ties. Taking the specific heat of air to be 0.267, as at that time determined by the observations of De la Roche and Berard, he found the dynamic equivalent of an unit of thermic energy to be 367 dynams. But if, in the calculation of this number, the more careful and accurate subsequent determination of the specific heat of air by Regnault be substituted, namely, 0.2375, the result gives as the equivalent 426 dynams; a result almost identical with that of Dr. Joule, but based on purely theoretical considerations.

Subsequently M. G. A. Hirn* pursued a course of observations exactly the reverse of that of Dr. Joule, namely, to determine the amount of heat converted into work in the steam-engine. Taking it as an axiom, which he showed to be in strict accordance with analytical investigations, that the difference between the heat existing in the steam as it enters the cylinder and that remaining in it after its exit, must be the thermic equivalent of the work done in and by the engine (which difference in the best constructed engines amounts to about 5 per cent. of the total heat due to the combustion of the fuel), he determined the value of one thermic unit to be 425 dynams; a remarkable result, and intermediate between those previously obtained by Mayer and Joule. In the face of such overwhelming concurrent evidence will even the reviewer be still bold enough to assert that the conservation of energy is a myth?

The principle of the dissipation of energy, as a corollary to that of its conservation, is of course equally ignored by the reviewer; but as his remarks on that point have no relation to anything beyond his own inner consciousness, it must here suffice to give a familiar illustration both of the conservation and the dissipation of energy, in the action of the rifle-ball. This reaches the target with less velocity, and consequently with less energy, that it possessed on leaving the muzzle; a portion of its energy has been expended in producing heat by friction against the particles of air between which it passes, which is dispersed through the surrounding atmosphere, and thus becomes *dissipated*. On reaching the target the progressive motion of the mass is arrested, and converted into molecular motion, which is cognisable only as heat, by which the mass is reduced to the fluid state, and splashes of molten metal are scattered in all directions. These again impart their heat partly to the air through which they pass, partly by radiation into space, and partly to the ground on which they fall; and thus the whole energy of the ball becomes dissipated. An analogous explanation will apply to all other cases of the dissipation of energy; thus the principle may be indefinitely illustrated, but it is hoped that it has now been sufficiently established that the conservation of energy is a fact, not a "heresy of science," the reviewer's opinions to the contrary notwithstanding, for

A man convinced against his will
Is of the same opinion still.

Want of space forbids the consideration of the larger cosmical relations of the conservation of energy to both organic and inorganic existence; one proposition only shall be alluded to as having been by some writers rather overstrained, viz., that the amount of energy in the world is unchangeable, the sum of the actual or kinetic and potential energies being a constant quantity. This may be taken as a postulate, and is probably true, but it is a proposition that is equally incapable of proof or of disproof, because the amount of potential energy in a body can be determined only by its development into actual energy, and cannot therefore be predicated. For example, two stones of equal weight lie one at the bottom of a well, the other on the ground at its edge; both are raised and placed side by side on the top of the windlass frame, much more work has been done on one than on the other,

but can any one predicate in which of the two the greater amount of potential energy resides? Or is there any conceivable difference in the amount of energy acquired by either, otherwise than as dependent on its descending through the greater or the lesser distance?

It may, in conclusion, be remarked with much regret that the principle of the conservation of energy has by some been misapplied in a fruitless endeavour to supersede the necessity of a creative intelligence. To the mind of the writer, and, it is earnestly hoped, to that of most of his readers, the indisputable establishment of this principle conveys only a more exalted idea of that infinite wisdom by which the perpetually recurring transformations and interchanges, not only of the materials, but also of the powers, of Nature are rendered subservient to predetermined laws, which govern the comfort and welfare of all created beings.

CHARLES BROOKE

SPECTROSCOPIC NOTES*

ALTHOUGH P. Secchi and others have recently published descriptions of the different varieties of solar prominences which have been observed, well illustrating the many forms in which these outbursts from the sun's chromosphere occur, a careful record of such disturbances as may be out of the more common order may in the end assist us to a further knowledge on this subject.

While looking for bright lines near F in the spectrum of a low prominence situated 25° north of east, at 11.35 A.M. (April 2), my attention was called to what appeared to me a sudden displacement of the F line toward the violet end of the spectrum.

I immediately brought the C line into the field of view, in order to discover if any change was taking place in the form of the prominence, but was wholly unprepared for the spectacle which met my eye. Upon widening the slit I found that where only twenty minutes before there had been a comparatively low mass of prominence matter not exceeding 50" in height, and remarkable only for the brightness of a jet issuing from the southern portion which was but slightly raised above the chromosphere, there had been an eruption of matter on a grand scale.

Fig. 1 represents the prominence as first seen at 11.15 A.M. At 11.35 A.M. the northern portion had entirely disappeared, and from the low mound, at the point where the jet mentioned above had been seen, an eruption had taken place far exceeding anything I have ever witnessed. Far above the chromosphere the air was filled with long wisps of glowing hydrogen, ranging from 20" to 50" in length, with the appearance of having been ejected in quick succession. Above them floated detached masses, in the form of thin fleecy clouds, and the highest point reached by these was fully five minutes of arc, or about 135,000 miles above the sun. In the mound appeared a low, sharp horn, exceeding in brightness any other portion of the prominence. The grandeur of the eruption lasted but a few minutes, gradually fading in brightness and diminishing in size.

Fig. 2 gives a correct idea of the general form and extent of the prominence as seen at 12 M.

When next observed at 1.40 P.M., nothing was left but a small cloud mass of about the height of the prominence when first seen, at 11.15 A.M. To the north of this, however, were two very small horns, of great brightness. It has generally been noticed that the appearance of these bright points in the chromosphere is a forerunner of increased activity. The forces at work beneath were only gathering strength for a final outburst, which, if not so great in extent, proved to be equally magnificent. I had not long to wait; for after a few minutes spent in examining the F line, just as the clock was striking the hour, I again brought C into the field, and found myself only in

* Reprinted from advance sheets of the Journal of the Franklin Institute furnished by the Editor.

* Cosmos, v. 22, 1863.

season for the grand *finale*. The chromosphere had again belched forth, and far above the sun could be seen the ejected matter, reaching to the height of 94,500 miles. The *débris* was in the form of jets or wisps, which appeared to be falling toward the chromosphere, here and there fretted with sharp horns or bristles. The remains of the first eruption existed unchanged since last seen, at

1.40 P.M., but the changes in the form of the new one were rapid; at one point the filaments were so interlaced as to resemble close network. In the more elevated portions the jets soon lost their brilliancy, and in less than

an hour scarcely anything remained but a few stray wisps floating low down near the chromosphere.

Fig. 5 exhibits the change which the last outburst had undergone at 2.20 P.M.

During the phenomena the C and F lines were completely broken up, being displaced toward both the red and violet ends of the spectrum, the greatest displacement being toward the violet, in the F line extending to the iron line above F numbered 2082 in Kirchhoff's map. The D₃ line also suffered a sensible displacement. I examined the magnetic needle during the outbursts and an hour

afterwards, but could detect no unusual disturbance. In the evening there was a slight auroral display.

The portion of the chromosphere in which the eruptions took place was in the neighbourhood of a group of spots which were just making their appearance upon the eastern

limb of the sun. The spots were completely surrounded by faculae which radiated from the spots themselves, and could be traced to the sun's edge. Fig. 6 shows the po-

sition of the spots upon the sun at the time of the eruptions. The sketches were made at the time of observation, and are as correct as the duration of the phenomena would allow, the general form and most of the details being preserved.

JOHN H. LEACH