy of Natural Sciences, passed away. The long illness of Julius G. Hilgard, who from 1845 till 1885 was connected with the U. S. Coast Survey in many capacities, including that of superintendent, terminated fatally on May 8, and now the Academy mourns the loss of William Ferrel, who has long been one of its most eminent members.

William Ferrel was born of humble parentage in Bedford (now Fulton) County, Pa., on January 29, 1817. The facilities for education were inferior in those days and were confined mostly to winter schools in log cabins. But such as they were, young Ferrel made the most of them until, at the age of fourteen, he "had mastered everything taught then in the schools of the country, and so my school education ended."*

Meanwhile, at the age of twelve, he removed with his parents into Berkeley County, now West Virginia, which, though only fifteen miles from his birthplace, was entirely across the State of Maryland, as at that point it was only two miles wide. Here he continued to aid his parents in the work on the farm, but did not neglect his books, for he continued to read and study everything that came into his hands, which, however, were very few.

Of his early fondness for science he has left a distinct account, and he says, "On the morning of July 29, 1832, as I was going to the field to work, I observed that the sun was eclipsed. I was not aware that there was to be an eclipse, and I had never read or thought on anything pertaining to astronomy." The eclipse excited an interest in such matters, and he at once began to study its cause. The only available text books on the subject were a copy of Adam's Geography, with an appendix containing various problems to be solved by means of globes, and a series of almanacs extending back for several years. From the latter he studied the motions of the sun and moon, and discovered that, although the motions of the moon are very irregular, they repeat themselves somewhat in each cycle of 15 revolutions of the moon and about 42 degrees, and that counting from any previous conjunction or opposition of the sun and moon, there is another conjunction or opposition occurring very nearly at the end of the time of the preceding cycle. Hence, by reckoning from some previous conjunction or opposition, he knew approximately the place of the moon at the end of the cycle, and so very nearly at the time of any new or full moon or time of any eclipse.

By similar means he determined the sun's place, and by applying the information he worked out he was able to predict future eclipses, so that at the age of sixteen he ventured to predict and put upon record the times and other circumstances of three eclipses for the year 1832. Concerning which he writes, "the greatest error in the times, according to the next almanac, when it appeared, was only nine minutes."

A year later he tried to procure a trigonometry, but on making inquiry for one was given a treatise on surveying, which he studied "mostly during winter evenings, by the light of a dim candle or the blaze of light wood, and mastered it very nearly all in about three months."

He was successful in obtaining a few other text books on mathematics, which he carefully studied until, at the age of twenty-two, having made a little money by teaching, and having the promise of some aid from his father, he entered Marshall, now Marshall and Franklin, College. For two years he continued at college, but at the close of 1841, no longer willing to burden his friends with the expense of his education, he left, and taught in Virginia. After several years' experience in this occupation, he entered Bethany College, and was graduated there in 1844.

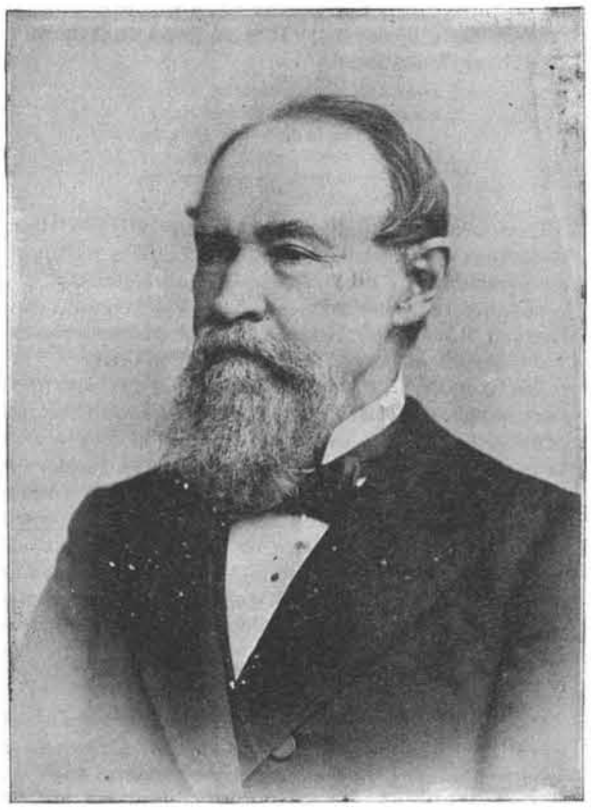
Resuming his vocation as a teacher, he settled in Liberty, Mo., near where Kansas City now is, and also devoted much of his time to study, especially in the higher branches of mathematics. From Liberty he went to Nashville, Tenn., where he taught for several years in a commercial college, and at the same time studied the works of Newton, La Place, and such books as Maury's "Physical Geography of the Sea" and Mrs. Sommerville's "Physical Geography."

He had now acquired a sufficient fund of knowledge to impart his ideas to others, and in 1856 he published in the Nashville *Journal of Medicine and Surgery* a popular essay on the "Winds and Currents of the Ocean," and later contributed to Dr. Benjamin A. Gould's *Astronomical Journal*, then issued in Cambridge, Mass. These led to his acquaintance with men of science, and early in 1857 he received an appointment as assistant in the office of the *American Ephemeris and Nautical Almanac*, then published in Cambridge, under the supervision of Professor Joseph Winlock. This place he held for ten years.

When Benjamin Peirce was called to succeed Alexander Dallas Bache as superintendent of the United States Coast Survey in 1867, he invited Professor Ferrel to accept an appointment in that service, with special charge of the consideration and discussion of tidal relations. In the annual report of the survey for 1874 there was published his "Tidal Researches," and subsequently in the annual volumes appeared contributions on this specialty by him. During his connection with the Coast Survey he invented a maxima and minima tide-predicting machine, which was constructed at a cost of $2,500, of which a full description is given in Appendix 10 of the "Report of the United States Coast and Geodetic Survey" for the year 1883.

In 1882 he was invited to accept an office in the United States Signal Service as professor of meteorology, which place he then continued to hold until October, 1886, when he resigned, to devote his entire attention to his private researches. While in the Signal Service he prepared a volume of 440 pages, entitled "On the Recent Advances in Meteorology," which is used as a text book in signal service schools and as a hand book in the office of the chief signal officer. It is said to be "a work of rare ability, and for a good while to come will be the chief authority at Washington in theoretical meteorology."

His leisure after retiring from government service was spent in the preparation of "A Popular Treatise on the Winds," which was published in New York during 1889. It is a volume of some 500 pages, and



THE LATE WILLIAM FERREL.

added materially to his reputation. A reviewer, in writing of him, says: "It places the author in company with Professor Peirce and a few others in this country on the plane still occupied by La Place in France and Europe."

There is not space in which to refer to the theories and newly discovered laws of Professor Ferrel in regard to the winds, tides and currents of the ocean. Such discussion belongs more properly to more strictly technical journals than this, but we are sure that the progress which he has inaugurated in the science of the ocean and of our atmosphere will prove to be both enduring and substantial.

His professional papers are more than fifty in number, and include, besides those published in the official reports of the departments with which he was connected, special contributions to the *American Journal of Science*, *Van Nostrand's Engineering Magazine*, *Science* and similar journals, and also to the transactions of various scientific bodies of which he was a member.

Among the more important titles of his papers are: "Motions of Fluids and Solids Relative to the Earth's Surface" (1859); "Determinations of the Moon's Mass from Tidal Observations" (1871); "Converging Series expressing the Ratio between the Diameter and the Circumference of a Circle" (1871); "Meteorological Researches. Part I. On the Mechanics and the General Motions of the Atmosphere" (1877); Part II. "On Cyclones, Tornadoes, and Waterspouts" (1880); Part III. "On Barometric Hypsometry and the Reduction of the Barometer to Sea Level" (1882); and "Temperature of the Atmosphere and the Earth's Surface" (1884).

Besides the degree of A. M., he had received the honorary conferment of that of doctor of philosophy. He was an honorary member of the Austrian, English, and German Meteorological Societies and an associate fellow of the American Academy of Arts and Sciences. In 1868 he was chosen to the National Academy of Sciences, and as at that time the membership was restricted to fifty persons, the honor was a most valuable one.

Professor Ferrel was never married, and made his home with relatives and friends in Kansas City, Mo., and there, at the ripe age of seventy-four, on September 18, 1891, he passed away. M. B.

*Personal letter to the writer.

The Clark University, Worcester, Mass.

One of the leading courses of study is that of original research relating to psychology. Moreover, this university is presided over by one of our own members as president, and another as trustee. It has a *Psychological Journal* of its own, which certainly is an honor to its founder, to ourselves, and to our specialty in this country. Here then, within our own ranks, there exist the very means by which we may anticipate a larger measure of progress in psychology, and incidentally also in psychiatry, than would be probable if sought in almost any other way.

Here can be trained a class of students for original investigation and experimental research in accordance with the strict requirements of science. Here are already, or hereafter are likely to be, gathered the requisite means of such research, in the way of special journals and books from the centers of the medical world; also laboratories, experimental and chemical, with their various needful appliances, together with facilities for ascertaining the physiological effects of drugs.

Already there are established scholarships by means of which a higher attainment in all that may conduce toward a more differentiated knowledge of comparative and human anatomy and physiology may be had. Pathological research may also be prosecuted under conditions which can be had only in thoroughly equipped laboratories; studies relating to those physiological changes which occur in the sensory system during the different seasons of the year, day and night, morning, noon, and evening; tests in the capacity of endurance in motor and psychic centers of the brain; the length of time required by different portions of the nervous and muscular systems to energize and to expend their store of energy; the rapidity of movement in the nervous system attending the physiological elements of sight, hearing, and general sensation; the periods requisite for peripheral irritations to pass through the afferent nerves to the sensory ganglia, thence to the cortex, and again through the efferent nerves, eventuating in motion or speech; a study of the anatomical arrangements of all the organs of the special senses, and their co-ordinating activities in connection with sensation, ideation, and motion; in short, all those physiological activities which are associated in the formation and exhibition of thought.

I hardly need to suggest that the stimulus of such investigations, such a library, laboratories, instruments, and opportunities for study, will tend greatly to enlarge the boundaries of our specialty beyond our present vision. It will lift the status and broaden the culture of our association.

It indicates the possibility of passing beyond the routine of that care and anxiety which ever attends the practical management of the insane into a higher sphere of research relating to the nature and treatment of their maladies. Here may be gathered those who, by virtue of their special attainments, may be able to sift the chaff from the wheat, and sit in judgment upon the merits of the work and its results which may be prosecuted by teachers and students in the laboratories. Is it too much to anticipate that in the future such study and experiment will reflect rays of light upon the physiological activities of the brain and nervous system, which will render more clear and definite the indications for scientific treatment?

May we not also anticipate that at no distant date there will be discovered in chemical laboratories some remedy which will act with increased efficiency in modifying and restoring nerve energy?—*H. P. Stearns, M.D.*

Eruptive Geysers.

Bunsen has explained the periodical eruption of geysers in such a satisfactory manner that doubt is no longer possible. A cavern filled with water lies deep in the earth, under the geyser, and the water in this cavern is heated by the earth's internal heat far above 212°, since there is a heavy hydrostatic pressure upon it arising from the weight of water in the passage or natural standpipe that leads from the subterranean chamber to the surface of the earth. After a certain time the temperature of the water below rises, so that steam is given off in spite of the pressure, and the column in the exit tube is gradually forced upward. The release of pressure and the disturbance of the water then cause the contents of the subterranean chamber to flash into steam and expel the contents of the exit pipe violently. These eruptions may also be provoked by throwing stones or clods of turf into the basin of the geyser. The water in the cavern below is disturbed by this means.

Some Electrical Words.

A very fair idea of the rise and progress of a science may be gathered from a study of the technical terms which have been used from time to time to explain the various phenomena or for the purpose of setting forth new theories. Should any one be disposed to make such an attempt in regard to electricity, he will find the material ready to his hand in the recently issued part (E—Every) of the "New English Dictionary on Historical Principles," a monumental work now in course of publication by the Oxford University Press. As there may be some who are unacquainted with this modern "Johnson," it is perhaps necessary to say that it is based, as the title sets forth, on strictly "historical principles." It is true that the definitions are generally in the editor's own words, but they are little more than a summing up of the evidence furnished by quotations from authors of acknowledged repute, and as full references are always given, the reader can verify them for himself and obtain further information if he wishes for it.

The word "electricity" and the various compounds under "electro" occupy more than ten closely printed columns of small type, enough to more than fill an entire number of the *Electrical Engineer*. We do not advocate any radical reform in scientific nomenclature, but it is curious to observe what a vast superstructure has been built upon a foundation which is, logically speaking, utterly insecure. Every text book tells us that "electric" is derived from a Greek word signifying "amber," that substance when rubbed developing electricity. But who thinks of amber in connection with the electrical science of the present day? The modern Latin word seems to have been first used by Gilbert, in 1600, in his treatise "De Magnete," and the earliest instance of its use in English is in Sir Thomas Browne's "Vulgar Errours" (1646). For "electrical" there is an earlier authority in Carpenter's "Geography Delineated" (1635). The editor notices the somewhat arbitrary uses of the words "electric" and "electrical," which are precisely synonymous, although we should not expect to be asked, "Have you bought any electric books lately?" nor do we usually speak of the "electrical light."

Proceeding in alphabetical order we come upon "electricalness," a word we never met with before. The only authority for it is Bailey's Dictionary (1736), but we doubt if the word was ever actually used. We were rather surprised to learn that "electrician" dates as far back as 1751, when we find Franklin saying in the *Philosophical Transactions*, "I have not heard that any of your European electricians have been able to . . . do it"—words which somehow or other have a familiar sound, as if we had heard them only the other day. "Electricity" is a long article, the earliest quotation being again from Sir Thomas Browne's "Vulgar Errours" (1646). The *Philosophical Transactions* furnish many examples, and the editor points out that the term "electric fluid" survives in popular language, and that "positive" and "negative," which we also inherit from Franklin's theory, are still in scientific use.

"Electric light," in its modern restricted sense, makes its first appearance in 1843, as the heading of a paragraph in the *Mechanic's Magazine*, "Electric Light a Substitute for Gas." The *Daily News* is responsible for "a beautiful electric-lighted clock." We come next upon the uncouth word "electricology," which is the title of a work on electricity, written in 1746 by one R. Turner. Bennet, a well known electrician of the last century, is credited with a proposal for "an electrico-meteorological diary." "Electrify" seems to be Franklin's word, and dates from 1747.

The compounds of "electro" number about a hundred, and although we are not disposed to set up as purists, we cannot avoid the observation that many of them are nothing better than base coin. This remark, however, must not be understood as attributing blame to the editor for retaining them. This is no "Dictionnaire de l'Academie" which is to serve as a standard of propriety of language, but it includes everything, whether good, bad or indifferent. Faraday's words are generally referred to their original source, and we should have thought that "electrolysis" was due to him, but Todd's "Cyclopædia of Anatomy" is the earliest authority given. The word is said to have two meanings: (1) chemical decomposition by galvanic action, and (2) the name of a branch of science. This seems to us to be unnecessary. The word "electromagnet" only goes back to 1831, which is the date of a paper in *Silliman's Journal*. "Electro-magnetic" dates from 1823, and "electro-magnetism" from 1828. We have to note some deficiencies here, and Oersted's papers in the *Annals of Philosophy* for October and November, 1820, would have furnished an earlier quotation for "electro-magnetic," while Faraday's "Historical Sketch of Electro-magnetism" in the *Annals* for September, 1821, shows that the word is at least seven years older than stated in the dictionary. It might also have been worth noting that "electro-magnet" meant originally a solenoid, such as the little apparatus known as De la Rive's "floating battery."

As the dictionary takes account of words only, some confusion occasionally arises by reason of the same word being used to denote different things. For instance, under "Electrometer" we have a reference to Lane's apparatus known by this name described in the *Philosophical Transactions* for 1766, where the contriver suggests that his instrument "may not improperly be called an electrometer." Under the same heading there are other quotations which obviously refer to "electroscopes," as we now call them, such as Bennet's gold leaf electroscope. One has to bear this change of name in mind to account for the fact that no authority earlier than 1824 has been found for the word "electroscope."

Under "electro-motive" our contemporary the *Engineer* is quoted in support of the use of this word as a substantive, in the sense of a locomotive engine worked by electricity. This is very sad, and should be rigorously put down along with "electrolier," though we have endured "gaselier" for so long that we fear this last abortion cannot be refused admission into our vocabulary.

The striking character of electrical phenomena seems to have taken firm hold on the popular imagination, and we find accordingly that the technical terms of the science have been largely adopted by general writers in a figurative or metaphorical sense. As early as 1752 Lord Chesterfield writes to his son, "You will not be so agreeably electrified as you were at Manheim." Coleridge (1793) has these lines:

> The electric flash that from the melting eye
> Darts the fond question or the soft reply.

The editors do not often "drop into poetry," or they might have given Clerk Maxwell's poetical rendering of Faraday's discovery. It is so good that it will always bear quotation:

> Around the magnet Faraday
> Is sure that Volta's lightnings play;
> But how to draw them from the wire!
> He takes a lesson from the heart.
> 'Tis when we meet, 'tis when we part,
> Breaks forth th' electric fire!

Here is a striking quotation from Carlyle's "Sartor Resartus:" "Wait a little till the entire nation is in an electric state; till your whole vital electricity . . . is cut into two isolated portions of Positive and Negative; of Money and Hunger." Max Muller speaks of "the electric light of Comparative Philology."

We have by no means exhausted the interest of this part of the dictionary; and those who are in the habit of occasionally thinking of the words they use daily, as they sometimes scrutinize the image and superscription of a current coin, will find much that is suggestive. As we have already remarked, theories now discarded have left their mark on the language of to-day, and it is more than probable that the words we now invent, and which we think are altogether admirable, will in turn become meaningless.—*Elec. Engineer, London.*

The Pressure of Gas in Coal.

Cool in the bituminous mine seams is always more or less subjected to bleeding. This is well known to the practical miner; he is constantly observing the sweating of the coal, accompanied with a hissing sound. The sweating undoubtedly is produced by the pressure of the gas stored up in miniature cavities and fissures of the seam.

The pressure of the gas is a subject of increasing interest; it has been found in some cases to be nearly equal to the pressure of the steam in the boilers of steamships. Pressures of 200 pounds and upward have been found to be common in deep seams newly opened out. What is interesting about the matter is the corelationship of the pressure of the gas to the pressure due to a vertical column of water, measured from the seam to the drainage level of the rocks overlying the seam.

To make this clear, let us suppose a seam to be 250 fathoms from the surface; again, let us suppose the drainage level is about 50 fathoms from the surface. Now by these data we may, with considerable accuracy, calculate the pressure of the gas stored up in the cavities of the seam.

Suppose the seam has not been wrought, but has been pierced by a bore hole. If a long iron tube was inserted in this bore hole and made gas tight, that is to say, made to fit the hole so closely by some system of packing that no gas could escape, and a pressure gauge was screwed on the upper end of this pipe and allowed sufficient time for gas to accumulate in the bore hole, the pressure ultimately observed might first be calculated as follows: Vertical height of water being 200 fathoms, then—

$$\frac{200 \times 6 \times 62{\cdot}5}{144} = 520 \text{ pounds pressure on the square inch.}$$

This calculation might, however, have been made by a simpler process, which we highly recommend: a square inch column of water having a vertical length or rise of 6 feet weighs nearly 2·6 pounds, therefore $200 \times 2{\cdot}6 = 520$, or is equal to a pressure of 520 pounds on the square inch, as before.

Often, as faults and dislocations, water and gas are met with in unusual quantities. Sometimes on cutting a fault, gas is given off, generally at the bottom of the seam, and this gas often consists of sulphureted hydrogen. Water is often met with at faults, and it generally comes off at the fault at the top of the seam, and after the water has expended itself, it is followed by gas, which also consists of sulphureted hydrogen. Now, why gas should be found at the bottom of the seam and water at the top of the seam is a matter full of interest. Water is sometimes given off at the bottom of the seam, and when that is the case, the reason why requires observation and investigation.

Now when water is given off at the bottom of the seam, some cavity in the neighborhood of the fault contains gas at a high pressure, but is situated above another cavity filled with water, so that while the gas is pressing on the water, water flows from the bottom of the seam, through some vent or parting in the fault; but as water is heavier than gas, if the water and gas are found in one cavity in the bottom stratum of rock communicating with the fault or fissure, then gas only is given off, and sometimes at a high pressure. But it will be noticed that after a while the gas is all spent off, and the air in the neighborhood of the fault resumes its normal condition. The gas is expelled by the operation of Boyle's law; it exists in this bottom cavity at a pressure considerably above that of the atmosphere, and if the pressure of the gas in the cavity was three times that of the atmosphere, on that pressure being removed it would expand into three times its original volume, or every cubic foot in the cavity would expand into three cubic feet, two of which would be expelled.

When the water is given off at a fault at the top of the seam, we may certainly expect this water to be followed by gas, because, being lighter than water, it is pent up at a high pressure above it, and the high pressure of the gas causes a rapid or violent outflow of water. Now as the gas cannot sink in the water, being lighter, if the bottom of the cavity communicates with the fault, then no gas will spend off until the water has all been expelled.

These facts correspond with every-day experience, and happy is the man that takes a pleasurable interest in these matters, because it is out of such observations that knowledge and experience are matured, and men are made useful and profitable to themselves and others.—*American Gas Light Journal.*

The Manufacture of Caustic Soda and Chlorine by Electrolysis.

An improvement which has recently been introduced in the production of chlorine gas and caustic soda electrolytically exhibits the following essential features.

The vessel in which the electrolysis takes place is made either of iron or of carbon; in the latter case it is jacketed with an adherent coating of electrolytically deposited copper. This vessel forms the cathode.

The anode consists of a cylinder made of any suitable metal and coated with a layer of carbon; this cylinder is placed in the center of the vessel which forms the cathode.

Between the two electrodes there is a porous diaphragm consisting of a number of V-shaped troughs made of porcelain; these are built up inside each other, and the intermediate spaces are packed with asbestos fiber or powdered steatite. This curious diaphragm is a special feature of the apparatus, and it is stated that it offers much less resistance than does the usual form of porous earthenware. Another advantage claimed for this arrangement is that it prevents the diffusion of the chlorine evolved in the anode section into the caustic soda formed in the cathode section.

The electrolyzing vessels may be arranged together in series or used separately.

The raw material is brine. This is supplied from separate tanks to the anode and cathode of the first vessel when a number are arranged in series, and the brine gravitating along the entire series through the respective sections of the cells flows ultimately into separate catch vessels from whence it is delivered back into the respective tanks.

This circulation is maintained until the solutions are sufficiently decomposed.

The chlorine escapes from the electrolyzing vessel through an outlet pipe, in a porcelain cover, which latter seals the vessel.

There is another combination in which an oblong vessel is divided, by a number of parallel plates (representing the poles) and diaphragms, into anode and cathode sections, through which the respective liquids circulate; but in this arrangement the cathodes are not coated with a layer of carbon.

THE Wheeler Condenser and Engineering Company has recently filed articles of incorporation with the Secretary of State at Trenton, N. J. The company has bought out the entire plant and business of the Colwell Iron Works, of Carteret, N. J., which is one of the largest concerns in this country manufacturing vacuum pans and special machinery for sugar refineries, salt works, condensed milk factories, etc. The Wheeler Company will continue to manufacture Wheeler's patent surface condensers and other of his specialties.