

up an accurate test could be made in a few minutes, the specimens being readily introduced and removed. He further pointed out that the instrument could conveniently be employed as an exceedingly dead-beat galvanometer, as an analyzer of alternate currents, and as a phasemeter.—*Industries.*

[FROM THE ALIENIST AND NEUROLOGIST.]

PLINY EARLE, A.M., M.D.

THE death of this distinguished American alienist, at his home in Northampton, Mass., May 17, severs the last link in the golden chain that bound the American psychiatry of the present to the past—a chain made of such sterling stuff as the Rays, the Brighams, the Butlers, the Galts, the Tylers, and the Stribblings. But one reminder of this golden era remains with us yet in body as well as spirit, the venerable Joseph Workman, of Toronto, and he lives on the other side of that only line which divides American from British alienism—a geographical one. Dr. Earle was the last survivor of the original thirteen founders of the Association of Superintendents of American Asylums for the Insane, now the American Medico-Psychological Association.

Dr. Earle was one of the earlier contributors to this journal and encouraged it and showed his faith in it from its foundation by subscribing for ten years in advance. He was physically and mentally a handsome man, broad of observation, and keen and logical in reason—a style of man of which the profession in general of his native section and American alienism were and are justly proud, and they will venerate his noble memory.

From a biography written by Rev. A. H. Coolidge we glean the following history:

Dr. Pliny Earle was the fourth son of Pliny Earle, the great-grandson of Ralph Earle, who came to Leicester in 1717. His mother was the daughter of William Buffum, of Smithfield, R. I. He was born December 31, 1809, and his childhood was passed in the home of his father, at Mulberry Grove. He was a pupil in Leicester Academy, and afterward in the Friends' School, in Providence, R. I., where he was a teacher in the winter of 1828-29, and also from 1831 to 1835, when he was made principal.

He pursued the study of medicine, first with Dr. Usher Parsons, of Providence, and afterward at the University of Pennsylvania, from which he was graduated with the degree of M.D. in 1837. The next two years were spent in Europe; one in the medical school and the hospitals of Paris and the other in a tour of professional and general observation, "in which he visited various institutions for the insane, from England to Turkey."

The results of these observations were published in 1840, in a pamphlet entitled "A Visit to Thirteen Asylums for the Insane in Europe." He had an office in Philadelphia for a short time, but in the spring of 1840 became resident physician of the Friends' Asylum for the Insane, near Frankford, now a part of Philadelphia. In 1844 he was appointed medical superintendent of the Bloomingdale Asylum for the Insane, in New York City. In 1849 he made another tour in Europe, visiting thirty-four institutions for the insane in England, Belgium, France, and the Germanic countries, and, upon his return, published his book upon "Institutions for the Insane in Prussia, Austria, and Germany." In 1853 he was elected a visiting physician of the New York City Lunatic Asylum on Blackwell's Island.

In 1855 he returned to Leicester for rest and the confirmation of his health, and passed several years on the homestead of his grandfather, Robert Earle, near Mulberry Grove (now called "Earle Ridge"). During this time, however, he spent the winters of 1862-63 and 1863-64 in the care of the insane soldiers of the army and navy, at the Government Hospital for the Insane, near Washington, D. C., of which his former pupil, Dr. Charles H. Nichols, was superintendent. He also wrote for the medical periodicals, and acted as an expert in the trials of several important cases involving the question of insanity before the legal tribunals of Massachusetts and the adjoining States.

Without seeking the position, he was appointed superintendent of the State Lunatic Hospital at Northampton, Mass., July 2, 1864, and held the office twenty-one years and three months, resigning it October 1, 1885. He made that hospital in many respects a model institution for the insane; and its trustees, in the resolutions passed at the time of their acceptance of his resignation, expressed as follows not only their own conviction, but the general judgment with reference to the value of his administration: "In its management he has combined the highest professional skill and acquirement with rare executive ability. By his patient attention to details, by his wisdom and firmness, his absolute fidelity to duty and devotion to the interests of the hospital he has rendered invaluable service to the institution, and to the community which it serves."

They then also expressed the hope that "he will continue to make his home in the institution, that they may continue to profit by his counsels," and they provided that his rooms should always be open and ready for his use. This offer Dr. Earle accepted, although his summers were spent at Mulberry Grove.

The Northampton Hospital had been erected in opposition to a widely prevalent opinion that it was not and never could be needed—an opinion which delayed its construction, made the obtaining of appropriations very difficult, and finally compelled the trustees to put it in operation in a very incomplete condition, internally. The civil war had tended to restrict the price of board for public patients to a very low limit, and in 1864, when Dr. Earle took charge of it, it had never paid its current expenses. He immediately addressed himself to the task of making it not only a first-class curative institution, but a self-supporting one as well. He purchased supplies at wholesale and in open market. He reorganized and reduced to a very complete system all the departments—domestic, economical, financial, and medical—with checks and counterchecks for the detection of loss, or of waste by carelessness, as well as for the exposure of unfaithfulness in the discharge of duty toward the patients, or in other respects. The so-called "moral treatment" of the patients was amplified, made more diversified, and extended over a greater portion of the year than in any other American hospital.

The pecuniary results of this system were the payment of current expenses in the second year, and during the whole period of Dr. Earle's service, the purchase of land at a cost of over twenty-five thousand dollars; the payment for all ordinary repairs, and over one hundred and seventy-three thousand dollars for buildings and other improvements, and an increase in cash assets and provisions and supplies of over forty-three thousand dollars, all of which became, of course, the property of the State, without any assistance from the State. The results, as productive of an improved curative institution, being less tangible, cannot well be illustrated, but as reflected in current public opinion, they were equally successful.

The importance of occupation for the insane was early recognized by Dr. Earle, and it has nowhere in New England been practically applied to a greater extent than at Northampton. As early as 1870 it was estimated that not less than two-thirds of the manual labor necessary to the running of the hospital was performed by patients.

Believing that a large part of the excessive cost of such hospitals as that at Danvers adds nothing to the curative capability of the institutions, Dr. Earle condemned such expenditure as unwise political economy, ostentatious charity and gross injustice to the payer of taxes.

Dr. Earle has been instrumental in introducing important changes in the treatment of the insane. In 1845 he established a school for the patients in the men's department of the Bloomingdale Asylum, and this was continued for two years. As early as 1840, while in the Frankford Asylum, he gave illustrated lectures on physics to the inmates. "This was the first known attempt to address an audience of the insane in any discourse other than a sermon, and has led to that system of entertainments for the patients now considered indispensable in a first-class hospital." At Northampton he gave a great variety of lectures upon miscellaneous subjects. One course of six lectures was upon diseases of the brain which are accompanied with mental disorder.

The average number of patients who attended them was two hundred and fifty-six. "This is the first time," he says in his annual report, "that an audience of insane persons ever listened to a discourse on their own malady." His observation of the effect on the audi-



PLINY EARLE.

ence was not unlike that of other preachers. If the listeners were slow to take the application to themselves, they were quite ready to appropriate it "to their neighbors." He also secured lectures and entertainments from other sources, and provided amusements in which the inmates participated.

Dr. Earle is the author of many papers upon insanity and other subjects, which have been published in the *Journal of Insanity*, the *American Journal of the Medical Sciences*, etc. Some of these have been issued in pamphlet form. He anticipated by many years the valuable treatise of Dr. B. Jay Jeffries, in a paper on "The Inability to Distinguish Colors." His twenty-two reports of the Northampton Hospital are classics in the literature of mental disease. By a combination of causes the public, so far as they knew or cared about the subject, had come to the belief that from seventy-five to ninety per cent. of the insane can be cured at the hospital.

Dr. Earle became convinced of the erroneousness of this belief, and was the first hospital superintendent who combated it. His researches upon the subject extended over a series of years, were embodied in his annual reports, and at length, in 1887, collected and published by the J. B. Lippincott Co., in a book entitled "The Curability of Insanity."

The doctor showed that one cause of the false opinion in regard to curability was the reporting of repeated recoveries of the same person, in paroxysmal insanity. One patient was reported cured six times in one year, another seven times, a third sixteen times in three years, and a fourth forty-six times in the course of her life, and she finally died a raving maniac in one of the hospitals. Judging from the results of the doctor's researches, not one-third of the persons admitted to the Massachusetts insane hospitals have been permanently cured.

Of his work on "The Curability of Insanity," a reviewer writes: "This book may mark an epoch in the literature of insanity, since it has changed the whole front of that literature, and set in motion investigating forces which will carry out its main doctrine into many useful details, upon which the veteran author has not dwelt."

He wrote the article on insanity in the United States census of 1860, and about ninety articles of reviews and bibliographical notices of insane hospital reports and other publications on mental disorders, which ap-

peared in the *American Journal of Medical Science* between the years 1841 and 1870.

In a third visit to Europe, in 1871, he visited forty-six institutions for the insane in Ireland, Austria, Italy, and intervening countries. His several foreign tours gave him opportunity to form the acquaintance and enjoy the hospitality of many professional, philanthropic, and literary people; he was well acquainted with Elizabeth Frye, knew the poet Samuel Rogers, and, at their own homes and tables, met socially the Howitts and Charles Dickens. He also cherished pleasant memories of American missionaries in the Levant fifty years ago; of Rev. Jonas King and other missionaries in Athens; Cephas Pasco, at Patras; Simeon Calhoun and David Temple, of Smyrna; Wm. Goodell, Rev. Mr. Shaffner, and Henry A. Homes, at Constantinople. He received kind attentions from all of them, and the home hospitality of several.

Dr. Earle was one of the original members and founders of the American Medical Association, the Association of Medical Superintendents of American Institutions for the Insane, the New York Academy of Medicine, and the New England Psychological Society, of which last-mentioned association he was the first president. He was also president in the official year 1884-85 of the Association of Superintendents. Besides holding a membership of various medical societies, he was a member of the American Philosophical Society, fellow of the New York College of Physicians and Surgeons, corresponding member of the New York Medico-Legal Society and the Medical Society of Athens, Greece, and honorary member of the British Medico-Psychological Association. In 1853 he delivered an adjunct course of lectures on "Mental Diseases," at the College of Physicians and Surgeons in New York City, and in 1863 he was appointed Professor of Materia Medica and Psychologic Medicine, in the Berkshire Medical Institute, at Pittsfield, Mass.

Insanity had never before been included among the required subjects of instruction in any full professorship at any one of the American medical schools. After the delivery of one course of lectures the doctor resigned his professorship, as he had been called to the superintendency of the Northampton Hospital.

In 1888 he published a large volume on the genealogy of the Earle family, a work of great labor, and a model of its class. From this book many of the dates and material facts of this biography are taken. Dr. Earle, up to his death, held his birthright membership in the Society of Friends.

Dr. Earle's generous and valuable gift to the academy in which he pursued his early studies has been elsewhere noticed. He has never wavered in his attachment to Leicester, and his people claim him as one of her honored sons.

Dr. Earle was often called as an expert in criminal cases. Among them the most important are those of Peck, at Greenfield, Mass.; Eastman & Montgomery, at Northampton, Mass.; Smith, at Springfield; Clark, at New Haven, Conn.; Thurston, at Ithaca, N. Y.; Klein & Russ, in New York City; and Charles J. Guiteau, at Washington, D. C. In the case last mentioned, after an attendance of a week he was obliged, by illness, to withdraw.

"Of trials before the tribunals of civil law in which he has been thus engaged, the most widely known are the Parrish will case and the suit for setting aside the marriage of Mary H. Croes, alias Patterson, both in New York City."

The will case was probably the most important trial of the kind ever adjudicated by an American court.

THE CEREBRO-SPINAL AXIS AS A THERMAL CENTER AND WATER POWER.*

By BENJAMIN WARD RICHARDSON, M.D., F.R.S.

MR. PRESIDENT AND GENTLEMEN:

While I feel very much honored by the presence here to-day of the members of the Medico-Psychological Association of Great Britain and Ireland to listen to a theory from me on the cerebro-spinal system as a thermal center and water power, I am, I confess, not a little anxious respecting the result of my labor. I know I stand before a body of listeners who, from their daily avocation as well as from their accomplished training in mental and physical science, form naturally the most critical audience I could address on the subject to be discussed, and this alone is a cause of grave concern. But there is something more before me. I am about to bring forward an entirely new line of research and observation in so elementary a stage that the simplicity of the thesis itself may, at first sight, seem to imperil its acceptance. I must, therefore, with special emphasis, claim, at the onset, your kindest indulgence.

Profound researches have been made into the anatomy of the cerebro-spinal system, into its microscopical structure, into its chemistry. Endless experiments have been performed in order to discover the functions of its different parts; but I am aware of nothing that has been done toward the study of it as a working mechanism, as a fixed central physical instrument playing its part methodically, according to the physical conditions in which it is placed, apart from the more refined details of function which its delicate and minute structures adapt it to perform in many and marvelous ways.

Preliminary Note.

Before I come to the new work on which I wish particularly to speak to-day, it is necessary to refer to the lines of thought and experiment that have led up to the present labor. Experiment making is a very slow and suggestive process. One new observation often unexpectedly opens up another. Constantly the route toward a certain end which, at first, looks clear enough is found to terminate in a *cul de sac*. Constantly it is necessary to go back altogether. Occasionally a new and promising path is disclosed, and all ends well. I hope, almost against hope, it is so now.

ELECTRICAL RESEARCHES.

Early in my physiological career I sedulously inquired, by experiment, whether the nervous centers

* Lecture delivered to the members of the Medico-Psychological Association, at a meeting of the association held at 25 Manchester Square, on Thursday, November 19, 1891, E. B. Whitecombe, Esq., President, in the chair.

could be charged with electrical energy. I tried to construct out of the animal structures a Leyden jar, and to discharge it in regulated directions by conductors. Some curious experiments were arrived at in this inquiry, by which I learned, after a certain fashion, to charge and discharge from the dead brain. But here came the practical difficulty that to do this some foreign structure had to be introduced into the experiment. To explain more precisely, I could not find any structure or tissue of the body that would serve effectively as an insulating medium. All parts were conductors to some extent.

In these labors I had the invaluable aid and advice of the late Mr. Becker, one of the best mechanical electricians of his day; and he agreed with me that in the animal organism there is no insulation. He constructed for me a battery and resistance measurer, by which I carried on some experiments of dynamic order, but the results were uncertain and unsatisfactory.

THEORY OF A NERVOUS ETHER.

In the end, I came to the conclusion that some other more definite principle must be sought after than what is now called electrical energy in the nervous centers, and it then entered into my mind that there might exist in the nervous matter a refined ethereal body, to which I gave the hypothetical name of *nervous ether*. I devoted many months to the study of this subject, and published the description of my views in the *Medical Times and Gazette* for May 6, 1871. The idea here suggested had much on its side, and many persons of mark looked upon it with favor. It was hypothetical, and yet it had many strong points. I supposed that the assumed gaseous or vaporous substance called ether was a chemical product of low boiling point, diffused through the water of the nervous matter; that at the temperature of the blood it was at considerable tension; that it was easily condensable by cold; that it was soluble in water; that in its gaseous or vaporous state it was a medium by which all vibrations were received and conveyed by the organs of sense from without to the brain; and that the collapse of death was due to the cessation of its production, its condensation and inertia. The field of inquiry in the study of this hypothesis was one of the most laborious I ever trod, and was only relieved of its weariness by the fascination of the pursuit. I tried the absorbing power of the brain for every light chemical body that was likely to answer the probable requirements of a nervous ether. As a result I obtained some curious and useful facts, but I failed in the end to satisfy myself of the existence in the brain of an ethereal substance that would serve the purposes named.

RESEARCHES WITH EXTREME COLD GENERALLY AND LOCALLY APPLIED.

The next line of research was of a different stamp, more practical, and yet broadly suggestive. I made a practical study, as you know, of the common ethers for the production of local anæsthesia by extreme cold. At first this study was applied to the effects of cold on the outer surfaces of the body, and to the sensitive terminations or peripheries of nerves. Here it succeeded well, and I began to extend the study to central nervous matter with remarkable and unexpected results. By subjecting the cerebral mass to such a degree of cold that it underwent congelation, all the voluntary functions of the body were suspended. Precisely as in hibernation, an animal whose cerebral centers were subjected to cold lay in deep sleep, the respiration and the circulation proceeding as before, and sustaining the life. If the process of chilling the cerebral substance were rapidly produced the spinal cord was rendered irritable, and unconscious muscular movements were for a time produced; but if the process were conducted while the rest of the body was exposed, at the same time, to moderate cold, so that the break of function between the brain, medulla, and cord was not too abrupt, the torpor was unattended by extra movement of muscles. In the torpor all communications between the external world and the animal were cut off. In plain terms, the cerebrum ceased, for the time, to be an absorbing center. The great center of the volition, cold and consolidated, would not receive light, would not receive sound, would not respond to pungent vapors. It was in the same dead condition as my own skin frozen at a limited point; it would not receive the impression made through a nerve; it was dead to common sensibility, not to mention pain; it ceased to be able to accept or reflect any vibration whatsoever. The water in its substance was waveless, and, for the moment, dead.

It was remarkable to observe that, although the resistance to absorption of vibrations was so complete that actual death could not have intensified it, there was, if the process were skillfully carried out, no death. The vital acts of circulation and respiration were still in progress, and if the nervous structure were allowed to return to its natural state in so gradual a manner as not to cause abrupt change of structure and injury, the recovery from the dead state was a sure and harmless as well as a painless restoration. In the case of warm-blooded animals, like birds, the artificial hibernation could be maintained for many hours with complete recovery if the temperature were allowed to return, slowly, to the natural state. In the case of cold-blooded animals, frogs, toads, and fish, the brain and spinal cord could be brought to inertia, and held in that condition for much longer periods. In my Croonian lecture to the Royal Society on *Muscular Irritability after Systemic Death*, I showed batrachians inclosed in ice, and exhibited their recovery to perfect life from that extreme condition. In another lecture I exhibited some carp that had been accidentally frozen in the Zoological Gardens during a hard frost. They were frozen so completely through that they were practically dead, but I was able to thaw them so gradually and uniformly that as they relaxed from their rigidity they recommenced to live, and showed, after a short time, no evidence of injury from the temporary death in which they had been held. In these animals the whole of the nervous centers, excepting, perhaps, those immediately connected with the heart, had been brought into inertia by the cold.

Researches with Cold Locally Applied.

The above was the effect of extreme cold extended to the whole of the vital nervous matter; but another

equally singular fact was discovered, namely, that the same effect of cold could be localized, so that parts only of the cerebral or spinal centers could be suspended in function, while other parts were unaffected. Thus when in birds the corpora striata were made to sleep by cold, the cerebellum being left unaffected, excited volition pushed the body forward, while, if the cerebellum were rendered insensitive, the body was carried backward usually with a series of somersaults. These events had their analogies in injuries and diseased conditions of brain in man himself, as in the temporary paralysis of the anterior centers of the brain on looking over a precipice; as in a case where a patient suffering from disease of the corpora striata was impelled to rush forward, careless as to any obstacle or danger that might stand in his way; and as in some conditions of somnambulism, where the impulse to move forward, regardless of consequences, is the dominant impulse; but I dwell now only on the fact that a portion of the brain structure could, it was found, be artificially brought into hibernation by temporary subjection of the affected part to cold, and that recovery would take place by restoration of the natural condition of fluidity. It was not a little astonishing to find how sharp is the line of demarcation between an affected and an unaffected portion of the cerebral matter. In warm-blooded animals the cerebrum, the cerebellum, part of the medulla, and parts of the cord could be rendered hibernate, and be kept so without danger to life, if the respiratory center of the medulla were left free. In cold bloods the whole could be affected without destruction of vitality.

Cold under Freezing Point.

It was ascertained by further experimental inquiry that, in order to produce very decisive effects, it was not necessary to carry the cold to the extent of actual freezing of the nervous matter. When cold was applied to a vascular part like the skin there were brought to view three stages of action: (a) a stage of exaltation of action in which the part was injected with blood; (b) a stage of inertia and insensibility in which the structure was left bloodless, firm, and insensible; (c) a stage during recovery, the cold being withdrawn, in which there was return of vascularity with that temporary exaltation called, usually, reaction. In a modified way the same thing occurred when the cerebrum was subjected to cold. The pia mater was at first injected, but its surface is so delicate, it soon was emptied of its blood, and the cerebral substance underneath it was rendered inactive without any extreme reactive condition. For this reason it was found comparatively easy to induce temporary somnolency and sleep by a process of moderate abstraction of heat. In one experiment I determined that drowsiness ending in sleep began when the temperature was merely reduced 6° Fah. in the nervous mass, and it was this observation that led me to suggest the original theory that ordinary sleep might well be accounted for as due to nothing more than a molecular change of structure in the nervous organization owing to the dissipation of energy from the brain and its subordinate parts during long periods of labor.

Physical Modification of Parts under Cold.

In yet another series of researches on nervous matter, both in its dead and in its living forms, I found that under the inertia induced by cold the passage of electrical currents through it was resisted. I made the muscles in this case play the part of the galvanometer. On an animal anesthetized with chloroform, in the year 1867, the sciatic nerve was exposed, and without dividing it a galvanic current was passed through the exposed portion in the direction of its length. The current was now increased until it caused motion in the muscles supplied by the nerve, attended with a deflection of 40° in the galvanometer then used when the current was closed or broken. The nerve was next chilled by the application of ether spray until it was frozen, whereupon the needle fell back to zero, and the muscular motion failed to be excited. Afterward the observation was varied by freezing the nerve, not between the two points included in the line of the nerve, but at a point above, on the brain side. The muscular motion produced by making and breaking contact was now as completely checked as when the frozen part itself was in the circuit. The facts showed that by changing the molecular condition of nervous structure by cold the same interruption to the course of vibration occurs as when the nervous structure is either firmly compressed or actually divided, but with this essential difference, that the cold produced no more than a temporary suspension of function or sleep, easily recovered from; while the mechanical effects of compression or division were apt to terminate in permanent disability. From still further observation in the same direction, it was found that involuntary muscles, like the diaphragm, could have their work suspended by reduction of the temperature of their supplying nerve in its course toward the center from which it arises, as well as from the interruption at that center itself; but that the inertia was most decisive the nearer the interruption was to the muscle, as if the nerve were, in fact, a mere continuation of the center, and in a minor way were still acting when the center itself was out of action.

From these experiments I was led to see that electrical vibration was an excellent test of the working condition of nervous matter, but in applying it there was always this obstacle: that in using the continuous current decompositions were apt to be set up which falsified results. Here, therefore, I was stopped for a long time. At last, in 1879, I was so fortunate as to become possessed of my friend Professor Hughes' beautiful electric balance as a means of research. Now I had an instrument which measured for me from the secondary coil, and by which I could measure through a scale of two hundred degrees of sound, and establish comparisons from minute variations or conditions of the nervous substance under investigation. I put dead nervous matter, brain or cord, after it had been warmed to its natural temperature in a specially constructed chamber, into the circuit, and noted on the scale the degree of conducting power that was exhibited. I raised the temperature of the structure and tested again; I cooled the structure down to freezing point, testing all the way along at stages of different degrees the conducting power. In the end I obtained results which indicated that the conduction became

modified according to variations of temperature, increasing with rise of temperature and decreasing with fall in steady and distinctive degree. Also, I brought the structures back from the extreme of cold to natural heat and to fever heat with the reverse results, from all which I inferred, I think justly, that no molecular injury was done to them, but that they had passed through the same physical change as the nervous matter of frozen animals in whom there is returnable vitality from what appears to be the absolute inertia of death. The value of the electrical test in this respect could not be overrated; it seemed to me to differentiate between the condition of death and the condition of life as illustrated by the effects of vibrations on animal matter.

INFERENCES LEADING TO NEW OBSERVATION.

From the study of phenomena of research above quoted, I was naturally led to think of the cause of them. It was easy enough to jump at the conclusion that a frozen brain would cease to be an active brain, that a frozen nerve would cease to be an active nerve; it was easy enough after freezing the peripheral surface of nerve, as on the surface of the skin, to say sensibility is destroyed in the part frozen. But this was not satisfactory; it did not explain what the changes effected; it did not account for local manifestations of the particular kind recorded; and it did not explain what parts in the affected nervous structure were modified in character under the process. Here, therefore, I began to inquire anew.

Giving up, for the time, the theory of a nervous ether, I looked at the construction of the nervous substance from a simple mechanical-physical point of view. In the crude form of it there were the three distinct kinds of matter, namely, water, uncoagulated albumen, phosphorized fat. These parts have their own specific attributes under the influence of heat and cold. The water would not go into solidity under cold until freezing point, and then suddenly with expansion. The fat, however, would pass evenly and by degrees from the fluid into the solid state under cold, and back again by degrees into the fluid state under the influence of heat. The albumen in which the vital endowments would be centered would remain at the normal temperature of the animal body, always fluid, and as free from coagulation as it is in the serum of the blood: it would be diffused through the water of the nervous substance as it is diffused through the serum; and of itself it would not be likely to be affected either by the cold or the heat at blood temperature. At the same time it would play an intermediate part as between the water and the fatty substance; it would cause, as in an emulsion, the fat and the water to unite so as to form a homogeneous compound. If, therefore, cold were applied to this mixture, the inference would be that the whole would undergo gradual cooling, and that the necessary effect of the cooling would be to increase solidification step by step without subjecting the water to congelation. The thought threw new light on construction for function. It suggested to me an explanation of the local action of cold. An expanse or surface of water alone would not show physical change of structure until freezing point was reached, and then a considerable surface would solidify from one point. But what would happen if a surface of a compound of fat, albumen, and water were exposed to cold? The experiment was made, and a comparison was struck. A compound as named was exposed to cold, and was found to solidify long before freezing point was approached. Then brain substance, triturated into solution and freed of membranous substance, was tested in the same manner. It responded in a similar way.

Another observation was made. When cooling of the surface of the compound was localized, the solidification was also local, a fact which corresponded with what had already been observed in the brain in its vital state.

To sum up. The position to which I was led ran as follows. The nervous substance is physically constructed of three parts: *water, soluble albumen, phosphorized fat*. The water, which in a certain manner is solidified, is susceptible of more complete solidification by cold, with the capability of restoration by warmth. The albumen, soluble in the water, and capable, like all similar colloids of hydration, to any degree, moves with the water in respect to solubility. The fat, rendered soluble with the water and albumen, solidifies under cold more readily than water, and becomes fluid by heat more readily, carrying the water with it in its change of physical quality, by which means the nervous substance under limited range of temperature varies in the consistency of its matter.

THEORY OF WATER POWER AND TENSION.

And now I come to the later development of reasoning from and on research, to which I desire particularly to draw attention. One day it struck me that the action of the refined nervous ether, about which I had worried myself so much, might all be effected by water changing in tension, expanding under elevation of temperature by oxidation, into vapor, and condensing under reduction of temperature. If this were so, then much indeed would be explained. Then we might be led to look upon the brain and its subordinate parts as an independent thermal center and water power, acting, however complicate their minute anatomy, as water influenced by the mode of motion called heat.

When the thought was opened there was an immense deal to be said in favor of it. A large part of the nervous matter is water. The degree of physical condensation of water in the closed cavity of the skull is most remarkable. Itself resistant to mechanical compression, it is here, in the simplest way, compressed: compressed into a certain solidity without being frozen, and connected with tubular nerves along which it ought to be able to maintain an extending column of nervous fluid into the remotest parts under the mere impulse of central vibration. If this were so, all impulses would be steadily flowing from the brain into the body during times of cerebral and spinal activity, while all vibrations from the external universe would vibrate back, and unless overwhelming in intensity, would sustain vigorous or subdued action according to temperature, as water in a steam engine in varied tension fashions the motion of the engine.

It was very encouraging to read by the light of theory

so much possible natural fact in support of it. It was as if one ignorant of the action of the watch had suddenly found the mainspring, and had felt one's self able from that instant to understand the movement of the hands and the regulation of their courses. Looking now at the central nervous system as a water power inclosed in resistant bounds, so as to be able to exert action under oxidation and the resultant heat, it lay before me as the mainspring of the animal body to which the blood and circulation play an important but, really, subordinate part. To test this view, I passed again to experimental observation, thinking now of water as a motor under various degrees of tension.

I said to myself, if water vapor be the motor under expansion and condensation, it must, after it has served its purpose, be condensed, and this led me to recall an observation which I originally made on the mode of exit of the cerebro-spinal fluid. I found, as detailed in the first number of the *Asclepiad* in 1884, that the escape of that fluid was by the lower extremity of the spinal cavity into the blood by the inferior cava. From this a fact of supreme importance was discerned. It showed the precaution taken by nature to keep every part of the brain and spinal cord in a water condenser, and the interior of the brain in communion by it with the exterior. The cerebro-spinal fluid is the condensed fluid, and is the regulator of the pressure under the varying moods of oxidation incident to variation of vibration.

When the brain and cord are unusually active, when they are receiving vibrations on every side; when, that is to say, the water tension of the centers is at its height, then the amount of condensed cerebro-spinal fluid poured into the veins must be enormous, and may easily and reasonably account for that free action of the kidneys which in hysteria and other kinds of mental excitement is so constantly observed. When, on the other hand, the central tension is reduced, the accumulation of the water in the ventricles and in the arachnoid sac will fill up the void, and by the even pressure it exerts favor quietude and sleep.

I considered this to be one of the best evidences of the truth of the theory of the brain as a water power. If the cerebro-spinal fluid should accumulate in excess there would follow, as I have more than once shown, deep stupor, coma. If it were drawn off in excess, there would be violent mania. The part played by the fluid is, in fact, in the most refined degree regulatory, and is one of the most beautiful and important parts of the cerebro-spinal mechanism. It is the dialyzed effluent fluid of the nervous centers; it is the condensed fluid of the nervous centers; but, in ebb and flow, according to the tension of those centers, it maintains also equality of balance, and almost certainly governs sleep and wakefulness.

This seemed very natural, and made the theory still more clear as a working theory; but I felt that certain other evidences were wanted, which experiment ought to yield, if the theory were correct. Two views occurred to me in this direction:

(1) I reasoned that if water plays the part supposed, then removal of it from nervous tissue ought to have the same effects in regard to vibration as condensing it by cold. That is to say, removal of water ought to reduce conduction in proportion to removal, while removal of fat ought to increase it.

(2) If the theory were true, there must be in the cerebro-spinal axis a steady combustion or oxidation, that stands alone, that is, in a sense, independent, a sovereignty that works the central power by its own mere motion. It also must be a modified as well as steady combustion, and the products of it must be soluble and dialyzable. We ought, therefore, to be able to excite a combustion in nervous matter, even when it is dead.

In order to test the first of these propositions, I followed the same series of inquiries, in regard to electrical vibration after the mere removal of water, as I did when the nervous matter was condensed by cold. Brain, spinal cord, and sections of nerves were subjected to observation under various degrees of hydration. A portion of the substance to be tested was placed in the electric balance, and its conducting power carefully noted. While charged with its water it was placed, at 100° F., in the drying chamber in order to be dried down to complete dryness, and as the process went on the conduction was tested day by day. The conduction was found to decline in proportion as the water disappeared, until, on complete desiccation, conduction ceased altogether. No demonstration can be clearer. It can be carried, so to say, backward and forward. The nervous matter can be dried down to complete inertia, and by exposure to water vapor, which it will readily reabsorb, can be made to resume its full conducting power. The fact explains why in some animals exposed to slow evaporation the nervous system may be brought to such inertia that death itself seems absolute; and yet, on immersing the animals in water, they revive and relive. This is the equivalent to hibernation from the action of cold.

I made an inquiry relating to removal of fatty matter. It was seen that, under cold, the presence of fat in nervous matter modified the action of cold, so that condensation progressed sufficiently to interrupt function before freezing occurred. The fact led me to ask what would be the effect of removing the fat and letting the water remain. The experiment was tested. Portions of nervous matter, brain and cord, were taken in the fresh state from the sheep just killed, and conduction was tested. The sections were placed in ether or in bisulphide of carbon and left until the fatty matter was dissolved out; then, being removed, the test was reapplied, with the result of finding that the conducting power had increased, by removal of the fat, ten degrees. Sections were tested also in intermediate stages with proportionate increase of conduction, according to the removal of fatty substance.

Hitherto I had made electric vibration the test of activity. I moved to the vibration of sound, and here again the telephone and balance came to my assistance. By putting nervous material between the vibratory drum of the telephone and the ear, I was enabled to detect variations under many varying conditions of the nervous material. The results were most important. There is not time to refer to them here in detail, and they are too delicate to be made matter of illustration so that all present could verify them at once; but,

briefly, they showed that absorption of sound by the nervous matter was most perfect when the water was in full, but not extreme, tension, that removal of tension by condensation lessened absorption, and that high tension increased it.

Turning to the second proposition for inquiry, namely, the combustion that is present in the nervous centers, I was helped considerably by a significant fact which I had learned in my earlier experiments on heat and cold. I had found by direct observation that, whatever was the nature of the combustion going on in the nervous centers, it was attended, in all animals, even in birds—in whose bodies what would be the highest fever heat in men is the natural condition—with a much lower development of temperature than in other active organs of the body. A difference of 4° F. was observed between the brain and the liver and 2° between the brain and the arterial blood. Moreover, I had learned in the most singular manner that there is going on in the living brain an actual phosphorescent combustion from oxidation, a combustion that would yield a steady low temperature with soluble products that would easily dialyze and make their way out of the nervous substance both by the blood and by the cerebro-spinal fluid. Whether combustion of carbon takes place in the substance of the brain or cord, with liberation of a gaseous product like carbonic anhydride, remains to be determined; but the oxidation of phosphorus there, with production of dialyzable products, cannot be doubted. It was necessary, therefore, to take this modified oxidation into account, with the surmise that the lower temperature of the brain in its natural state, compared with that of other vascular organs, is from this cause. On this inquiry I have been long, and am still, engaged.

I have carried out the inquiry by taking the dead brain of the sheep divested of its membranes, and rubbing it into pulp or emulsion. The emulsion is phosphorized by the simple process of mixing with it phosphorus dissolved in carbon bisulphide; the bisulphide is rapidly removed by the air pump, leaving the phosphorus in the finest state of distribution in the emulsion. The phosphorized brain mass is now experimented on in divers ways. A mould of albumenized tissue involuted into convolutions is charged with the brain substance, and is then floated on richly oxidized blood—derived from the same slaughtered animal—rendered alkaline with soda, and placed at the temperature natural to that blood. The oxidation is sustained for several hours, the blood being often removed and changed for new blood freshly oxidized. Under the warmth the brain pulp oxidizes, until a slow combustion is established through the whole structure. It yields, during condensation, a fluid analogous to the cerebro-spinal, a gray exterior, where the blood has dipped, and a white central interior mass.

Into these experiments I introduced another line of research. I mixed with the oxidized blood different foreign substances, in order to see if they were accounted for after the exposure to the combustion. Some, like alcohol, were rapidly changed, others, like strychnine, slowly.

I would like to dwell on these experiments and on others similar, but my time is nearly exhausted, and I have yet to glance at the bearings of the theory I have advanced on some of the diseases with which you are most familiar. As preparatory to such application let me, however, in a brief summary place before you the argument of the theory under a few distinct heads.

The Argument.

(1) The cerebro-spinal axis is a static thermal center and a water power—the mainspring of all vital actions. The cerebro-spinal nerves are tubular continuations of the white matter of the centers, producing a fluid responsive to the centers themselves, practically static, and liquid during life, but susceptible, while normal, of receiving and conveying pressures, much in the same manner as the fluid in a barometric tube; susceptible also of rapid condensation on change of condition from the natural state.

(2) In those parts of the centers called gray, where the surface comes in contact with blood charged with oxygen, there is in progress a slow combustion in which phosphorus plays a leading part, maintaining an equally reduced combustion, with the formation of dialyzable saline products. The gray matter, the seat of the combustion, takes its color from the blood, extending to the depth of the blood membrane, dipping into it from its surface, and separated by the convoluted blood membrane into centers, each center possessing its own surface of oxidation and acting as an independent organ. The white matter, on its part, is the great receptive center, supplying combustion material, to the gray centers of combustion, as the stem of the candle supplies the wick, but acting also as the receptive medium of vibration to and from the vibrating nerves. In the combustion of the great centers sufficient heat is developed to bring the whole volume of the centers into proper tension. In the nervous cords the same process is going on, so that under the combustion sustained by the centers the nervous cords, cerebral and spinal, are brought also into natural tension for conveying vibrations from the centers to the peripheries, and from the peripheries back to the centers. The nervous fluid in the nerves is practically static and easily condensed under exposure or injury; but it is most probable that at their peripheral terminations they give up fluid during central pressure, which fluid stimulates muscles into contraction and glands into excretion.

(3) The theory accounts for the grand nervous phenomena of life in their activity during wakefulness, and their repose in sleep. Wakefulness and sleep depend on variations of tension. When the brain is at full, but not too extreme, tension; when the cerebral fire is at full, but not excessive, work, all parts that respond to it are active and wakeful. When the tension is reduced—in other words, when the oxidation wanes—the process of central condensation comes on, with production of cerebro-spinal fluid and phenomena of weariness and sleep, which last until the cerebral fire attains its restoration, tension is restored, and the organic functions subservient to the nervous, including the muscular functions, are brought back to what is called life. The cerebro-spinal system is, in fact, a true water engine, so true that an artificial engine acting on the same principles

could be constructed upon it for the production of motion.

(4) The theory explains the well known effects of varying external pressures and temperatures on the central nervous organism. Atmospheric pressure tells on it through the nervous expanse, as it does, only in a more refined degree, on the mercury or spirit of the barometer. Reduced pressure of moderate degree would give a freer expansion to the centers. High temperature without evaporation would produce enfeebled tension; low temperature, in moderate degree, would favor high tension; but an extremely low tension, sufficient to produce actual solidification of nervous surface, central or circumferential, would produce complete cessation of action, a fact that admits of demonstrable proof, local and general, by the action of cold.

(5) The theory attributes to the cerebro-spinal fluid the most important functions. It declares this fluid to be the condensed fluid of the combustion of the cerebro-spinal axis, the regulator of pressure, and the medium by which many poisonous substances are removed from the blood. Charged and recharged with various foreign substances like alcohol, glucose, urea, chloral, strychnine, it eliminates some directly, others, less decomposable, by repetitions of eliminations marked by paroxysmal seizures.

(6) The cerebro-spinal axis is not merely an absorbing center for the reception of external vibrations, but a true chemical and dialyzing center, and the center of the static combustion, by which under the fluid pressure, regulated by the spinal fluid, the nervous tension is sustained in all parts of the body having nervous communications with it. It is a true physical autonomy.

(7) Under this theory, ganglia are supplementary centers, supplied from the main source. They lie as intermediates between the great centers and the involuntary muscles, feeding the involuntary muscles with nervous stimulus in steady and continuous supply so long as they are steadily supplied themselves, but exciting the muscles, when oversupplied, to overaction. Plexuses, in their turn, are intercommunicating points or meetings of nerves in order to enable vibrations to be carried on should one or more nerves belonging to a plexus fail in function from disease or injury. Decussating fibers are explained as the means by which centers are prevented from becoming independent of each other and losing compensating balance.

(8) If the theory be correct, two distinct combustions exist in the animal body, one the central or nervous combustion, a combustion leading to low tension and pressure, the static combustion; the other that higher combustion of the muscular and active vital organs, the combustion yielding the animal heat which we recognize as the sensible heat of the body, having its own independent and, apparently, more active function; and yet, possibly, dependent for its continuous existence on the slower and central combustion which keeps it alight, and regulates its activity by regulating its supply of blood and, therewith, its oxygen and its combustible material.

PRACTICAL APPLICATIONS OF THE THEORY TO SOME FORMS OF CEREBRO-SPINAL DISEASE.

Under this theory an immense number of explanations of phenomena hitherto unexplained come, I hope, into view with perspicuity. Whatever should quicken or exalt the nervous combustion at the center should quicken the current of impulse along the nervous tracts and excite muscular motion from action to overaction. Whatever should reduce the central oxidation should reduce the nervous currents, and produce sleep, or in extreme degree collapse and inertia, or death. Let there be removed, rapidly, the supply of oxygen carried by the blood, let the brain fire, that is to say, be suddenly put out, as in hemorrhage, and so rapid will be the condensation that for a brief interval, under the pressure, the nervous influx into the muscles will throw them into convulsion and rigidity. Let the brain temperature be raised as in fever, and straightway there must be an excessive nervous excitement, an overflow of nervous current, with quickened action of the involuntary muscular pulsations and direct radiation of the increased heat from the cutaneous surface of the body, the mucous surface of the viscera, and the serous expanses. What is called a chill from exposure of the body to cold or wet is explainable on this theory. The peripheral nervous surface, arrested in radiation, receives a check primarily, followed by a necessary excess of temperature and that fever which always follows sudden arrest of peripheral function.

The phenomena of inflammation, local and general, are also explainable on the theory without any complication or difficulty; but what I would now notice more particularly is the exposition it offers in relation to some forms of cerebral disease.

Reflex Action—Epilepsy.

The phenomenon of reflex nervous action is by it rendered explicable. The impression on the peripheral surface, which gives rise to the reflex movement, after vibrating along the aqueous line up to the center, radiates out at the center, and exciting quicker oxidation there, causes an impulse which produces local central injury with return vibration back by the nerves to be dissipated in the muscle or muscles which the conducting nerves supply. But for this time is required, and therefore the time of the reflex. If the impression be too severe and too universal, there may be no reflex, but an actual injury to the nervous center, a stun, a stroke, or an apoplexy, fatal possibly, or if not followed by a reactive flash of vibrations from the center to great groups of muscles, causing general convulsion. Epileptic seizures, on this argument, may be peripheral in origin, due to an intense vibration sent to the grand centers, temporary increase of vibration there, and radiation back into the muscles until, by exhaustion of the excitement by the muscles, equilibrium is restored. In other words, if there were no epilepsy, there would be apoplexy and death; so that the very phenomena of the seizure are indications of the mode by which its occurrence and repetition are compatible with continuance of life.

Mania.

By this same theory acute mania is logically explainable as a fever; an overaction of the great nervous centers, springing up originally either in them,

or from quickened oxidation developed in some part of the nervous expanse, in periphery, as in acute pneumonia or pleurisy.

Mania may also be accounted for from changes in the cerebro-spinal fluid. If the cerebro-spinal fluid were rapidly drawn off, the inevitable result must be convulsive movement and spasmodic movement, with intense excitement, up to tetanus. If it were drawn off slowly with other fluid from the blood, the result would be collapse, with spasms, as in cholera. If it accumulate in quantity, the result would be coma from pressure, with convulsive movements. If it collect into itself toxic substances, the result will vary according to the substances.

Structural Changes.

The theory applies to the explanation of structural changes in the nervous masses themselves. Excess of fatty matter in them must reduce the oxidation. Increase of water in the substance must also lessen oxidation, induce pressure, lead to general absence of tension, and cause paralysis. Alcohol in the centers must lead to quick and temporary expansion and excitement, probably from combustion of it there, followed by extreme condensation, stupor, and exhaustion. Many times repeated the action of alcohol in producing general palsy is a necessity in those who are unable to eliminate the substance with rapidity.

Toxic Substances.

One more word. I found in experiments on cerebral oxidation that the process was very much impeded by the presence of some foreign substance. If, for instance, the carbon bisulphide were not well removed, the oxidation was checked. It has been observed that workers exposed long to the vapors of carbon bisulphide become affected with a special paralysis and cerebral failure, and now we see that this phenomenon is, under the circumstances, inevitable. I name this because similar interruptions to cerebral oxidation may be induced by other disturbing substances, and melancholia and hypochondriasis may be traceable, ultimately, to some persistent disturbance of this nature.

By this theory the phenomenon of alcoholic craving is naturally accounted for. If alcohol is burned in the brain fire and feeds it, the crave for alcohol may well be as insatiable as we know it to be in the alcohol-stricken.—*From the Asclepiad.*

COLOR HARMONY.*

MR. KELLY.—In order to understand the general scope of color I think it best to commence at the very beginning. I will run over the subject hastily. First the terms generally used by painters are greatly confounded. Tints, hues, shades, neutrals and a number of other words applied to colors are used indiscriminately without positive knowledge of the derivation.

As I run over the charts I have here you will get a short practical illustration of just the different properties or proportions of colors. Beginning with the first chart, we represent the sun. All color is proportions or divisions of sunlight. Any material, as I understand it, affords no such thing known as color, and there is no color in any material. Color is the action of sunlight on material—the property of material reflecting sunlight. Sunlight is composed of three sets of rays—red, yellow, and blue. Material is composed of small particles of, as it were, sand, particles so small that we cannot see them. This "sand" is of different shapes, one kind of shape, for instance, like the ordinary house brick, fitting together tight. Material of this shape reflects all the sun back to our eyes and produces white. If our material is of such a shape as to have openings like a sieve, letting all the sunlight pass through, we call it black. If again of such a shape as to permit yellow and blue rays to pass through and reflect the red, we call it red material. We have these three colors, red, yellow, blue, primary colors. Outside of these we have a row of three other colors called secondary colors, or the second row made by mixing the inside row together. Any two colors of the outside row, called the tertiary, are made by mixing the second row together, which gives us the third row. Although scientifically white and black are not known as colors. The first little square we have is primary; the second, the secondary colors, violet, orange, and green; the third, the tertiary. The tertiary row is russet, citrine, and olive. The last we have is the neutral, black, gray, and white. Gray is any combination of black and white; pure gray is half and half. The first property we have of color is hue. This is color in its purity, like sunlight. The purest colors we have are English vermilion, ultramarine blue, and lemon yellow. We have pure and neutral hues. To form a neutral hue we take a neutral, any proportion of gray, and add it to a hue. The top line represents neutral hues of red. The left hand square is pure hue. The right hand shows a proportion of hues in that strip. The row of squares on the left shows pure hues of long strips and the proportion used to produce these hues. The center strip we have pure hues again. Next to hues we have tints. Tint is any color placed in sunlight where you will get a reflection, or, in other words, in the painter's terms, a tint would be any color with white added. Here we have a pure red gradually adding white, bringing to about one-half white. We have pure tints and neutral tints. A neutral tint is white and black added to a color where the white predominates. At the right hand side of the red we have shades of red. The shade of a color is a color placed in darkness. If I take a red piece of cardboard into a room fifteen or twenty feet back, without windows, and I place the red in the room gradually, it would take the shade and give a dead black, simply showing that shades of red are darkness added. We have pure shades of all colors, then neutral shades. These are equal to neutral tints, excepting that black predominates. We add black and white to produce the neutral shades.

Next we have what is known as harmony of color. This is the same as harmony of music. I refer to this as the general public are generally educated in music, while in color we are quite in the background. We are far behind what science has developed. When we strike two notes on a piano, if they are pleasing to the ear, we say it is a harmony. This is produced by

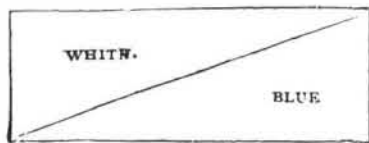
equal vibrations of air. A little hammer strikes a string, causing the string to vibrate in the center and waving the air equally in strength and pulsations and equally in their distance apart. Sunlight is composed of infinitely small waves of light. Ether waves they are called; when they pass from the sun to the earth, they pass in a straight direction. If there is nothing to disturb the motion of those waves, we call it harmony. If we have the red or blue waves crossing each other, we have a discord. This discord shows in colors as spots, as is seen on a smooth plastered ceiling. If frescoed, the color seems to be spotted. So to have color in perfect harmony these other waves must not conflict. We have a contrast in harmony, blending harmony, an individual harmony. First let us consider individual harmony. We have two or more colors placed side by side. Two or more shades of any color is individual harmony. If you wish individual harmony of blue, you take blue and add black or white in any or all proportions to suit. You cannot get any discord. The same is true of the other colors. Take, for instance, those light pinks and add a brown shade to red, and you cannot go wrong. Next, we come to blending harmony. Any two colors put side by side generally produce a new color where they lap. Any two colors in a regular order, as in rainbows, are always in harmony, as violet and indigo. We can put these together and produce no new color. Blue and green to a yellow, yellow to an orange, and orange to a red. Those only can be used in blending which are in perfect discord when used in solid colors.

Contrast in harmony. This is two colors placed side by side, which will improve each other and enhance and beautify each other. We cannot put any two colors together that do not have the same color in their composition. Take, for instance, yellow and blue, they produce green. Any tint or shade of the opposite is always in perfect contrast with green. It is a very simple rule and you cannot get wrong. The red and yellow produce all the tints of the orange. The opposite of orange is a blue.

Tone of color. Tone of color is that property of color which holds heat and which acts on our imagination. Although it is a very slight difference in temperature, it has been found by testing that there is a difference of eighteen degrees in three minutes between a glass filled with blue water and one with red by focusing the sunlight on it. If we are tinting a room to be used in the winter, use red or browns or anything that is composed of red, and it will appear to be a great deal warmer than it really is. If we use yellow, we have a neutral effect. If blue, a cold effect. For blue is cold in tone, yellow is neutral.

I will make a few of the colors to show how the different hues, tints, and shades are made. Any person present can call for any color he would like to have produced. I will say further that all the colors known as opaque colors can be produced with these three—red, yellow, and blue. As they can in dyes, but cannot take an oil color and produce a dye color. First, contrasting harmonies. As I said before, contrast in color improve each other—do not fade; beginning at the top of the card, you will notice the difference and notice whether it improves or fades, and give your answer. Green is any and all proportions of yellow and blue. Neutral color is black, white and gray. (The lecturer then compared the colors on the plates and asked the audience to give the effects.) Another thing which bothers many painters is what proportion to use on a frieze about a picture moulding, after selecting your harmony to tell how strong or weak is the color. Our eyes, to see naturally, require all the colors in equal parts, red, yellow, and blue, or, in other words, pure white. So then, to have a room look right and proper, we should have the same amount of color in the door casing as in the wall. If we have a strip four inches in width, we have as much color then as material. We must have as much to reflect back sunlight in one as in the other. Suppose we are going to use yellow. (The lecturer here painted an equilateral triangle in lemon yellow, and on the bottom side painted a strip of the darkest color required. He then took a brush and brushed up and down, thus distributing the dark color over the surface of the triangle, making a perfect graduation from the apex of the triangle to the opposite side.) At this point we would have a ceiling color. This ceiling color divides this into four parts, this is the wall color. The ceiling should be twenty-five per cent. lighter to produce the same effect on the side wall. Take the width of your door casings, which are right across the triangle, the width of the casing, and this gives you the color. The narrower the casing the sharper the color. You do not have to use the same color, simply the strength.

(A delegate asked that an exposition of tints be shown.) The tint of any color is white added to any color. (To get this the lecturer pinned upon the wall a



piece of shellacked paper, having an open rectangle. He then painted diagonally across one-half from opposite corners in blue and the other half in white, and then blended it by using a clean brush vertically, giving a perfectly graduated tint from dark blue to white.)

BENZINE IN BLEACHING.

MAHIEU'S process consists in mixing benzine with the solutions of carbonate of soda used in the different bleaching operations, or with the baths of chloride of lime or other bleaching chlorides. This application of benzine in the lyes has the effect of dissolving and removing the vegetable coloring and resinous substances contained in the textile matters. Taking, for instance, 1,000 kil. linen to bleach, the way of operating after this method is as follows, viz.:

In a sheet iron keir or other reservoir containing 200 lit. water, 50 kil. soda (preferably Solvay soda) are heated for fifteen minutes at about 100° C., when 1½—1¾ lit. benzine is added and heating continued for ten minutes, the mixing operation taking up twenty-five minutes in all. After standing for ten minutes the

mixture is let out into another keir placed under the first, containing 5,000 lit. hot water and 12½ kil. lime. This lime water bath is prepared one hour in advance and heated to 90–100° C. This new mixture is heated for another hour, and then left to stand for twelve hours before using it. The 1,000 kil. linen being placed in a proper tub, and the prepared lye run in, it is boiled for three hours under 1½ atmospheres pressure, instead of five hours as usual.

This process applies to the whole habitual course of operations, which are more or less often repeated according to the degree of bleaching required, that is:

1. Benzine lye as above indicated.
2. Rinsing in running water.
3. Chloride of lime bath.
4. Rinsing.
5. Neutralization of the chlorine.
6. Rinsing.
7. Grass bleach.

Benzine is also added to the chlorine bath, thus: Mix 8 kil. benzine with 60 kil. Solvay soda, and let it boil up; run this mixture into a cistern containing 4,000 lit. solution of lime 8°, or about 4 per cent. benzine. Then the chlorine baths are prepared, as stated, to the required strength, and the yarns or linens laid down in them for the suitable period.

This process renders all the ordinary bleaching operations more active, at the same time shortening them, maintains the fibers at their original strength, and affords a considerable saving in steam and chemicals.—*Textile Colorist.*

EXPLOSIVE SUBSTANCES.

By CHARLES D. LIPPINCOTT.

THE following paper was, says the *Pharmaceutical Era*, read before the Pennsylvania Pharmaceutical Association at its meeting in 1886.

SECTION FIRST.—*a. Substances which explode when triturated singly.*—Under this head are to be found only a limited number, among which are:

1. Potash chlorate (commercial), under sharp concussion.
2. Mercury fulminate, explodes with green flame.
3. Mercury nitric oxide.
4. Copper nitrate, dry.
5. Copper fulminate.
6. Antimony fulminate.
7. Gold fulminate.
8. Silver fulminate.
9. Glonoin (nitroglycerine).
10. Hydrogen chloride.
11. Nitrogen iodide.
12. Nitrogen chloride.

The latter three substances and the fulminates are among the most violent of the explosives, their chemical stability being very light.

It may be well to state that in substances which contain carbon, oxygen, and nitrogen, the latter in a more or less feeble state of combination with the whole or part of the oxygen, when the explosion takes place the N parts with its O, which combines with the C, forming CO₂ and CO with generation of heat, and N is set free.

If H be present in the explosion, H₂O is formed in the form of greatly expanded vapor. When Cl is present, it takes the part of the N as from potash chlorate.

We find that nitro substitution for H forms very dangerous explosive compounds, as glonoin, a tri nitro product, also xyloidine, a bi nitro, and last, but not least, nitro mannite, a product from manna sugar, and containing six molecules of nitric peroxide (N O₂) associated with the carbon of the sugar.

b. Substances which explode when mixed with other substances and triturated:

1. Potash chlorate with acid tannic.
2. Potash chlorate with sulphur.
3. Potash chlorate with antimony sulphuret.
4. Potash chlorate with pot. nit. and ammon. phosphate.
5. Potash chlorate with picrate of ammonia.
6. Potash chlorate with am., sulph., copper and soda hyposulphite.
7. Potash chlorate with picrate of potash produces purple flame.
8. Potash chlorate with picric acid, yellow flame.
9. Potash chlorate with acid oxalic, detonates violently.
10. Potash chlorate with potash permanganate, detonates.
11. Potash chlorate with sulphur and iodine, violent detonation.
12. Potash chlorate with antimony sulphuret.
13. Potash chlorate with sulphur and fulminate of mercury (very sensitive).
14. Potash chlorate with potash prussiate and sugar.
15. Potash chlorate with ammonio sulphate of copper.
16. Potash chlorate with soda hyposulphite, fuses and deflagrates.
17. Potash nitrate, dry carbonate of potash and sulphur.
18. Potash permanganate and tannin, deflagrates.
19. Potash permanganate and picric acid, violent detonation.
20. Potash permanganate, picric acid, and tannin, violent detonation, with yellow flame.
21. Potash permanganate and potash picrate (loud).
22. Potash permanganate, potash picrate, and tannin, very loud.
23. Potash permanganate and potash oxalate.
24. Potash permanganate, potash oxalate, and tannin, violent.
25. Chloride of lime and iodine and iodine resub. (detonates).
26. Dry nitrate of copper and oxalate of potassa, with tannin acid, explodes.
27. Antimony sulphuret, acid picric, and potassa chlorate, detonates with flash.
28. Amorphous phosphorus, acid tannic, acid picric, potassa chlorate, potash permanganate (very sensitive, flashes without detonation).
29. Manganese black oxide, picric acid, permanganate of potash, flash, no detonation unless confined.
30. Potassa bichromate, tannin, and picric acid (orange red flash).

* Abstract from the recent convention of the New Jersey Association of Master Painters and Decorators.—*Painting and Decorating.*