XXXVII. An adjustable and reversible stereoscope

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of strict mathematical interpretation. His theory of visual triangulation is inaccurate at best, and almost totally inapplicable in the very department to which it has been most applied—that of stereoscopic perspective.

40, W. 40th St., New York,
February 24, 1882.

XXXVII. *An Adjustable and Reversible Stereoscope.*

By W. LE CONTE STEVENS*.

[Plate VIII. figs. 6 & 7.]

THE experiments which formed the basis of my recent papers on Physiological Optics† were, for the most part, made without the aid of any stereoscope, except the modification of Wheatstone's reflector, with which various values of the optic angle were measured. As few persons, however, have sufficient muscular control over the eyes to test my results, I devised an instrument which renders possible for untrained eyes quite a number of experiments which with the ordinary lenticular stereoscope would be either difficult or impossible.

The principal objects to be attained were as follows:—

I. To secure ready motion to the semi-lenses, so that they may be adapted in position for any pair of eyes, whatever may be the distance between the pupils, and for any stereograph, whatever the interval, within the usual limits, between corresponding points on the two pictures.

II. To secure the possibility of removing the semi-lenses at will, so that they may be reversed in relative position, or be replaced by prisms with their bases turned toward each other, so that, without uncomfortable muscular strain, the left picture may be viewed by the right eye and the right picture by the left eye simultaneously, thus producing reversion of relief in the binocular image, if desired.

III. To secure ready motion to the screen, so that to each eye either the whole stereograph, or its right half or its left half separately, may be visible.

IV. To secure the means of examining the binocular image either alone or attended by monocular images, so that the difference between the two kinds of vision may be noted.

V. To secure the means of using the same instrument either with glasses or for binocular combination of images by direct

* Communicated by the Author.

† Proceedings of the American Association for the Advancement of Science, Cincinnati Meeting, August 1881; Transactions of the New York Academy of Sciences, Oct. 24, 1881, and Feb. 12, 1882; American Journal of Science, November and December 1881; Philosophical Magazine, December 1881.

vision, and to reduce to the utmost the difficulty usually attendant upon stereoscopic vision by the latter method.

VI. To secure the means of producing stereoscopy from perfectly similar pictures, by making the retinal images of these dissimilar by oblique vision.

It gives me pleasure to acknowledge my indebtedness to Messrs. E. and H. T. Anthony and Co., of this city, for every facility that could be asked in testing such devices as presented themselves to my mind; and the form finally adopted gives entire satisfaction, the instrument being compact, inexpensive, and easily managed.

The semi-lenses, *l, l* (fig. 6), instead of being cemented to wood or brass, are gently pressed into a pair of boxes, in the opposite walls of which square openings have been cut to transmit the light from the stereograph, which is held on the cross bar, *a*, by pressure between a pair of brass springs, and may be adjusted to any desired position by sliding this along the longitudinal bar. A pair of adjusting-screws, *s, s*, come into contact with the bases of the semi-lenses, and are opposed by a pair of springs, against which the thin edges press. If the semi-lenses are thus pushed together as near as possible, the rays which enter the observer's eyes pass through the thicker parts, and hence are but little deviated. If they be as far apart as possible, the increase of deviation makes it convenient to employ a stereograph on which the interval between corresponding points is greater than on those generally prepared. This interval is ordinarily limited to about three inches. The focal length of the semi-lenses being seven inches, it has been found that a stereographic interval of four inches can be allowed without any very objectionable coloration due to lack of achromatism, the visual lines of the observer being now parallel or slightly divergent. This divergence may be increased to any extent that he is willing to endure, by turning the adjusting-screws, so as to press the semi-lenses closer together. Binocular fusion of images is thus retained; but the associated contraction of the external rectus muscles produces the illusion of slight recession of the object viewed and increased depth of relief. Similar effects may be obtained by using conjugate pictures separated by the ordinary stereographic interval; but they are much less noticeable, because there is less disturbance of the ordinary condition of the muscles.

In front of the partition between the lens-boxes is hinged a pair of narrow brass screens, *c, c*, which, in the experiments just described, are pressed flat as in fig. 6. The left picture is thus hidden from the right eye and the right picture from the left eye. By folding them together, as in fig. 7, neither

picture is hidden by them from either eye. There is a second sliding cross bar, to which is attached by hinges a light wooden screen, *bb*, which in the same experiments is pressed down, as in fig. 6. By lifting this, as in fig. 7, the opening at the middle leaves the left picture visible to the right eye while the right picture is hidden from it; and *vice versâ* for the left eye. The semi-lenses may now be taken out; and for them are substituted a pair of prisms, *p, p* (fig. 7), whose refracting-angle is 12° or 15° . The bases of these are pressed against the springs. The cross bar on which the stereograph rests (*a*) is pushed back to the end of the longitudinal bar; and on looking through the prisms the binocular image is seen in pseudoscopic relief. This effect is very striking if the stereograph selected be one in which ordinary perspective is not strong; that of the full moon has been found best. The cross bar may now be pulled as near as convenient, the visual lines becoming more convergent, but not uncomfortably so. Folding down the wooden screen (*bb*), a pair of monocular images of the moon are seen, one on each side of the concave binocular image, but themselves presenting no relief. They appear very perceptibly larger than the binocular image, but slightly smaller than either picture when viewed with normal vision over the stereoscope. Since the prisms have no magnifying- or diminishing-power, this illusion cannot be referred to the effect of refraction, but is explicable only on physiological grounds.

By removing both prisms and semi-lenses the instrument becomes a direct-vision stereoscope, for use with the unaided eyes. To secure natural perspective, arrange the screens as in fig. 6, but push the cross bar as far off as possible. By now gazing, as if through the stereograph at a very distant point, with the muscles of the eyes perfectly relaxed, double vision results, and the two interior images are seen to overlap and then coalesce. For most persons this experiment is difficult if the stereographic interval much exceeds the observer's interocular distance, and it is not at first easy to secure enough muscular relaxation. Some have found it better to draw the cross bar up as near as possible, and then push it off after coalescence of images has been attained, the binocular image being at first very dim.

To secure the pseudoscopic effect by direct vision, arrange the screens as in fig. 7, but push each of the cross bars out as far as possible. Fix the gaze upon the projection (*a*) at the top of the opening in the wooden screen, and keep it thus fixed while the latter is pulled nearer. When this almost reaches the position *bb*, in fig. 7, the interior images beyond

will be seen to coalesce; and the attention can then be transferred to their resultant combination. This is a hemispherical lustrous cup, if the stereograph be that of the moon, which is smaller and nearer than that obtained by use of the prisms. By pulling the cross bar nearer, the cup becomes smaller, relatively shallower, and, for obvious mathematical reasons, elliptic with the minor axis horizontal. The wooden screen can now be folded down, as before, and attention be given to the variable size of the image as determined by the conditions under which it is seen.

The semi-lenses may be restored, and the screens arranged as in fig. 6. The cross bar, *a*, is removed; and in its place is put one upon which are pivoted a pair of revolving bars, whose springs hold in position a pair of cards on which are perfectly similar outline figures, such as series of concentric circles. The production of stereoscopic effects, either orthoscopic or pseudoscopic, at will, by oblique projection upon the curved surfaces of the retinas, has been already fully discussed* and now needs no explanation.

40 W. 40th St., New York,
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XXXVIII. On *Pseudo-Carbons*.

By C. F. CROSS, *B.Sc.*, and E. J. BEVAN†.

THERE is a general knowledge amongst chemists that the term "carbon" has been loosely applied to a number of substances whose composition and properties, on the experimental side, and the consideration of the condition of whose formation, on the theoretical side, completely prove their non-elementary nature. Notwithstanding this, a glance at the most modern text-books will show that *coal* is still spoken of as "a form of carbon;" *charcoal* also; and the action of sulphuric acid on sugar is still taught to consist in the resolution of the *carbohydrate* into carbon and water‡, the *dehydrating* energy of sulphuric acid being the efficient cause. It is necessary therefore that these defects in our terminology and classification should be stated, in order that they may be removed. In reviewing this subject we would first account for the existence of the errors in question. Certainly the cause would seem to lie in the inertia of the chemical mind—a desire to *know* without *ascertaining*, a tendency to accept a simple

* See the preceding article.

† Communicated by the Authors.

‡ This explanation may be dismissed without discussion.