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# A NEW EYE-MODEL (ANAKLASIMETER[1]) FOR DETERMINING THE REFRACTION BY OPHTHALMOSCOPY AND RETINOSCOPY.

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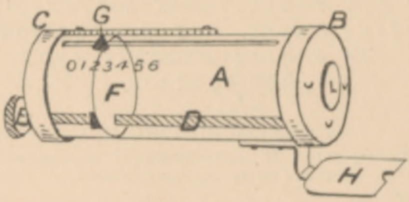
THAT an *accurate* and *inexpensive* apparatus for practice with the refraction-ophthalmoscope is a desideratum will be conceded by all that have endeavored to avail themselves of this most valuable aid of ophthalmology. The tyro, especially, who has to learn the use of the ophthalmoscope and who must endeavor to relax his accommodation, is very much in need of an instrument that will allow him to accurately observe how far he has succeeded in his efforts; or, if he cannot relax his ciliary muscle wholly, how much accommodation he still employs in his observations.

It is for this reason that I have constructed a little model of the eye, which by axial changes permits the accurate determination of all refractive conditions from —10 to +10 dioptries, with or

[1] From the Greek ἡ ἀνάκλασις, the refraction, and τὸ μέτρον, the measure. The usual word, *refractometer*, a compound of Latin and Greek stems, seems rather barbarous, and has therefore been avoided.

without astigmatism, in gradations of 0.50 dioptry, if wanted. The little apparatus consists essentially of a blackened tube, A (diagram), about one inch




Half of actual size.

in diameter and three and one-half inches in length, and closed at either extremity by metal discs, C and B, the anterior disk, B, having a central opening of about one-half inch, which contains a lens of +20 D power. Near the bottom of the instrument is a screw, D, which extends along the whole length of the tube and has at the back a little handle, E, which projects from the posterior disc and allows the screw to be turned. Along this screw there slides on a nut a plate, F, representing the retina, the position of which is indicated on the outside of the tube by a pointer, G. The number to which the pointer is directed indicates the refractive condition of the eye, the white numbers applying to the degree of hypermetropia and the red ones to the degree of myopia. From the anterior part of the tube projects a metal plate, H, which supports the ophthalmoscope and is so constructed that if the ophthalmoscope rests against it the lenses of the latter are exactly fifteen millimeters from the lens of the eye-model. In order to produce an astigmatic eye three little hooks are attached to the anterior plate, B, so that a —2 D cylinder can be slipped in and turned to any desired angle.

As, of course, the eye of the completely relaxed emmetropic observer is only adapted for parallel rays, it will only see the objects on the artificial retina distinctly if the rays coming from the eye-model have been made parallel by the lens of the ophthalmoscope. The numerical value of these lenses for the different positions of the retina can be easily calculated as follows: If $f$ is the focal distance of the lens of the eye-model and $d$ the distance of the artificial retina from this lens, then, by the known laws of refraction, $b$, or the distance of the image of the retina from this lens, will be determined by means of the formula: $\frac{1}{b} + \frac{1}{d} = \frac{1}{f}$; from which we find that $b = \frac{fd}{d-f}$. This equation shows that $b$ is positive as long as $d$ is greater than $f$, *i.e.*, the image of the retina falls in front of the lens, and we have therefore to do with myopia. The ophthalmoscopic lens is 15 mm. in front of the lens of the model, or $b$—15 mm. from the retinal image; it is therefore necessary to find a minus lens that has a focal distance of $b$—15 mm., so that the rays that would come to a focus $b$—15 mm. behind the ophthalmoscope are made parallel after their passage through this lens. The focal distance of this required lens must then be $b - 15$ mm. $= \frac{fd}{d-f} - 15$; or, in dioptries, its refractive power D must be $\frac{1000}{b-15} = \frac{1000}{\frac{fd}{d-f} - 15} = D.$

From this we find that $d = \frac{(1000 + 15\,D)\,f}{1000 - (f - 15)D}.$ This value for $d$ shows us how far from the lens of the model we have to place our artificial retina in order to obtain a given number of (D) dioptries of myopia. In the same way we would find for hypermetropia that $d = \frac{(1000 - 15\,D)\,f}{1000 + (f - 15)D}.$ (It must be remembered that the D's have to be taken with their absolute values only, without regard to the sign.) In this way the following two tables were found:

*Myopia.*

| | | | | | |
|---|---|---|---|---|---|
| $d = 50.00$ mm. | gives | a | myopia | of | 0. D. |
| $d = 52.59$ | " | " | " | " | 1. D. |
| $d = 55.37$ | " | " | " | " | 2. D. |
| $d = 58.38$ | " | " | " | " | 3. D. |
| $d = 61.62$ | " | " | " | " | 4. D, etc. |

*Hypermetropia.*

| | | | | | |
|---|---|---|---|---|---|
| $d = 50.0$ mm. | gives | a | hypermetropia | of | 0. D. |
| $d = 47.5$ | " | " | " | " | 1. D. |
| $d = 45.3$ | " | " | " | " | 2. D. |
| $d = 43.2$ | " | " | " | " | 3. D. |
| $d = 41.2$ | " | " | " | " | 4. D, etc. |

In accordance with these two tables the scale of the instrument has been so constructed that all refractive conditions from —10 D to +10 D can be accurately determined. Practically all that is necessary is to take the model in one hand and the ophthalmoscope in the other hand, and then, after bringing the ophthalmoscope in contact with the rest, to find the highest plus or the lowest minus lens with which accurate and sharp definition of the details of the image can be obtained; and finally, to compare the number of the ophthalmoscope with that of the model. Perfect agreement shows perfect relaxation of the emmetropic eye; a plus lens in the ophthalmoscope too low or a minus lens too high by a certain number of dioptries shows just so many dioptries of accommodation used by the emmetropic observer. If the observer is not emmetropic, and if his refraction is not perfectly corrected, he has, of course, to make allowance for this in the reading of his ophthalmoscope.

If we place the cylinder of —2 D in its proper position in front of the +20 D lens we have then a sphero-cylindrical combination of +20 D in one and +18 D in the other main meridian. For the first meridian the former scale remains therefore the same, but for the +18 D lens a new scale is given below the other, so that the value of each meridian can be read off directly. Let, *e. g.*, the retina be at 85.7 mm. from the lens, then we find the pointer indicating a myopia of —7 D in one and of —4.5 D in the other.

How the instrument may also be used for retinoscopy will be clear from the foregoing description, and needs no further remarks. Of course, there are a good many contrivances that one might feel tempted to add, *e.g.*, a stand for the whole instrument, a changeable iris and a lens-holder in front of the rest for the ophthalmoscope, in order to get a point of reversal of 1 meter by using the lenses of the trial-case in this holder. The aim, however, has been simply to furnish a *reliable* and *inexpensive* means for the *γνῶθι σεαυτὸν* of the ophthalmologist and to omit all unnecessary accessories, which can be added, if desired. I am under great obligations to Mr. D. V. Brown, 740 Sansom Street, Philadelphia, for the elegance and accuracy with which the little apparatus has been constructed, and which is sold for $3.50.

315 North Sixth Street.