

the latter into the slot, E, and the forked plate, B, is fastened to the other end by means of its slot, C, in a similar manner. When thus secured, the lever, A, is raised or turned toward the bale until the hook of the plate, D, will enter a hole, F, on the lever. The parts then assume the position shown in the dotted lines of Fig. 2, marked 1. The lever, A, is then carried over until it is placed as indicated by the dotted lines, 2, thus drawing the ends of the band together, so that they may be fastened. The length of the lever, A, of course, renders but slight power necessary, so that the labor can be readily and quickly performed.

Patented December 10, 1872. For further information address the inventor, Mr. R. S. Sayre, Stilesborough, Bartow county, Ga.

#### STEVENS INSTITUTE LECTURES.—SUNLIGHT AND ITS SOURCE.

BY PRESIDENT HENRY MORTON.

The spring course of lectures at the Stevens Institute opened on Tuesday, April 15, with a brilliant lecture by the President of the institution. The substance of the lecture may be described briefly as follows:

For the purpose of measuring lights of different brilliancy, the light of a candle serves as a standard of comparison. An ordinary gas flame is equal to the light of fourteen to eighteen candles, a fact we do not generally appreciate until the gas gives out and we are obliged, as in New York city lately, to substitute candles for it. While the shadow of a gas flame is much more sharply defined and more opaque than that of a candle, it is surpassed by that produced with an oxyhydrogen lamp, the latter by a magnesia burner, this again by the lime light, and so on, until we finally come to the electric light, the most intense artificial illumination we are able to produce. All these lights were exhibited by means of the shadows of objects they cast upon the screen, and it was stated that the brilliancy of the electric light was equal to that of five hundred and seventy-two candles. The intensity of sunlight, however, is so very much greater than the latter that it would take a body many times larger than the sun, composed of incandescent carbon points, to give us the same amount of light.

Next to this brightness of the sun, the whiteness of his light strikes us as a prominent characteristic. Now, this whiteness is due to a harmonious blending of lights of all colors in proper proportion, as is seen in the spectrum, where a ray of white sunlight is broken up by a prism into its component colors. By reason of its composition it has the property of exhibiting all colors with equal effect, a property not shared by colored lights. The lecturer exhibited a large burner in illustration of this fact. It was covered with disks of green, blue, and purple, purposely selected on account of their dullness by gas light. When illuminated by the electric light, they became very brilliant. When light of any color other than white is passed through a prism, its spectrum is not continuous but composed of alternate bright colored and black bands. These vary with the source of light, and are so characteristic as to enable us to tell what substances give the light. A piece of brass burned in the electric arch showed upon the screen the bands due to its components, copper and zinc. This is the principle of spectrum analysis. Now, on examining the spectrum of sun light, we notice that it is full of dark lines. Kirchhoff was the first to indicate the connection between these and the bright lines produced by the vapors of burning substances. He observed that some of them, for example nickel, iron, and hydrogen, produced bright lines exactly coinciding in position with certain black lines in the solar spectrum, and he concluded that these substances were present in the sun. But why should they produce black lines in this case? It is because light passing through vapors is deprived of certain portions of its rays, which are absorbed by these vapors. This was beautifully shown by causing the spectrum of the electric light to be formed on the screen, and then interposing the vapor of sodium to its passage; a black line was immediately produced in the yellow part of the spectrum, and this line corresponds to the sodium line in the solar spectrum. Transparent solutions similarly blot out portions of the light by absorption. Some substances produce a great number of lines: iron, for example, about 200. These have been carefully studied. Mr. Rutherford, of New York city, who, in appreciation of his eminent services to science, has been recently elected a member of the Royal Society, has produced beautiful photographs of these lines, and Dr. Draper has obtained unparalleled photographs by means of diffraction plates.

This apparatus, represented in Fig. 1, consists of a series of prisms, by which the light entering from the right is made to pass twice around the prisms, and is finally photographed in the solar camera on the right. These photographs, extending far beyond the visible spectra, have never been equaled.

The lines in the solar spectrum are the means by which we can recognize the substances of which the sun is composed.

When examined with the telescope, the surface of the sun presents a mottled appearance, likened by Nasmyth to overlapping willow leaves, and by Father Secchi to rice grains. Pictures of their drawings were exhibited upon the screen, as was also a photograph taken in the  $\frac{1}{500}$  of a second during the total eclipse of August 7, 1869, at Ottumwa, Iowa, just as the "nose of the moon touched the sun's disk."

The spots on the sun gradually travel over its surface, appearing foreshortened as they approach the edges. Over and near them are sometimes visible very bright clouds or faculae. An ingenious apparatus, invented by Professor Morton, enabled him to represent the passage and the foreshortening of a solar spot over the surface of a disk representing the

sun. It consisted simply of an image of the spot upon a rotating glass cylinder placed before the lantern and having before it a screen with a circular hole. The spots also change their shape, and photographs have been taken by Mr. Rutherford and others of the same spot in different phases. Some of these were exhibited on the screen.

When the edge of the sun's disk is examined by means of the spectroscopic, red hydrogen flames of different shapes are observed. These have been the subject of considerable study. A society of Italian observers, composed of Father Secchi, Respighi, Tacchini, and others, have mapped out simultaneously, at different stations, the whole edge of the sun's disk; but the most remarkable observation ever made of them is the following by Professor Young. He observed

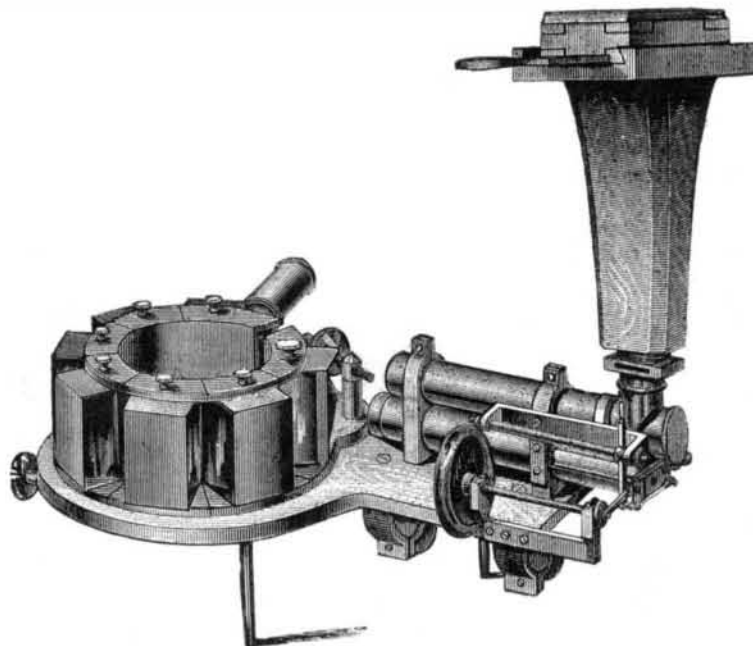


FIG. 1.—DR. DRAPER'S APPARATUS

a large flame, much resembling a grove of trees, for some time, when his duties called him away for about half an hour. When he returned, he found that the flame had been blown literally to shreds, some of which were ascending at the enormous rate of 166 miles a second. Their velocity at starting must have been double or triple.



FIG. 2.—SOLAR FLAMES.

Fig. 2 represents some solar flames, two of them in contact with the sun's disk, and one separated from it. It is supposed that the interior of the sun is in a liquid state under enormous pressure, and that from it the flames burst through the surface with a terrific explosion. The lecturer represented them by means of the apparatus represented in Fig. 3. A glass tank placed in the lantern is filled with a red solution below and cold water above. The coil of wire seen in the engraving is heated by means of a battery, and causes

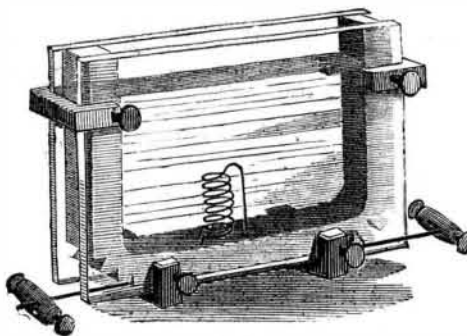


FIG. 3.

the red fluid surrounding it to ascend. The effect is strikingly like that of the red solar flames. Formerly these could only be observed during total eclipses, at the moment the sun's disk was totally covered by the moon. Thus the corona of red flames flashes out with the appearance shown in Fig. 4. This was beautifully shown in its natural colors by placing behind the perforated screen, of Fig. 4, hydrogen tubes, represented in Fig. 5, through which the electric spark



FIG. 4.

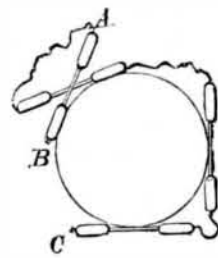


FIG. 5.

was caused to flash. This ingenious experiment elicited much applause. Proctor's theory is that the heat of the sun is maintained by the enormous heat generated by the impact and combustion of meteoric bodies constantly attracted into the liquid mass of the sun. Such impact would cause a grand explosion, carrying with it the propulsion of

liquid and gaseous masses thousands of miles upwards, and would account for the solar spots and the flames rushing out from the edge of the disk. Bodies leaving the sun with a velocity of 300 miles a second would get beyond his attraction and never return. Some of these strike the earth in the form of meteorites, and prove their solar origin, according to Graham, by the hydrogen contained in them. The fact that most meteorites fall in the day time, more especially at noon, when the sun is towards us, tends to confirm this opinion.

#### THE WONDERS OF THE EGG.

[A RECENT LECTURE BY PROFESSOR AGASSIZ.—CONCLUSION.]

In the radiates, the lowest type of the animal kingdom, the eggs are mostly microscopic. I shall have more to say of them hereafter, and of other modes of reproduction common to this type. Before entering upon this part of my subject I wish to make a broad experimental statement about all eggs and all animals. These eggs, whether of vertebrate, articulate, mollusk, or radiate, appear at some time or other to be identical in structure. At least, no investigator has ever been able to detect any essential difference in them. They are all formed in an organ belonging to the maternal being, known as the ovary. In some animals this organ is very simple. Whatever its structure, however, whether complex or simple, there is a spot in the female organism known as the ovary, in which eggs are formed, from which new beings may be developed. But before the egg develops into the new being, it must be fecundated. For what I have said thus far with reference to absolute identity of egg structure throughout the animal kingdom refers only to the egg as egg, before the process of fecundation takes place. There is an organ in the male organisms, cor-

responding to the ovary in the female organism, in which sperm cells are formed, the contact of the contents of which with an ovarian egg is an indispensable condition for the growth of a new being. There are no animals known in which these corresponding organs do not exist.

Reproduction in the vegetable kingdom is based on similar structures with similar relations to one another. These two conditions, essential to the maintenance of types, should be well weighed by any one who would approach the problem of the origin of life.

Before showing you the structure of the egg proper, as it exists in all animals before it takes upon itself any individual character, I will say a word on other modes of reproduction, in order that you may have before you the whole subject, and that I may not be limited in my comparison to the ovarian eggs and fertilizing cells, but be able to include budding and self division among the reproductive processes.

With radiates, especially among the hydroids, multiplication by buds and by self-division is common. An individual such as I sketch on the board (hydroid), puts out a bud from the main trunk. This bud grows into an individual similar to the parent, and it gives rise in its turn to a number of buds which go on multiplying in the same way till a large community is formed. In other instances, such buds may drop off, and become free, independent individuals. Sometimes again, new individuals arising in this way differ from the parent, and only in their offspring reproduce a being resembling the one from which they sprang. Many hydroids, and even some of the aculephs, multiply by a still more simple process—that of self-division. The primitive stock breaks up transversely at regular intervals by constriction, and each such part, when thrown off, becomes a new individual, while the parent remains unimpaired in its vitality.

Certain worms, also, multiply in this way, dividing into parts, and each part building itself up into a new and perfect being. Instances are also known of longitudinal division leading to the same result. Not only is it true that there are other modes of reproduction besides that of eggs, but it is also a fact that the antagonism between male and female, on which the whole process of multiplication and increase among animals seems to rest, is not always necessary for the production of a new individual.

There are cases in which the germ is formed, and passes through all the changes until it reaches the adult condition without being fecundated at all. We owe this discovery to Liebold, who followed the whole history of the unfecundated egg in species of moths, with an ingenuity and perseverance which leave no possibility of doubt as to his results. There are also cases which exhibit an essential difference in the product of a fecundated egg and of one which has not been fecundated. Upon such difference rests, for instance, the whole economy of the bee community. All the eggs laid by the queen bee prior to copulation produce males, and these males are what are called drones. The working bees are undeveloped females, and are the product of fecundated eggs. What is called the queen is the result of a special training of one of these imperfect females. The workers choose one of their number, and, by peculiar treatment and mode of feeding, etc., develop her into a perfect queen, whose office it is to multiply the community. There are also some butterflies which produce perfect male and female individuals from non-fecundated eggs.

The young shark is favored at his birth with what seems to be an egg. It is, however, a bag of nourishment, sup-