SCIENCE IN TOYS.

XIII.

An ordinary glass prism, such as may be purchased for fifty cents, is sufficient for the resolution of a beam of white sunlight into its constituent colors. By projecting the dispersed beam obliquely upon a smooth white surface, the spectrum may be elongated so as to present a gorgeous appearance. It is not difficult to understand that whatever is exhibited in the spectrum

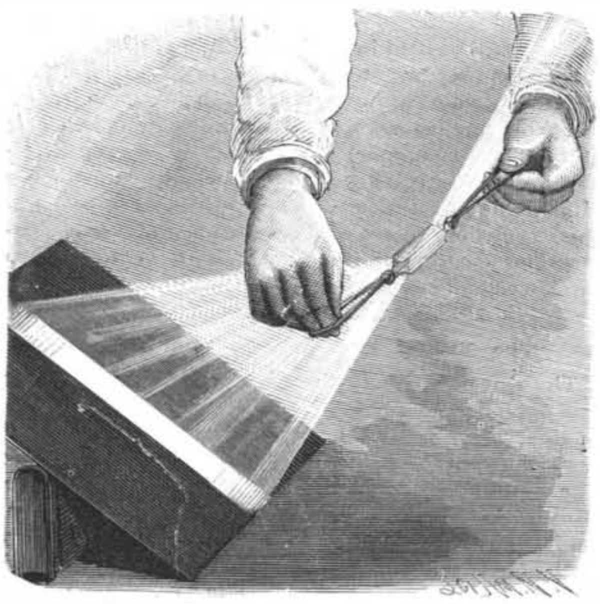


Fig. 1.—SIMPLE ROCKING PRISM.

must have existed in the light before it reached the prism, but the recombining of the colors of the spectrum so as to produce white light is of course conclusive.

The colors of the spectrum have been combined in several ways, all of which are well known. Newton's disk does it in an imperfect way by causing the blending, by persistence of vision, of surface colors presented by a rotating disk. Light from different portions of the spectrum has been reflected upon a single surface by a series of plane mirrors, thus uniting the colored rays forming white light. The colored rays emerging from the prism have been concentrated by a lens upon a small surface, the beam resulting from the combination being white. Besides these methods, the spectrum has been recombined by whirling or rocking a prism; the movement of the spectrum being so rapid as to be beyond the power of the eye to follow, the retina receiving the impression merely as a band of white light, the colors being united by the superposing of the rapidly succeeding impressions, which are retained for an appreciable length of time.

The engravings show a device to be used in place of the ordinary rocking prism. It is perfectly simple and involves no mechanism. It consists of an inexpensive prism, having attached to the knob on either end a rubber band. In the present case the bands are attached by making in each a short slit and inserting the knobs of the prisms in the slits. The rubber bands are to be held by inserting two of the fingers in each and drawing them taut. The prism is held in a beam of sunlight as shown in Fig. 1, and with one finger the prism is given an oscillating motion. The band of light thus elongated will have prismatic colors at opposite ends, but the entire central portion will be white. To show that the colors of the spectrum pass over every portion of the path of the light, as indicated by the band, the prism may be rocked very slowly.

By inserting four screw hooks in a standard and stretching the bands over the hooks as shown in Fig. 2, the prism is adapted for use in connection with a lantern. The light emerging from the lantern must pass through a narrow slit to secure a perfect spectrum, and between the screen and the prism should be placed a screen with an oblong aperture, which will allow all of the band of light to appear upon the screen with the exception of the colored extremities. With the prism supported in this way, it is an easy matter to turn it slowly back and forth, showing on the screen the moving spectrum, which, with the more rapid movement, produces the pure white band. G. M. H.

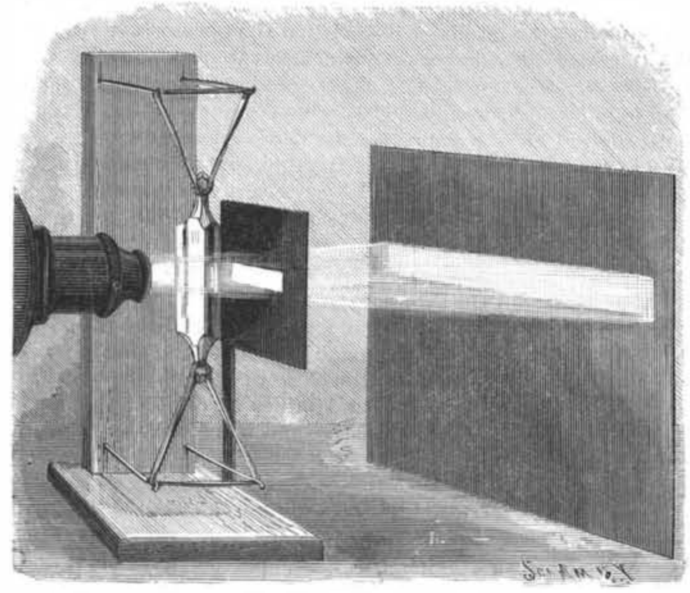
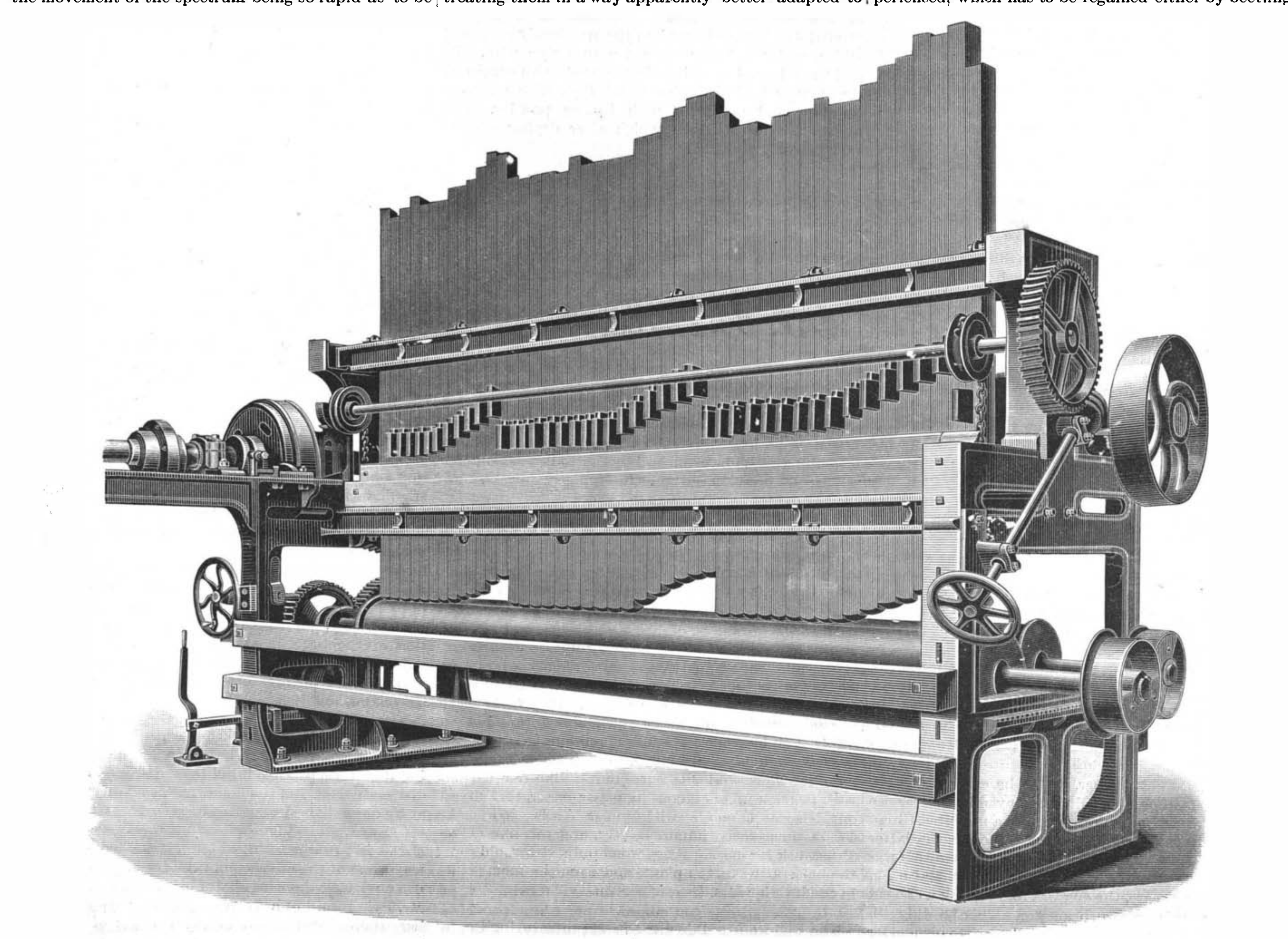


Fig. 2.—ROCKING PRISM ADAPTED TO THE LANTERN.

BEETLING MACHINE.

Among the exhibits at the Manchester Exhibition none is more sure to attract attention, when at work, than the beetling machine exhibited by Messrs. J. H. Riley & Co., of Elton Iron Works, Bury, and which is here illustrated. Not only is a beetle one of the noisiest of machines, making its presence felt at a distance, but the process which it is employed to carry out is one which excites great interest in the stranger, as it deals with fabrics to be found in every household, treating them in a way apparently better adapted to insure their destruction than to effect any improvement in their condition.

The cotton cloth to be beetled is wound on a long roller, called a beam, several pieces being wound side by side, but with a space of a few inches between the edges or selvedges of the adjacent pieces. This beam is then placed under a row of fallers, made of beech wood, and arranged to have an 11 inch drop. By means of an equal number of three-armed wiper cams, which are not shown in the engraving, the fallers are alternately raised and dropped on to the cloth, the beam being slowly rotated and reciprocated endwise at the same time. This pounding operation has two effects on the cloth. First it spreads it sideways, increasing its width in a way which is more permanent than any other process in vogue for this purpose. The non-textile reader may be inclined to ask why the cloth is not made the proper width in the loom, so as to avoid the need of a separate operation. Unfortunately, nearly all the processes to which cloth is subject tend to make it narrower. In the first place, the act of beating up the weft in the loom draws the warp threads together from 5 to 10 per cent; then in bleaching, the tension of the drawing rollers on the softened fibers continues this process, and a further loss of width is experienced, which has to be regained either by beetling



IMPROVED BEETLING MACHINE FOR FINISHING CLOTH.

or by a stretching machine. To manufacture the cloth an extra width to allow for the losses would entail increased expense, and would fail of the object, for a shrunken cloth would be different in texture and "feel" to one restored to its natural width.

But beetling is never undertaken for the sole end of stretching cloths, as it is too expensive a process. Its chief purpose is to give a "finish" which cannot be obtained by any other means, although very many attempts have been made. As each faller descends it flattens the yarns on which it impinges, and at the same time produces a slight motion of the various layers upon one another, the result being that the threads are given a distinctness and a brilliancy which is characteristic of linen, and with which every one is familiar in the white pocket handkerchief of daily use. It is only in high class goods that the process of beetling can be carried out, for it is slow, and takes very considerable power. For cheaper cloths, the stretching machine and the calender are made to suffice.

Referring to the engraving, it will be seen that there are two beams, either of which can be placed under the fallers while the other is being filled or stripped, as the case may be. The fallers can all be raised out of range of the wipers by means of a cross bar lifted by chains and drums from a shaft operated by worm gear and a hand wheel. The wiper shaft is driven by bevel gear through a friction clutch.—*Engineering.*

CHARLES FREDERICK CHANDLER.

BY MARCUS BENJAMIN.

The early history of chemistry reads with the fascination of an Oriental tale, for out of alchemy came chemistry. It seems as if there were giants in those days, for with rude implements and impure reagents great results were obtained. Honor and distinction came to those who followed the new-born science. An apothecary's clerk became the great Scheele; the medical student was made Baron Berzelius; the boy who walked to Paris developed into the mighty Dumas, famous as the great lecturer and cabinet minister; and then Hofmann, once a poor student in Liebig's laboratory, discovered the aniline colors, and was called to fill the most important of all scientific offices in the German empire, that of a professor in the University of Berlin.

The history of American chemistry shows no such conspicuous illustration of phenomenal success, but in the annals of that science in this country there will be found many names that have been made illustrious by ability and research. The discovery of oxygen was made by Priestley, whom we claim as our own. The oxyhydric blowpipe was invented by Robert Hare, in Philadelphia; Samuel Guthrie was the first to give chloroform to the world, and Charles T. Jackson followed with ether, and so on until recently, when saccharin was discovered by Ira Remsen and Charles Fahlberg in the chemical laboratory of the Johns Hopkins University, and a new process for the reduction of sodium invented by Hamilton Y. Castner, in New York. America has, indeed, great reason to feel proud of the work that has been accomplished within her boundaries.

Personal influence has had much to do with this. The elder Silliman gathered around him many of the scientists of a former generation, most of whom have since passed away. The elder Draper likewise attracted to his lectures students who have enriched science with their discoveries. Of later date is Louis Agassiz, from whom nearly all of the American naturalists of to-day received their inspiration, and it is from him that Professor Chandler first received his fondness for natural science.

Charles Frederick Chandler was born at the residence of his grandfather, Nathaniel Chandler, in Lancaster, Mass., on December 6, 1836. His paternal ancestors were descended from William Chandler, who came from England in 1637, and settled in Roxbury, Mass. On his mother's side he came from John Whitney, an old Boston merchant.

The curious chiastolites and the lithium minerals, spodumene and petalite, which he gathered in the vicinity of his grandfather's home in Lancaster, whither he went to spend his vacations, were evidences of his interest in practical science, and were perhaps the first indications of that collecting mania which he has since put to so excellent a use in his museum of applied chemistry in the Columbia College School of Mines, New York. As he grew up he attended lectures on scientific subjects, and among others those by Agassiz. The latter seemed to have determined his career, for the old workshop in the attic was transformed into a laboratory, where, with improvised apparatus and kitchen chemicals, his first experiments were made.

Regular studies, however, were not neglected, and in due time Chandler graduated at the high school in New Bedford, and then after a year's private study of the advanced classics, began his professional education by entering, on September 1, 1853, the Lawrence Scientific School of Harvard University. In this institution he received instruction in chemistry from Eben N. Horsford, geology from Louis Agassiz, and mineralogy from Josiah P. Cooke.

But a chemist in those days needed the prestige of a course of study under the German masters, and so Chandler went to Europe. At first he entered the University of Göttingen, where he studied chemistry under Wöhler, the pupil of Berzelius, and in 1856 received from that institution the degree of doctor of philosophy for his researches in mineralogical chemistry. His inaugural dissertation, printed with that peculiar Roman type used in Germany, has a colored paper cover, with the imprint "Gottingen, 1856," and contains the eleven following papers: 1, Zircon from Buncombe County, N. C.; 2, Sassurite from Zobten; 3, Stassfurthite from Stassfurt; 4, Analysis of a rock resembling talcose slate, from Zipser; 5, Columbite from Middletown; 6, Columbite from Bodenmais; 7, Tantalite from Chateloube; 8, Yttrotantalite from Ytterby; 9, Samarskite from the Ural; 10, Experiments on the Cerium Metals; 11, Artificial heavy spar.

From Göttingen he went to Berlin and became the private assistant of Heinrich Rose, having as his associate the now celebrated Arctic explorer, Nordenskiold. He spent nearly a year in Berlin, studying also physics under Dove, applied chemistry under Magnus, and mineralogy under Gustav Rose.

On his return to the United States, in 1857, he was invited by Charles A. Joy to become his assistant at Union College, and a few months later (April, 1857), when Professor Joy was called to the chair of general chemistry in Columbia College, Chandler succeeded to the vacancy at Union, being thus an actual professor before he had attained his majority.

For eight years he continued in charge of the laboratory in Schenectady, also lecturing to the college classes on general and agricultural chemistry, mineralogy, and geology.

In 1864, at the suggestion of Prof. Joy, he was invited to come to New York City and take part in the formation of the School of Applied Science, now known as the Columbia College School of Mines, then about to be established under the direction of Professors Thomas Egleston and Francis L. Vinton. The department of chemistry was assigned to him, and without salary he began the delivery of the lectures on qualitative analysis, stoichiometry, quantitative analysis, applied chemistry, and geology. In 1865 he received the title of professor of analytical and applied chemistry, and became dean of the scientific faculty. The arrangement of the large qualitative, quantitative, and assay laboratories was developed under his guidance, and he continued in the active administration of these departments until 1877.

Meanwhile new buildings had been erected, and in lieu of a few students, classes numbering upward of fifty were receiving instruction, not from a handful of professors, but from a large and efficient faculty. This institution had become the greatest mining school of the United States. The departments of chemistry, assaying, mining engineering, and metallurgy have no superiors, and but few equals, in the country.

The school was reorganized in 1877, and the chair of general chemistry given to Professor Chandler, since when he has delivered the lectures on general chemistry to the students, not only in the School of Mines, but likewise to those in the School of Arts, and also the lectures on applied chemistry.

His work on the last named subject deserves special recognition. Professor Chandler at once recognized the importance of this branch. Appreciating the value of having educated chemists in various departments of the industrial pursuits of the country, he made himself thoroughly familiar with those subjects, visiting various factories and collecting specimens to be used for class room illustration. The latter now form his museum of general and applied chemistry, in which his specimens illustrating the manufacture of pottery and of the various photographic processes are probably unique.

In 1875 the department of chemistry and its applications in Johnson's New Universal Cyclopædia was placed under his control, and the resulting articles from his pen contributed to the four volumes issued since that year are unequaled in any work of similar character.

Professor Chandler has obtained recognition as having no superior as an authority on technical chemistry. His reputation extends throughout the United States, and he has been very frequently called into court as an expert to testify on matters pertaining to this specialty. Indeed, no case of great importance would seem complete unless his services were retained on one side or the other.

To return to his lectures, in 1872 he became adjunct professor of chemistry and medical jurisprudence in the College of Physicians and Surgeons, the medical department of Columbia College, and in 1876 succeeded to the full professorship.

Soon after his advent to New York City he was asked to assist in the development of the New York College of Pharmacy, and in 1866 he became professor of chemistry in that institution, giving two lectures an evening, twice a week, during the college term. Through his active interest this school has become one of the most flourishing and advanced colleges of pharmacy in the United States.

In 1866 Professor Chandler was invited by the Metropolitan Board of Health to make scientific studies of sanitary questions affecting the health of New York City. There was no appropriation for this purpose, and he performed the work gratuitously. The authorities were so well satisfied with the importance of this undertaking that, at the end of the year, they created the office of Chemist to the Board of Health, and appointed Professor Chandler to the place, which he then held continuously until 1873.

His work while in this office was of the utmost importance, and it has resulted in enormous benefits to the community, concerning which comparatively little has ever been fully appreciated.

The food supply was one of the first subjects to which he turned his attention. Chemical analysis showed that the milk sold in New York City contained on the average one-third of water, or, in other words, frauds to the amount of $10,000 a day were perpetrated by the milkmen. After years of contention, during which several cases were tried in court, the action of the health board was finally sustained by the Court of Appeals, and thereafter the rigid inspection of milk became possible. The value of this reform is most apparent when it is recollected that a milk diet constitutes the principal food supply of fully 200,000 children under five years of age.

The sale of inferior qualities of kerosene, with resulting accidents, was one of the subjects very thoroughly investigated by Professor Chandler. Samples of this burning fluid, sold under various names, were collected and tested. In consequence of its almost uniform inferior quality, legislative action was obtained, fixing a definite burning point, below which nothing was permitted to be sold.

Intolerable odors resulting from the use of lime in the gas works were prevalent at various points in the city. Professor Chandler recommended that the process employed by the gas companies be modified, so as to prevent a continuance of this nuisance, and after a prolonged contest before a referee, his purpose was accomplished.

In 1873, the Board of Health, as now constituted, was organized, and Professor Chandler appointed its president by Mayor Havemeyer. Four years later, he again received the office at the hands of Mayor Ely. In 1883, Mayor Edson presented his name to the Board of Aldermen, but this body rejected the nomina-