from two different points and he called the instrument a stereo­scope. Let us imagine in fig. 6 a plane F1' F2' between the two eyes A1 and A2 and the points P, H and V in the object-space, and on this plane the perspective projections pf P, H and V produced towards A1 and A2—as, for example, by photographing on the plates F1 and F2 with objectives O1 and O2 at A1 and A2—then the object can be taken away and we obtain from the projections the same spatial effect as when observing the object itself. The change of accommodation of the eye which, however, has no influence on the power of perception of depth, is excluded, and a further difference (according to I. I. Oppel, 1854) is that in unrestricted vision the image-points not situated on the yellow spot undergo slight displacement in consequence of the difference of the position of the pupil and of the centre of rotation of the eye, which is taken as the centre of projection. This can in no way be imitated in the pictures. In order to obtain a stereoscopic effort from such pictures apparatus is not always necessary. When the pictures L and R in fig. 6 are at a distance equal to that of distinct vision, the stereoscopic effect can be obtained by observing them when the optic axes of the eyes are parallel, and if the pictures are interchanged, when the axes intersect. The second of these methods, which were discovered by Wheatstone, was later widely used for the stereoscopic observation of large wall pictures.

The 1852 model of the Wheatstone stereoscope is shown diagrammatically in fig. 7. This differs from the original model in that the pictures L and R can be placed at different inclina­tions to the mirrors *s*1 and *s*2 and at different distances from them in order to observe the pictures under exactly the same inclination of the image and the same angle of con­vergence as when the picture was taken. Photographs with a large base line and converging axes were then often taken (in Germany first by L. Moser). This mirror stereo­scope had no practical result worth mentioning on account of its awk­ward shape and of the difficulty in obtaining equal illumination of both pictures. It was also inconvenient that the pictures had to be placed separately and reversed in the apparatus. These difficulties are for the greater part avoided in the L. Pigeon (Nancy, 1905) new mirror-stereoscope for large pictures, which can be purchased in book form. Fig. 8 shows diagram­matically the arrangement by which one picture is seen direct and the other in a mirror (H. W. Dove, Sir David Brewster and W. Rollmann). The disadvantage attached to this, that the picture observed in the mirror must be reversed, can according to Pulfrich@@1 be obviated by f rotating the correct picture through 180°in its own plane and placing it in the position of the picture L and by using a so-called roof-prism in the place of the mirror.

Incorrect stereoscopic effects easily arise when using pictures. If for instance the distance of a picture from the centre of projection is different at the time of observation from what it was when the photograph was taken (see fig. 9), objects appear to be either too much in relief or too flat even in monocular vision, just as when looking first through the objective of a telescope and then through the eyepiece. An excellent example is provided by the stereoscopic observation of the moon, first performed by Warren de la Rue (1858) to show that the three-dimensional image is modified by altering the angle of convergence and by placing the pictures obliquely. If the pictures obtained with converging axes are placed further apart on the same plane, the stereoscopic image of the moon has the shape of an egg; this, however, immediately disappears and changes into an approximate sphere, if the picture be broken in the middle and both sides bent back. If the pictures are observed, as by Warren de la Rue, in a Wheatstone stereoscope under exactly the same conditions as when the photographs were taken, the im­pression of a sphere is obtained.

Μ. von Rohr (*Die* *binocularen Instrumente,* 1907) drew atten­tion to the optics of the older stereoscopists and in particular to the works of Wheatstone, and it is to be regretted that so

little notice was taken of these older works during the recent development of most binocular instruments. It would, however, be erroneous to demand that the above-mentioned conditions for the observation of three-dimensional images should always be considered. This is impossible, for example, in the stereo-comparator in which the three-dimensional image is only seen in portions, and never all at once. Neither does it concern stereoscopic measuring instruments, and it is a curious coin­cidence that the stereo-planigraph (see fig. 15) constructed after Wheatstone’s stereoscope, and correct as to the so-called ortho- morphy of the three-dimensional image, was of no use as a measuring instrument.

A lens-stereoscope invented in 1849 by Sir David Brewster and constructed by J. Duboscq is very largely used. The causes of its success were its convenient form and the fact that a series of adjusted stereoscopic pictures (landscapes, machines, &c.) could be observed in rapid succession. The Brewster stereoscope, by making an easy observation of stereoscopic pictures possible when the distance between identical points on both pictures was considerably greater than that between the observer’s eyes, supported to a certain extent the in­clination of photographers not to detract from the pictures. If the lenses shown in fig. 10, on the focal plane of which the stereoscopic image is formed, are large enough, and the distance between the image-points *h1* and *h2* is not greater than the distance between the cen­tres of the two lenses (avoiding the divergence of the axes of the eyes), then the distance between the eyes is secondary and the observer sees the distant points with the axes of the eyes parallel. These apparent advan­tages, however, are counteracted by the defect that the picture seen through the lenses is eccentric, and consequently an incorrect impression of the picture is obtained, and an alteration in the three-dimensional image occurs.

Wheatstone showed later in his controversy with Brewster that this disadvantage in the lens-stereoscope could be avoided by adjusting the lenses and distant points to the distance between the observer’s eyes. This same condition was fulfilled in the “ double-verant ” constructed by v. Rohr and A. Köhler (1905),

@@@1 This fact is published here for the first time.