

quick in their movements, which increased the difficulty of observation, but that the bees themselves were the agents, in making the holes, there can be no reason to doubt.

Highfield, Gainsborough, December 21 F. M. BURTON

Photography Foreshadowed

THE first prophetic allusion to the photographic art, the discovery of which was to take place eighteen centuries later, is perhaps found in the story of the miraculous occurrence told in the life of St. Veronica.

The second instance is about the year 1690; but intermediate instances may probably be found. I extract from the works of Fénelon¹ the following passage from an imaginary voyage in 1690:—"There was no painter in the country, but when anyone wished to have the portrait of a friend, a beautiful landscape, or a *tableau* which represented any other object, he put water in large basins of gold or silver; then placed this water opposite the object he wished to paint. Soon the water congealing became like a looking-glass, in which the image of that object remained ineffaceable; and it was a picture as faithful as the brightest mirrors." One could wish that the author had entered into detail as to the manner "of placing this water opposite the objects he wished to paint."

The third instance is about 1760, that is seventy years later, and seventy-nine years before 1839, the date of Daguerre's discovery. It is reported² by Ed. Fournier, who extracted from what he calls "un assez mauvais livre," written by a certain Tiphaigne de la Roche³, the entire passage, extremely curious, but rather long. This passage contains many details. The "water" of Fénelon is replaced by "a material very subtle, very viscous, and very ready to dry and harden." "They" (certain "elementary spirits") coat with this material a piece of linen, and present it to the objects which they wish to paint," &c.

In the two last examples the pictures formed reproduce the images of the objects, with their natural colours and their forms, so that the objects are seen as if reflected in a mirror. The photographs of the present day are still very far from this ideal perfection, which, however, they will probably never cease to approach without ever being able to reach.

Rotterdam

J. A. GROSHANS

Average Annual Temperature at Earth's Surface

HAVING lived for many years both in the southern and northern hemispheres, I have a very strong impression that if means were taken to ascertain, with more or less approximation, the average annual temperature at the earth's surface, by a combination of the daily averages of a sufficient number of places of observation, there would be found a very considerable difference in the yearly values of the said average annual temperatures. But whether, on inquiry, there should prove to be a decided difference or an absolute agreement between these averages, the fact in either case would surely be worth ascertaining, and could not fail to be instructive. It might be objected that it would be impossible to obtain the observations of the daily average temperature from such a number of observatories as would render the desired annual average for the whole earth of any value, but I think this objection overstates the difficulty. Suppose that the subject were taken up by some one of the meteorological authorities in Great Britain, it would not be difficult to obtain from existing daily records, a good average annual value for the temperature of the British Islands. Similarly, an average annual value could be obtained for the temperature, from the daily averages in the various colonies and dependencies of the British empire; and I take it to be certain, that the conductors of the various meteorological observatories all over the empire would cheerfully respond to an invitation to co-operate in such a work. In a similar scientific spirit it is to be hoped that the observatories of all civilised countries would be willing to exchange their observations, and an approximate result could thus be arrived at, possibly in two or three years. Certainly, it might be at first a rough approximation only, but it would be yearly becoming better with the rapid increase of meteorological observatories all over the world. And as it is not too much to hope that, sooner or later, the whole habitable earth will be civilised and covered with observatories, it is certain that the figures ultimately obtained to represent the average annual temperatures at the earth's surface

¹ Paris, Auguste Desrez, 1837, tome 2^{me}, p. 643.

² Le Vieux Neuf, Histoire Ancienne des Inventiones et Découvertes Modernes, Paris, Dentu, 1859.

³ Giphantie, à Babylone, MDCLXX, 12^o.

would have the value of scientific approximations of considerable accuracy. If this be so, it cannot be too early to begin these statistics now.

Supposing that these annual averages should exhibit a difference in their yearly values, it is probable that these differences would vary in sympathy with the total sun-spot areas of the years to which they belonged. What could be done for temperature, could be done at the same time for other subjects of meteorological investigation, and it is impossible to anticipate at present what light these tabulated annual averages might be able to throw upon various problems of solar and terrestrial physics.

Balham, December 4

D. TRAILL

ON A MEANS FOR CONVERTING THE HEAT-MOTION POSSESSED BY MATTER AT NORMAL TEMPERATURE INTO WORK

IN a previous article¹ we considered how, by a simple mechanical means, diffusion renders it possible to derive work from matter at normal temperature. As the subject is an important one we propose to develop it somewhat further here.

2. The normal temperature of objects on the earth's surface represents a vast store of energy in the form of molecular motion. The sea (for example) at normal temperature possesses an amount of molecular energy which (by computation), if it were entirely utilised, would be competent to lift it to a height of upwards of seventy miles. The air and the crust of the earth itself possess comparable amounts of energy. It might therefore well be asked beforehand whether it is not possible to transfer some of this intense molecular motion to masses and utilise it. It may be observed that this intense store of energy is being continually dissipated in space in the form of waves (by radiation). The energy possessed by the molecules of matter, however, maintains (as is known) a constant normal value on account of the waves of heat received from the sun, whose mechanical value at the earth's surface (as represented by the results of Herschel and Pouillet) is normally equal to about one-horse power per square yard of surface. Here, therefore, we have a continual store of motion kept up in the molecules of matter on the earth's surface to be wasted in great part in imparting motion to the ether of space. It would certainly look, *à priori*, as if there ought to be some means of utilising this store of motion.

3. The second law of thermodynamics would (as is known) assume that this would not be practicable. This law was propounded simply as what was considered a legitimate inference from the observed behaviour of heat. But a great advance in the knowledge of the nature of heat has been made since that time, and it should be noticed that the law is (admittedly) by no means *theoretically* necessary or requisite to satisfy the principle of the conservation of energy. Indeed a conceivable case opposed to it has been pointed out by Prof. Maxwell, though one not capable of being practically carried out. It was my purpose in the last article to direct attention to a physical process opposed to the law and admitting of practical realisation, in the effects attendant on the diffusion of matter. At the time when this law was enunciated the character of the motion termed "heat" (as illustrated in the now accepted kinetic theory of gases) was unrecognised, and therefore the *mechanism* of the diffusion of gases was not understood. Under these conditions, therefore, it would not be much a point for surprise if increase of knowledge should show the law not to be generally applicable (or not to admit of that general application which is implied by the use of the term "*law*").

4. It may serve greatly to facilitate the following of this subject if we visualise the relations of heat and work more closely. Since "*heat*" is simply a *motion* of small portions of matter (termed "molecules"), and since the

¹ "On the Diffusion of Matter in Relation to the Second Law of Thermodynamics," see NATURE, vol. xvii. p. 31.