[For the Scientific American.]

THE DISCOVERY AND HISTORY OF THE CHROMOSPHERE.

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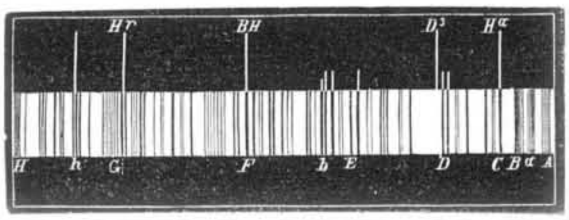
Extensive preparations had been made to observe the chromosphere and prominences during the eclipse of 1868. The spectroscope, for the first time, was directed toward these mysterious flames about which there had been so much discussion. They were about to disclose the secret of their composition. The observers, stationed at different points along the path of the eclipse, met with general success. A spectrum of bright lines was found to be given by the chromosphere and prominences, although at this time the word chromosphere had not been invented, and that envelope which now bears the name had not, in reality, been distinguished as an envelope or atmosphere separate from the photosphere; yet a red light had been seen around the sun, and it was this which gave the bright lines. The spectrum of bright lines seen at once showed that this envelope must be gaseous and existing at a very high temperature. To M. Janssen, the well known astronomer, belongs the honor of succeeding in seeing the bright lines when the sun was shining in full splendor; Mr. Lockyer attempted, independently, to discern these lines, but failed, owing to defective instruments. The difficulty to be surmounted was this: the brightness of full sunlight eclipsed the comparatively feeble light given off by the prominences and chromosphere; how to get rid of this intense light was the problem. If a beam of sunlight be passed through a prism of glass, it will be dispersed, giving a spectrum of a certain length and brightness. Now if instead of one, two or more prisms be used, there will be an increase in the length of the spectrum and a corresponding diminution of its brightness. Now, as the spectrum of the chromosphere and its appendages is not a continuous spectrum but a spectrum of bright lines, the only effect which an increase in the number of prisms used could have would be that of more widely separating the lines, not to any great extent diminishing their brilliancy. Mr. Lockyer hoped, by using a sufficient number of prisms, to be able to see the prominences; for after toning down the glare of the solar spectrum, as given by one prism, he expected to see a monochromatic image, of the prominences he should examine, in each of the lines given by the prominences. As stated above, he failed, not because his theory was wrong, but because of the imperfection of the instruments he used.



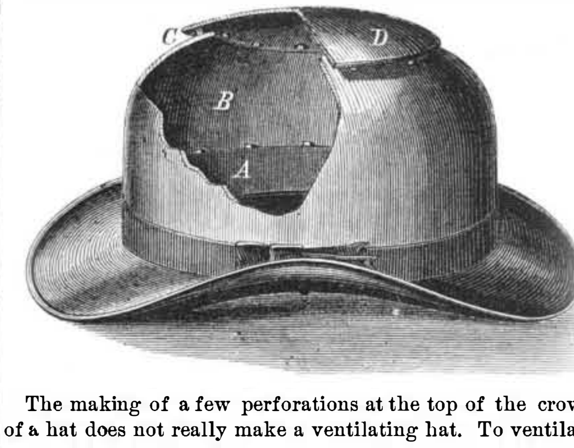
The next day after the eclipse of August 19, 1868, M Janssen tried the experiment and succeeded. There were the bright lines. Astronomers could now examine the prominences at their leisure. That which could be investigated heretofore only during an eclipse would now become a subject of daily study; in fact, M. Janssen had proved that it was possible to produce in effect a total eclipse whenever desired, providing the sun shone clear of clouds.

The next question which engaged astronomers was that of the coincidence of the lines seen with those given by some known gas or gases. Sodium and other metals had been proved to exist in the sun long before. Kirchoff had discovered the law that every body has the power of absorbing such light as it emits. The coincidence of the bright lines given by the vapor of sodium with the *D* lines in the solar spectrum had been announced. The coincidence of the chromospheric lines with certain dark lines in the solar spectrum was soon established. The line, marked *Ha* in the engraving, was found to coincide with the *C* line of Kirchoff's map. *BH* with *F*, and *Hy* with a line near *G*. These lines were coincident with those given by glowing hydrogen, and as they were the most prominent and the brightest, hydrogen was announced as being the chief constituent of the prominences and chromosphere. Another line was seen in the orange part of the spectrum, which at first was thought to be the sodium line *D*; but this was a mistake, and the line was soon found to be more refrangible than D. This line has been called the *D*3 line. What is the nature of the substance which produces it is still unknown; it is found whenever the prominences and chromosphere are examined. Other lines are sometimes seen, such as the sodium and magnesium lines. These are, however, generally found in the lower portions of the prominences and in the chromosphere proper, rarely being seen in the more elevated portions of the prominences, probably by reason of the greater gravity of the vapors of these metals over hydrogen gas. Continued observation showed that the sun was surrounded by immense masses of hydrogen, ejected from the chromosphere, which were continually changing their form, bursting out, now here, now there; and when we consider that only a small portion of the sun's surface can be examined on any one day, only the edge or limb, it is apparent that innumerable outbursts occur of which we have no knowledge.

Of the mighty forces which are at work in that orb, which has been justly termed the ruler, fire, light, and life of the planetary system, we can have no conception: of the forces which have the power of hurling immense masses of matter to the hight of hundreds of thousands of miles, and at a velocity with which we are entirely unacquainted. That the chromosphere is the abiding place of terrific cyclonic storms, and (if we may be allowed the expression) volcanic eruptions, is a fact beyond doubt; daily evidence meets our eyes attesting to the turmoil going on therein.

HEARD'S VENTILATING HAT.

Not only in tropical climates, but in the torrid temperature of midsummer, experienced in our latitude, will such an invention, as the one illustrated in our engraving, be found of great service and comfort. The overheating of the head has often resulted in total prostration and even death, while undoubtedly many lesser disturbances of the general health are indirectly caused by it, not to speak of the great discomfort, resulting from a heavy almost air-tight head covering, in hot weather. While it is requisite that the head should be protected from the direct rays of the sun, it is also desirable that the air should have free access to all parts of the scalp, thus keeping it cool, carrying off the perspiration, and obviating not only the greater evils above alluded to, but the minor one of baldness, which is greatly hastened by overheating.



The making of a few perforations at the top of the crown of a hat does not really make a ventilating hat. To ventilate an air space requires either very much larger openings than these, in proportion to the space to be ventilated, or else openings below as well as above, so that the currents of heated air rising may meet opposing descending currents, and may be freely replaced by cooler air entering at the bottom.

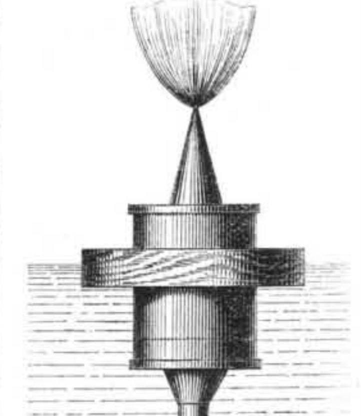
Now, in this hat, these principles are fully carried out. Air enters through an annular space formed between the sweatband, A, and the exterior, B. Rising equally about all parts of the head, it passes out of the opening, C, which extends entirely about the top of the crown, the part, D, overlapping the part, B, so as to exclude rain.

The hat may be made of any suitable material, and the ventilating device does not, as will be seen, interfere with conformability to reigning styles.

The invention was patented May 24, 1870, by Dr. Joseph M. Heard, then of Aberdeen, Miss., but now of West Point, Miss., whom those desirous of manufacturing on royalty may address for further particulars.

INEXTINGUISHABLE SIGNAL LIGHT.

In a Belgian exchange, the *Chronique de l'Industrie*, we find the description of an interesting little invention, which has found favor with the Grand Duke Constantine, of Russia, and has been adopted into the naval service of that country. It is a signal light of peculiar properties, being ignited by water, and, although unable to ignite other objects, not to be extinguished by wind or water. It is said to produce a very powerful and brilliant light, which can be observed at a great distance and retains its illuminating quality, though in small compass, for a considerable length of time.



The apparatus, an invention of N.T. Holmes, consists of a sheet metal cylinder, having a conical top and a tube of about six inches in length projecting from its bottom. It is filled with phosphate of calcium, which is prepared in the following manner: Pieces of chalk are put into a crucible, together with a quantity of amorphous phosphorus, and then brought to a white heat. The chalk, becoming incandescent, absorbs the vapors of phosphorus, and thereby becomes phosphate of chalk. The apparatus, when filled with this substance, is hermetically closed and preserves it for an indefinite period.

When to be used, the top of the cone is cut off, and a hole bored through the end of the pendent tube. A float is connected with the cylinder in the manner shown in the engraving, and then launched. The water, entering the tube, causes the phosphate of calcium to decompose and to generate a quantity of gas, which, escaping at the top, is ignited by contact with the air, and remains so until the contents have been entirely consumed. It is stated that the London Board of Trade has recommended the adoption of these signals in place of the blue danger signals at present in use in the commercial navy, experiments having proved the superiority of this ingenious invention.

HOW TO PRESERVE SOAP GREASE.—Fill a cask half full of good strong lye and drop all refuse grease therein. Stir up the mixture once a week.

[For the Scientific American.]

COMBINED CAST IRON AND WROUGHT IRON ARCH GIRDERS.

A cast iron arch girder is considered as a long column subject to a certain amount of bending strain, and the resistance will be governed by the laws affecting the strength of beams, as well as those relating to the strength of columns. By reason of the slight curvilinear form of the cast iron arch girders, so much in general use, they will not compare as favorably with the laws governing columns as with those governing beams.

The metallic arch in one piece differs materially from a stone or brick arch. In the latter, by the use of separate blocks, the capacity of the material to resist compression only is exerted; while, with the use of an arch of any material in one piece, both extension and compression are brought into play.

A stone or brick arch is an arrangement of blocks (*voussoirs*) set in a curvilinear form, each block separate from the other, and subject only to compression. The greater the weight placed upon the arch, the more compressed and compact these *voussoirs* become. Their resultant pressure, or the thrust of the arch, is received by piers or abutments at the extremities; and, should a slight yield of the abutment take place, it would only cause a further setting of the *voussoirs*, and not affect the strength of the arch in the same degree that would be caused by the elongation of the wrought iron tie rod in a cast iron arch girder, as the deflection of the latter is not great before rupture takes place, and a slight elongation of the rod causes considerable deflection.

Most materials used in the construction of arches have a much greater capacity to resist compression than to resist extension; and it is obvious that this system of *voussoirs*, when made of a material whose resistance to compression is greater than to extension, has an advantage over those in which the material is used in one piece. As wrought iron possesses the property of greater resistance to extension than to compression, its use is analogous that of a tie rod.

In the cast iron arch girder, both extension and compression are exerted, as on a straight beam, and these are the greatest at those points which are most distant from the neutral axis of cross section; hence the point of rupture will occur at one of these two extremes.

In cast iron, the resistance of compression is to that of extension in the ratio of six and a half to one; and, being a rigid, crystalline, unmalleable substance, weak in its resistance to extension as compared to that to compression, it becomes a matter of calculation, which should be based upon

experiment, to adjust the malleable wrought iron tie, which has a certain degree of extensibility, coming into play in proportion as the girder is loaded. These girders, as ordinarily constructed, have the arch or casting in one piece, with grooves at the ends to receive the wrought iron tie rods; the latter, being a little shorter, are expanded by heat and then placed in position in the casting, and allowed to contract in cooling, to tie the bottom of the casting, thus acting as an abutment to receive the horizontal thrust of the arch. If the tie rod should be too long, it does not receive the full proportion of the strain until the cast iron has so far deflected that its lower edge is subject to a severe tensile strain which cast iron is feeble to resist.

If, as is more frequently the case, the tie rod is made too short, it is subject to severe initial strain, which is added, to the strain proper induced by the load, to produce rupture. Wrought iron is extended about a one thousandth part of its length by every ten tuns of direct strain per square inch of cross section, which is the limit of elasticity of the best iron, as eight tuns per square inch is for ordinary iron. Therefore, a cast iron arch girder, with wrought iron tension rod, cannot be considered as an elastic arch confined between fixed abutments.

The usual careless manner in which these wrought iron tie rods are adjusted to the cast iron arches, ordinarily one quarter of an inch and occasionally three eighths of an inch less in length than the recess made in the casting for their reception, thus detracting from their capacity to resist strain and causing the cast iron arch to camber or the rod to elongate—usually both—with want of knowledge of the proper proportion of the cast iron arch to the tie rod, imperfect castings, bad welds, and great atmospheric changes, are the causes of the several failures of these girders in this city during the past few years. The last case of this kind occurred in a building on the southeast corner of 56th street and Sixth avenue, New York, on the 28th of last November. The thermometer had fallen 22° in a few hours, and the three inch rod of the girder parted at the weld. This girder, whose distance between the supports was about 25 feet, was marked to sustain 125 tuns, and broke with a load of about 60 tuns. It was set up in the building just before the enforcement of the law requiring it to be tested.

In view of these facts and the observations I have made in testing about 270 of these girders, I conclude that, as ordinarily made, in proportioning the wrought iron tie to the cast iron arch, one square inch of cross section of tie rod should be allowed for every ten net tuns of load imposed upon the span of the arch. Regarding the arch as flexible, or as possessing no inherent stiffness, and the tie rod as a chord without weight, the following formula is proper:

Let S equal span in feet; V the versed sine in feet; U the