Munson (F. A.)

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A NEW AND ORIGINAL MODEL.

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THE errors of refraction in the human eye have, within the past few years, awakened a widely-increased interest as their great importance has been gradually developed, the recognition of which has necessitated, on the part of the general profession, the possession of at least an intelligent theoretical knowledge of these anomalies.

The peculiar and characteristic train of symptoms denominated asthenopic, so apparently independent of ocular trouble; other more complex and romote phenomena, such as pain in the back of the head and neck; the rapid increase of myopia in our schools and colleges; and the more recent but perhaps hypothetical inductions associating these errors with severer nervous lesions, have all contributed to render this subject one of general interest and importance.

That this chapter of ophthalmology has, in the past, received so little attention in the college curriculum is neither because its importance has been unappreciated by the special teacher, nor because of its somewhat complex character, but rather, we believe, on account of the fact that a *demonstration* of the optical principles involved is not a little difficult and complicated, owing to the want of some more simple means of clearly and intelligently illustrating these conditions.

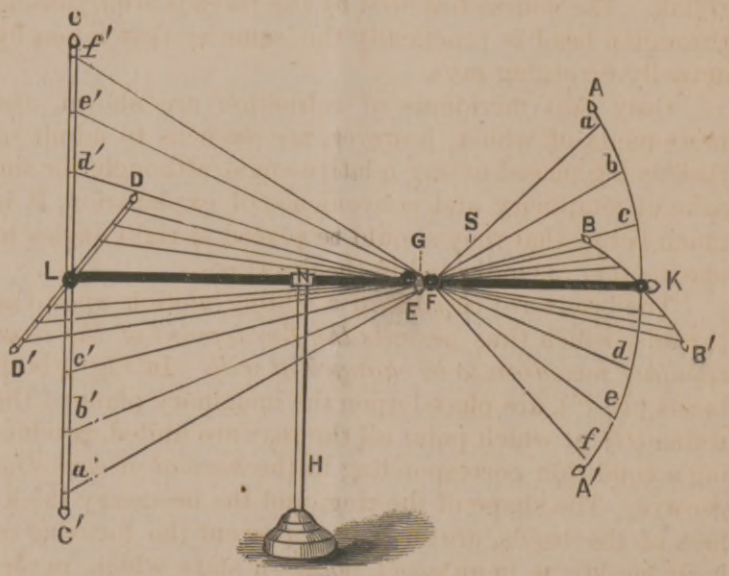
Blackboard drawings have always been of indispensable service in the class-room; but, for their full value to be realized, it is not only necessary to make repeated delineations of similar conditions, but also often to resort to perspective drawing, or to call upon the imagination to picture certain lines or planes, which are supposed to pass vertically through the surface of the diagram(this is

particularly true of the representations of astigmatism); either process, unless, on the one hand, the teacher is an expert artist, or, on the other, the student is especially apt, demands both time and frequent repetition, and even then too often fails to make an enduring impression.

Stimulated by a sense of these facts—1. Of the growing importance of this subject to the general profession; 2. Of the difficulty attending its simple demonstration—the writer has recently devised a *model*, illustrating, in a clear and simple manner, *all of the errors of refraction*. This instrument is so constructed as to be readily adjusted to represent either the optical conditions of the normal eye (*emmetropia*), or those of *myopia*, *hypermetropia*, or *astigmatism*, including all of the various forms of the latter error.

The following is a brief description of the model, as represented in the accompanying drawings:

FIG. 1.



EMMETROPIA

It consists of a brass rod (*L K*, Fig. 1), fifteen inches long, at one end of which (*K*) are two spring wires (*A A'*, *B B'*), bent so as to indicate the anterior curvature of the eye and its refracting media ; at the opposite end of the rod (*L*) are placed two straight heavy wires (*C C'*, *D D'*) for the purpose of receiving the rays of light, represented by silk threads, after their divergence from a focal point. The long rod (*L K*) possesses a sliding movement backward and forward, and a rotary motion also in a small arm (*N*), which is in turn supported by an upright stand (*H*), in the top of which it also possesses a horizontal rotary motion. An ivory ring (*G*) slides, if desired, upon the brass rod, and is intended to indicate the position of the *plane of the retina*. Variously-colored silk threads (*a*, *b*, *c*, etc.) represent the course taken by rays of light after their refraction in the two principal meridians of the eye ; all the rays in a given meridian *pass through a bead* (*E* and *F*), which represents the focal point for that meridian. The course followed by the threads after passing through a bead is practically the same as that taken by actually diverging rays.

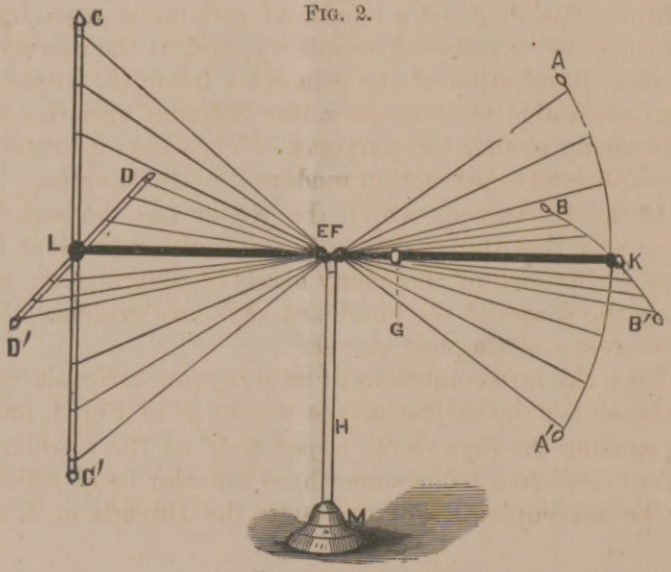
Only two meridians of refraction are shown, the movements of which, however, are such as to admit of their being placed at any relative angle, although, for the sake of simplicity and convenience of explanation, it is much better that they should be placed at right angles to one another, as indicated in the drawings.

The beads are capable of a sliding motion upon the threads, which thus *permits the focal point of the rays in either meridian to be changed at will*. In Fig. 1 both beads (*E*, *F*), are placed upon the imaginary plane of the retina (*G*), at which point all the rays are united, producing a condition corresponding to the *normal* or *emmetropic* eye. The shape of the ring, and the necessary thickness of the beads, are such as to prevent the focusing of both meridians in an exact point—a state which, never-

theless, corresponds precisely with what is found in a normal eye, it being a well-known fact that a really perfect eye is rarely, if ever, seen. A slight degree of astigmatism, insufficient in itself to affect useful vision, forms a rule, the existence of which causes distant luminous objects to be seen as stars or rays, instead of points of light, as they would appear were the eyes optically perfect. Hence, what might seem a mechanical imperfection in the model, in reality illustrates a constant condition of the ordinary eye.

To render evident the optical features of *hypermetropia*, it is only necessary to slide both beads to some one point behind the ivory ring, or retina (Fig. 2), or the latter may be moved anterior to the focal point, thus showing, at the same time, that the rays are not only brought to a focus posterior to the retina, but that such an eye is actually a short one, and would demand a convex lens to collect the rays to a proper focus upon its retina—conditions peculiar to the hypermetropic or far-sighted eye.

FIG. 2.



HYPERMETROPIA.

Myopia may be represented by the opposite movements—both beads (*E*, *F*, Fig. 1 or 2) being changed to a point anterior to the plane of the retina (*G*), or the ivory ring being slid backward ; the latter procedure also shows that the eye is a long one, while either manœuvre indicates equally well that the refractive condition is such that all the rays are united in front of the retina, and would require the use of a concave lens to disperse them sufficiently for union upon the retina—all of which is equally true of the myopic or near.sighted eye.

The many different forms of *astigmatism*, in which the rays of light are unequally refracted in the different meridians, are also clearly and simply demonstrable. Some years ago Dr. Knapp constructed an ingenious thread-model, intended to illustrate the conditions of this refractive error, in which he analyzed a *bundle* of rays, represented by the *circular* arrangement of threads upon a wooden frame, in which the lines formed by dispersion at the two principal foci were shown by bent wires through which the threads passed. This model exhibits truthfully the shape of a bundle of astigmatic rays, but does so at the expense of simplicity, and at the sacrifice of a clear illustration of the principles involved, without being adjustable so as to show the different varieties of astigmatism, so that for purposes of class demonstration its complicated construction renders it of little value.

In the instrument which the writer has devised, it will be seen that the analysis of meridional rays alone is made, so that *all* of the many forms of astigmatism, as well as the shape of the bundle of rays, are evidenced in the clearest and simplest manner.

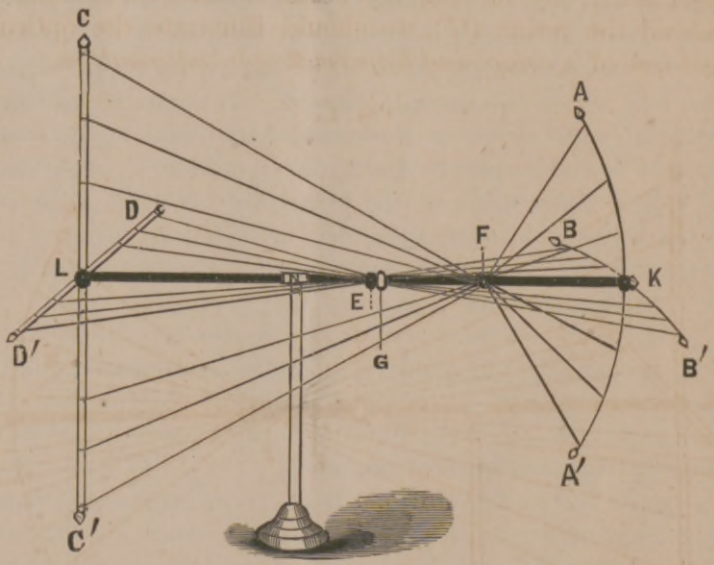
Even the rare conditions of an *irregular astigmatism* may be shown by adjusting the model as in Fig. 1, and then causing the rays *in the upper half* of the meridian *A A'* to come to a focus somewhere anterior to *F*, which may be accomplished by pressing the threads *a*, *b*, *c*,

down upon the rod *L K*, with the point of the finger upon them at *S*, so that the two halves of the meridian have different foci—the rays *d*, *e*, and *f*, in the lower half being brought to a point *upon* the retina, while those (*a*, *b*, *c*) in the upper half have their focus more *anterior*.

The three varieties of *regular astigmatism* are quite as easily demonstrated:

1. If we place both beads upon the imaginary retina, as in Fig. 1, and then move either one or the other anterior or posterior (according as we desire to indicate myopia or hypermetropia in one of the meridians), it is evident the conditions will then respond to the definition of a *simple astigmatism*, for, while there is a simple error of refraction existing in one meridian, the opposite remains of normal focus. After sliding the bead *F* for-

Fig. 3.



Simple Myopic Astigmatism

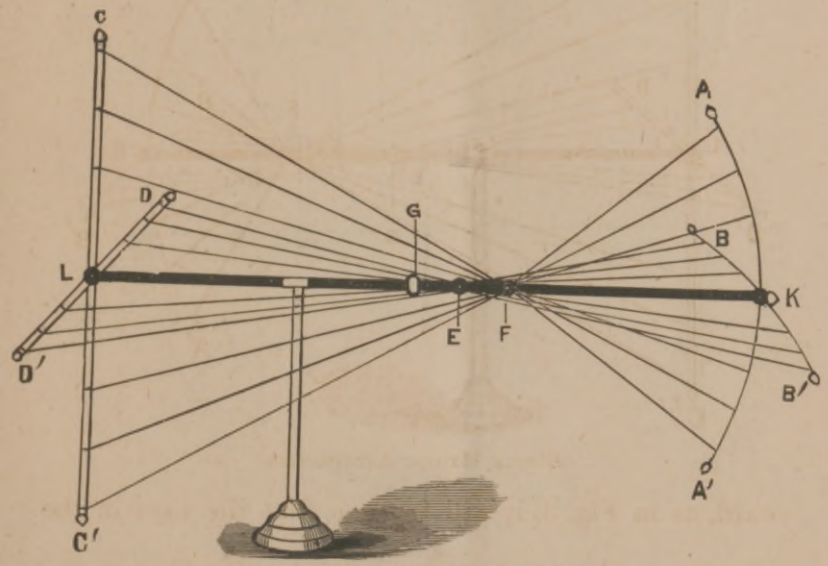
ward, as in Fig. 3, it will be seen that the rays in the

horizontal meridian $B\,B$ are brought to a focus upon the retina (G), while the vertical rays are united in front of the retina at F, so that we have a *simple myopic astigmatism* in the vertical meridian. To show the same condition in the horizontal meridian, it is only necessary to rotate the rod $L\,K$ in the arm N, by which means the meridians change their relative positions.

A *simple hypermetropic astigmatism* would be shown if in Fig. 1 the bead E were moved to some point (toward N) farther away from the retina.

2. By changing both focal points (E and F) to *unequal* distances, either in front of or behind the retina, we comply with the essentials of a *compound astigmatism*. If they are placed as in Fig. 4, the conditions manifest are those peculiar to a *compound myopic astigmatism*, for different degrees of myopia are shown in the different meridians. By moving the beads to unequal distances behind the retina (G), we should illustrate the optical features of a *compound hypermetropic astigmatism*.

FIG. 4.



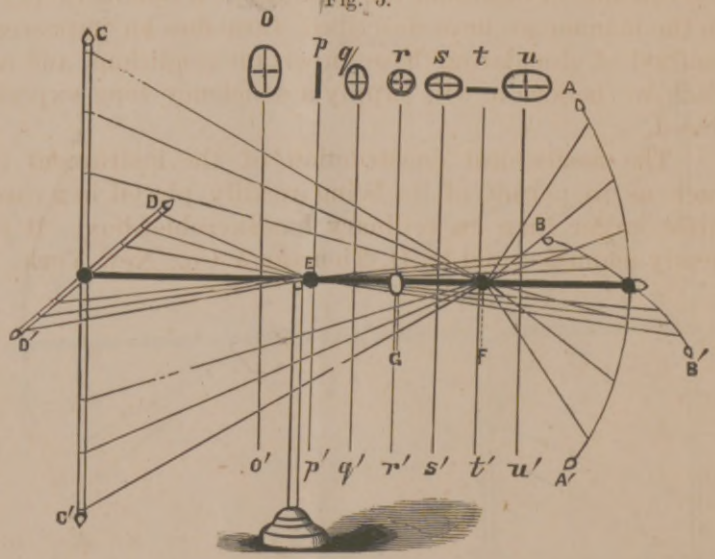
COMPOUMD MYOPIC ASTIGMATISM.

Fig. 4 also indicates that the greater degree of myopia exists in the vertical meridian; but, to show a preponderance in the horizontal meridian, it is only necessary to change the relative position of the meridians, which is done (as above mentioned) by rotating the rod *L K*.

3. Finally, if we adjust the beads so that the rays in one direction are united in front of the retina, and those in the opposite direction are united behind the retina, we then produce conditions peculiar to a *mixed astigmatism*, for we exhibit the presence of myopia in one meridian, and of hypermetropia in the opposite. (*See* Fig. 5.)

It is known that, if cross-sections of a bundle of astigmatic rays are made at different points, the outlines thus obtained correspond to the shape of the dispersion images which would be formed upon the retina, were the latter placed at the point of section. If, for instance, the retina were moved to *F* (Fig. 5), a bright *horizontal line* of dispersion would exist upon it, formed by those rays

Fig. 5.



Mixed Astigmatism.

which, nor having their focus at *F*, cut the retina in the horizontal line *t t'* ; an eye thus constructed, it is evident, would only obtain a clear image of objects (without the aid of a cylindrical lens) by looking through a narrow slit (stenopaic apparatus) held vertically so as to cut off the lateral rays. It will be further evident that a section made through *E* (the focal point of the horizontal rays) would have the form of a *vertical* line, while a section midway between *E* and *F* (the *focal interval*) would show the form of the bundle at that point to be circular (*r*) ; other sections carried anterior or posterior to those already named would have the shape of ellipses (*o*, *q*, *s*, *u*), varying in size, with their long axes either horizontal or vertical, all of which may be more easily demonstrated by the model than by the pen.

Several complicated instruments have been devised illustrating the errors of refraction by means of lenses and movable disks ; but we believe that the use of adjustable threads, to represent the outlines of a bundle of rays in the manner we have described, furnishes an improved method of elucidating these important conditions, and as such we believe it will supply a deficiency long experienced.

The mechanical construction of the instrument is such as to permit of its being readily placed in a case little larger than an ordinary handkerchief-box. It is neatly manufactured by G. Tiemann & Co., New York.