mere efforts of the will can easily bring either the one or the other into view. The importance of this law, which enables the mind to select its image, was pointed out in different cases of ordinary vision. It obviates the difficulty already adverted to, of having two different pictures on the same spot; it has not improbably an important influence in producing the general stereoscopic effect; it also, to some extent, remedies the effect of squinting, by obliterating the picture in the imperfect eye, which could not be else done without shutting it. The effect of the law, in some extraordinary cases, was also noticed, especially in the power of the will to fix images on the sight, as Sir Isaac Newton instances in his own case (see his 'Life,' by Sir David Brewster). The author pointed out the great interest of the subject, not only in its practical aspect, but also as having an important bearing on the connexion between mind and matter.

On some Optical Properties of Phosphorus. *By* Dr. Gladstone *and the* Rev. T. P. Dale.

The authors had recently examined the effect of temperature on refraction by means of the instrument constructed by the Rev. Baden Powell, from a grant of the British Association. They had extended their examination of the optical properties of phosphorus to other points. Solid phosphorus at 25° C. gave the following refractive indices :—

Fixed line A	2·1059
,, ,, D	2·1442
Extreme violet	2·3097

This shows an amount of refraction only just exceeded by diamond or chromate of lead, and an amount of dispersion perhaps unapproached by that of any other substance.

Melted phosphorus at 35° C. gave the indices—

Fixed line A	2·0389
,, ,, D	2·0746
,, ,, F	2·1201
,, ,, G	2·1710
Extreme violet	2·2267

This shows a considerable diminution both of the refractive and dispersive power. At the temperature of 35° C., the refraction of the orange ray through solid phosphorus was to that through the liquid body in the ratio of 2·117 to 2·071.

The change of refrangibility caused by change of temperature is greater with liquid phosphorus than with any other known body. A saturated solution of phosphorus in bisulphide of carbon is almost as refractive and dispersive as the element itself. Refractive indices for the principal fixed lines of the spectrum, as seen through such a solution, were given. There is a certain indistinctness about the prismatic image seen through phosphorus not depending on opacity or crystalline structure, and not arising from the high refraction or dispersion, nor wholly from the great sensitiveness to changes of temperature. It may be connected with the well-known allotropic variations of this body, no particular specimen being really homogeneous. The phosphorus experimented on was colourless; yellow phosphorus cuts off the red rays. The white flame of phosphorus contains all the visible rays of the solar spectrum, but exhibits no trace of any dark line or band.

A Hand Heliostat, for the purpose of flashing Sun Signals, from on board Ship or on Land, in Sunny Climates. *By* F. Galton, *Sec. R.G.S.*

A flash of sunlight from a looking-glass, of a few inches in the side, can be seen

assist in making it apparent. Let a person stand before a papered wall with pictures hanging on it, and shift the optic axes so as to bring different patterns of the paper together. The images of the pictures formed in the two eyes will then be separated in the sensorium, and shifted off upon the image of a part of the paper; and if the attention is turned upon these parts, it will be found that it may be made to depend on an effort of the will whether the picture or the paper will be seen there. The experiment might be still better made with a suitable piece of a different paper pinned on the wall; as in the case of pictures, the more interesting or much brighter objects are apt to force themselves too much on the attention.

further than any terrestrial object whatever; and the instrument about to be described shows how this remarkable power may be utilized for the purposes of telegraphy. Heliostats are used in all Government surveys, and their power is well known in penetrating haze, and their utility in requiring no "sky line." They were also habitually employed by the Russians for telegraphy during the Crimean war. But all heliostats that have been hitherto used have been fixtures of large dimensions; commonly, a shaded screen, with an aperture in it, was placed at many yards from the signaller, who stationed himself in such a way that when he could see the play of his flash about the hole in the screen, he might be sure that some of the rays which passed through the aperture would be visible at the distant station. At other times, a polished ring was used for the same purpose as the screen, but the principle was the same. The present instrument dispenses with all fixture; it is more portable than a ship's telescope and as manageable as a ship's quadrant, and may be made by a carpenter for 4*s.*, if he possesses a convex spectacle-lens of short focus and a piece of good looking-glass. The looking-glass attached to the heliostat is about 3 inches by 4½ inches, and therefore capable of being seen at distances, which may be calculated from the fact, that a mirror 1 inch square is perfectly visible, in average sunny weather, at the distance of 8 miles, and that it shows as a brilliant and glistening star at 2 miles. Before describing its principle and action, it will be necessary to explain clearly the peculiar characteristic of the reflexion of the sun's rays from a mirror. If, for instance, we take a small square looking-glass and throw its flash upon a wall 2 or 3 feet off, the shape of the flash will be little different from that of the mirror itself, seen in perspective; but if we direct it on an object 3 or 4 yards off, the angles of the flash will appear decidedly rounded; at 20 or 30 paces it will appear fairly circular; and if we can manage to see it at 50 or 100 yards (which can only be effected by selecting some object to throw it on, that is naturally of a light colour, but lying under a dark shade), it will appear like a mock sun, of identically the same shape and size as the sun itself; and for all greater distances the appearance remains the same. That is to say, whatever may be the shape or size of the mirror, and whatever the irregularity of the distant objects on which the flash happens to be thrown, the shape and size of that flash, if it could be seen by the signaller, would always appear to him as exactly that of the sun. In fact, the flash forms a cone of light, at the blunted apex of which are the mirror and the signaller's eye, and whose vertical angle equals that of the sun's angular diameter. Whoever is covered by the flash sees the mirror, like a small fragment of the sun itself, held in the hand of the observer; and the larger the mirror, compared to the distance, the larger and the more dazzling does it appear. Now, the hand heliostat provides a bright appearance of the sun, which, when the instrument is adjusted and looked through, overlays the exact area which is covered by the flash of the mirror, which is attached to its side. It is a perfect substitute for that mock sun which we can see at 50 or 100 paces distant, but which becomes too faint to be traced much further. All we have to do, when we wish to send a flash to a distant object, is to make that image of the sun overlay the object, just as may be done in rough sextant observations. The principle of the instrument is extremely simple. A convex lens, of any focal distance (5 inches is convenient), has a small screen attached to it, whose surface is at its focal distance. The mirror is so placed that a small portion of its flash impinges upon one end of the lens; say, the right-hand side of it. The signaller's eye looks partly through the other end of the lens, and partly free of it. Now the rays from any one point of the sun's surface are converged by the right side of the lens to a bright speck on the screen; and those rays which radiate from that speck and impinge on the left side of the lens are brought back by means of it to a state of parallelism with the rays that originally left the mirror. Consequently the signaller's eye sees the bright speck in the precise direction of the vanishing point of the mirror's flash, and he can, by looking partly to the side of the lens, refer it to some particular spot in the distant landscape. But what is true for any one point on the sun's disc is true for every point, and accordingly we obtain a bright disc upon the screen, which appears of exactly the same shape and size as the sun itself, and necessarily overlays the exact area covered by the flash of the mirror. It is scarcely possible to describe the instruments that were submitted to the Association without drawings. They consisted of a tube of wood 15 inches long, and with an eye-hole at one end; a mirror turned on an axis at right angles to the tube; and, in front of the mirror, a slip was cut away from the side of the tube, and the lens was inserted athwart the cut-out part. Part of the lens projected within the tube, and part outside of it and in front of the mirror. The screen was placed at the further end of the cut-out part, and an envelope protected the whole from injury. A slide in front of the lens regulated the amount of light thrown on it, and toned the image to the required degree of brightness. The addition of a telescope was not found practically of much use; neither was that of a second mirror, for double reflexion, to meet the difficulty of sending signals when the sun was behind the back of the signaller. It is not difficult to signal within 12° of the point opposite to the sun, and it is possible to do so within 7°. The looking-glass should be of the very best plate-glass, and it ought to have its sides truly parallel, else there will be a confusion of images and an irregularity in the flash. Letters are conveyed by treble groups of flashes, each of which groups consists of one, two, or three flashes, as the case may be.

The author detailed the experiments he had made with the help of an assistant, and trusted that a full trial of the instrument at sea would be made by the authorities of the Navy, with a view of determining whether it should not be accepted by them as a subsidiary signalling instrument throughout Her Majesty's Service. One of the land heliostats has been sent to the United Service Institution, in Whitehall Place, together with a more detailed explanation.

On the Fixed Lines of the Solar Spectrum. *By* J. H. Gladstone, *Ph.D., F.R.S.*

The author exhibited maps of the fixed lines and bands seen in the solar spectrum between those usually designated A and B, and of those which he succeeded in seeing beyond K. The light examined was that of the full sun at noon about midsummer-day. The dark lines and bands in the lavender rays coincided with those drawn by Prof. Stokes, as occurring in fluorescent phenomena; and with those of M. Becquerel, which occur in the photographic image; but the author's map contained many finer ones. It extended to M. Becquerel's N. Another map was exhibited of the dark lines and bands that make their appearance in the orange and yellow rays when the sun is near the horizon, as previously described by Sir David Brewster. The long space of air traversed by the sun's rays when setting also absorbs the more refrangible rays, but makes no difference in the angular position of the fixed lines themselves. The light of the moon exhibits the same black lines, and, when close to the horizon, it shows the additional lines in the orange in the same angular position. The light of the moon, answering in position to the violet rays of the sun, appears lavender, and even grey, like the most refracted rays of the sun. As to the origin of these lines, Dr. Gladstone had endeavoured to determine whether they were due to the absorbent power of the earth's atmosphere, as the lines in the orange appear to be. Fraunhofer's conclusion, that they do not occur in the light of some of the fixed stars, was thought to be open to objection; but the author's observations on the light of the stars had not led him as yet either to a positive or negative result. Artificial lights seen at a very great distance might determine the point. If these fixed lines are dependent on the sun's atmosphere, they ought to be darkest in the light coming from the edge of the sun's disc; but the author had been unable to find any difference between rays proceeding from different parts.

On the Influence of Light on Polarized Electrodes. *By* W. R. Grove, *M.A., F.R.S. &c.*

The author, soon after the publication of Daguerre's experiments, had shown that when light is allowed to impinge on a prepared daguerreotype plate in water, a voltaic current is evolved which affects the galvanometer. In the present experiments, two platinized platinum plates are placed in dilute acid, and the one exposed to sunlight while the other is in the dark. A current is detected by a galvanometer connected with the plates, which, after many experiments, the author found was dependent upon the original polarization or unequal chemical action on the electrolyte,