# A VARIABLE MAGNIFICATION TRIAL LENS HOLDER

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## Abstract

*A variable magnification trial lens holder is described. The unit is designed primarily for producing small order overall and meridional magnification for diagnosing and measuring aniseikonia. However, the unit can be used alternatively as a trial device in low vision.*


Nearly all procedures for diagnosing and measuring aniseikonia utilize afocal magnification lenses (1). In the relatively sophisticated space eikonometer (2), they are part of the design; however, auxiliary size lenses are often required. In the simpler procedures for assessing aniseikonia used most often today, series of afocal magnifiers are usually needed. This paper describes a simple devise that will hold a pair of standard trial lenses so that an overall or meridional magnification is produced. The unit can be used as an auxiliary magnifier, or it can replace an entire series of size lenses.

A typical example of the simpler methods for assessing aniseikonia is the Maddox rod technique first introduced by Brecher (3). In principle, this method consists in dissociating a double target by means of a Maddox rod held before one eye. The distances between the two targets as perceived by each eye can then be compared. Afocal magnifiers are used to neutralize any difference between these distances and thus provide a measure of the aniseikonia along a particular meridian. Many of the present day techniques are variations of this method. Other methods depend on the stereoscopic observation of a tilting board (4) or a similar target. Again, size lenses are applied so that the tilt of the target is neutralized. Thus, afocal magnifiers are a common requirement of nearly all methods of measuring aniseikonia.

However, afocal magnification lenses are not always readily available. Whereas some prescription laboratories will manufacture size lenses to order, others appear rather reluctant to do so. Furthermore, the delivery period tends to be relatively long. It is therefore useful to have alternative methods of producing small order magnifications.

One alternative method is to place positive and negative trial lenses of equal denomination in the front and back cells of a trial frame. If the minus lens is placed in the cell closer to the eye, the combination will represent a Galilean telescope of low magnification power. However, this procedure is rather awkward if the trial frame must also hold the patient's correction lenses. Furthermore, since the distance between the cells cannot be controlled, the magnification can be changed only by varying the power of the pair of lenses.

A more flexible device for controlling the magnification trial lens holder can be made to order in most machine shops. A metal rod, milled flat on one side, is the carrier for two moveable lens holders, each of which is supplied with a spring clip. The dimensions of the holders are machined to fit standard trial lenses. The distance between the lenses can be varied from a minimum of about 5 mm, depending on the type of construction, to the full length of the rod. The lens holders can be fixed in position with thumb screws. The rings holding the spring clips are supplied with degree divisions so that cylindrical lenses can be rotated to the appropriate axis. The model shown is hand held, but it can be supplied with clamps for attachment to a trial frame.

If a minus lens and a plus lens are placed in the device with the minus lens closer to the eye, we have a system whose magnification power varies with the distance between the lenses. If the two lenses are of equal numerical denomination, the system will be nearly afocal if the lens interdistance is not too great. A rough estimate of the magnification in percent can then be obtained by multiplying the power of the plus lens by the interdistance measured in centimetres. Thus for a +4.00 D lens and a −4.00 D lens placed 1 cm apart, the magnification is approximately 4%.

An exact value for the magnification can be obtained by applying the well known exact formula,

$$M = \left(\frac{1}{1 - kV}\right) \left(\frac{1}{1 - cF_1}\right) \quad (5)$$

where k is the vertex distance, V is the vertex power, c is the reduced thickness, and $F_1$ is the front surface power, when a single lens is considered. In our example, c is simply the interdistance between the lenses, and $F_1$ is the power of the lens farthest from the eye. In our exam-

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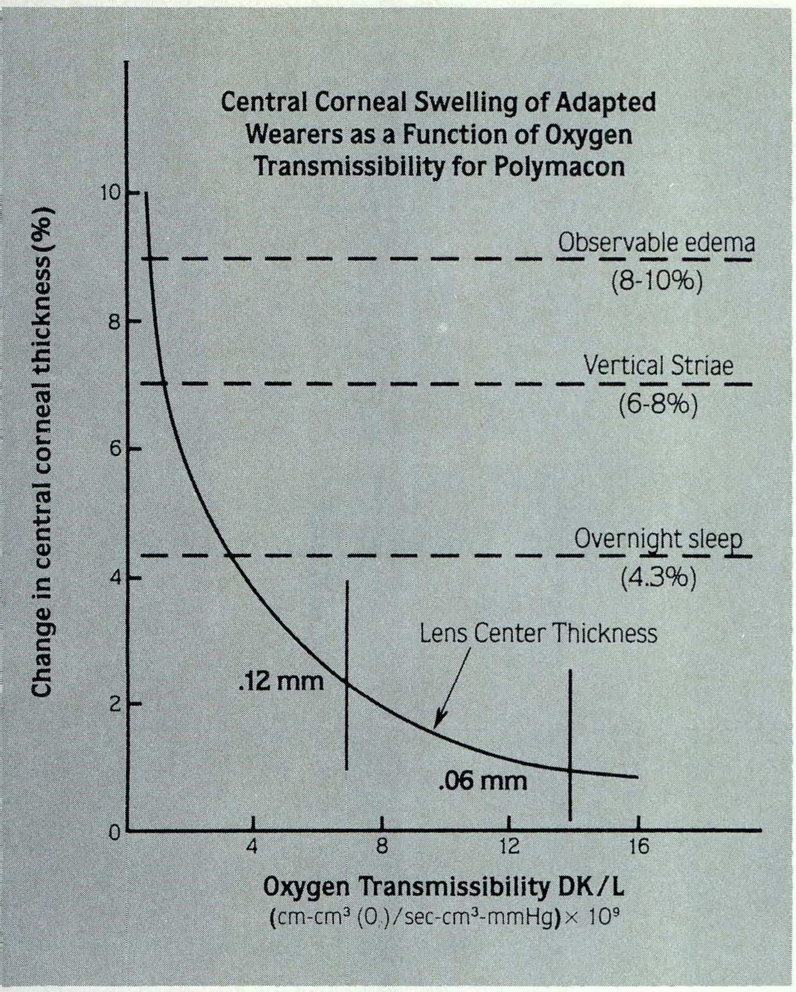


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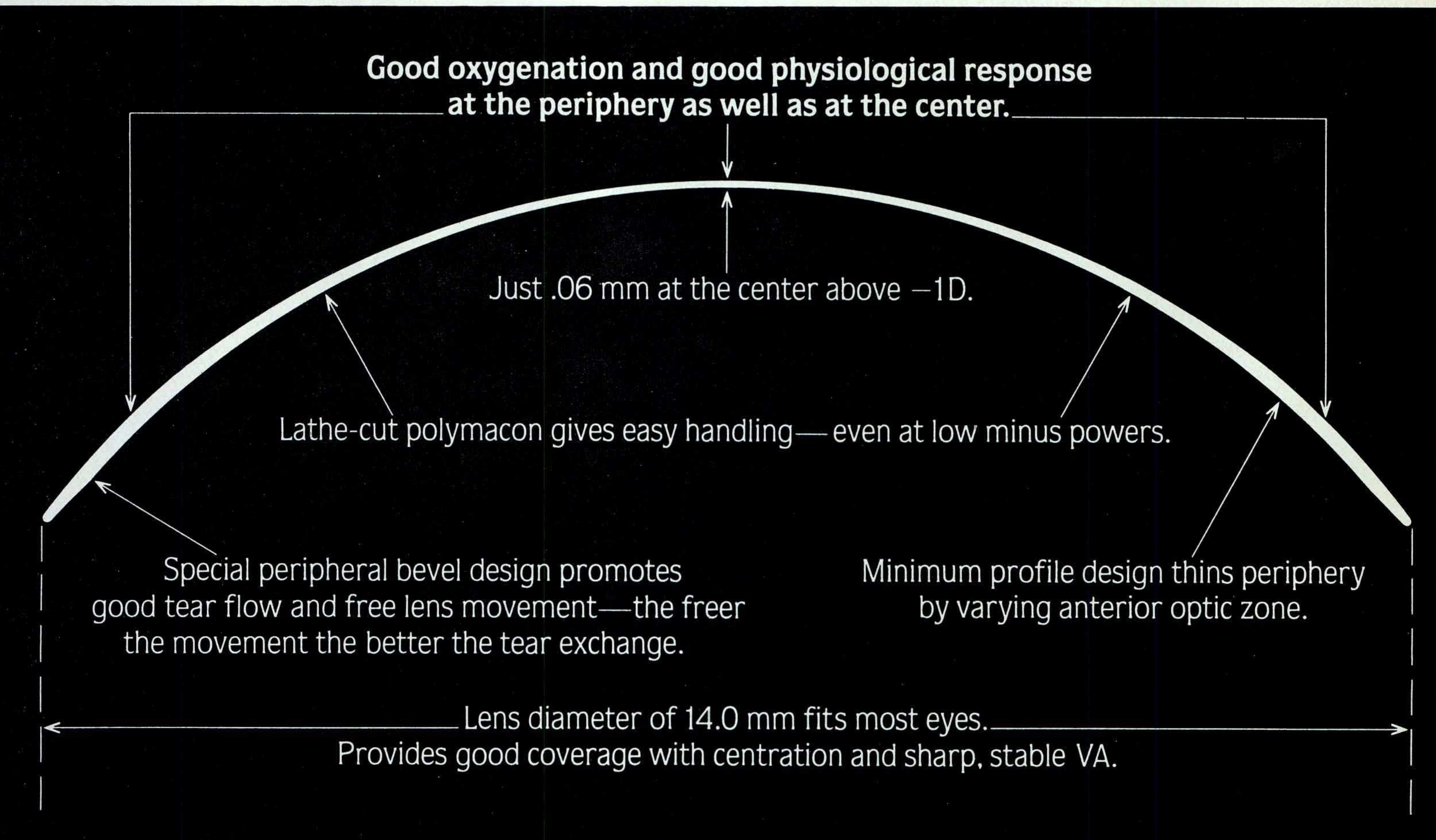

ple, if it is assumed that the lens interdistance is 10 mm, the vertex power at the plane of the minus lens is

$$\frac{+4.00}{1-0.01(+4.00)} - 4.00$$

$$= +\ 0.16666\ \mathrm{D}.$$

Assuming that the vertex distance measured from the minus lens is 15 mm, we have for the exact magnification:

$$M = \left(\frac{1}{1-0.015(0.16667)}\right)\left(\frac{1}{1-0.01(+4.00)}\right)$$

$$= (1.00250)\ (1.04166) = 1.04427, \text{ or } 4.43\%.$$

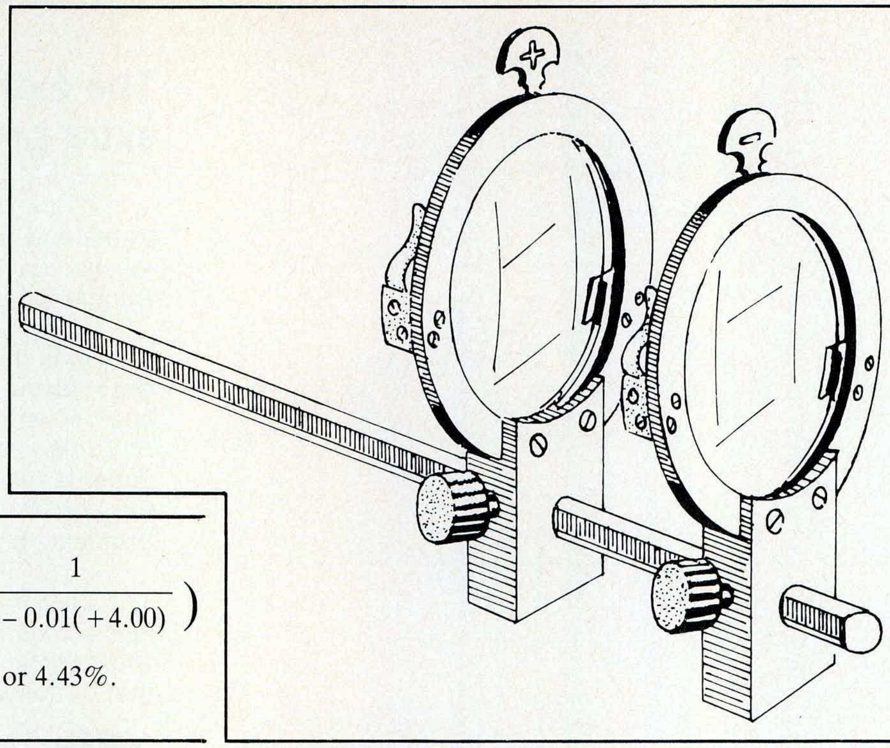

*Fig. 1 Variable magnification unit for trial lenses.*

It is seen that the contribution by the back vertex power of the system is relatively small. For routine clinical procedures it is seldom necessary to calculate the exact magnification; the approximation described above is sufficiently accurate in nearly all cases. For minification, the positions of the plus and minus lenses in the holder can be reversed.

In the above, we have demonstrated the small change in vertex power produced by the separation of the lenses. The blur generated by this slight change is insignificant and would not interfere with most tests for aniseikonia. A change in vertex power of up to 0.25 D would be acceptable in the majority of cases for this purpose. Since it is convenient to vary the lens separation without having to change lens powers, it is useful to know at which separation a back vertex power of 0.25 D is generated. Fig. 2 shows the change in vertex power with lens interdistance for pairs of lenses of numerically equal denominations, such as in the above example. Graphs for lens denominations of 1.00, 2.00, 3.00, 4.00, and 5.00 D have been plotted by applying the factor in the exact formula that describes the effect of the lens separation (i.e., the "shape factor")

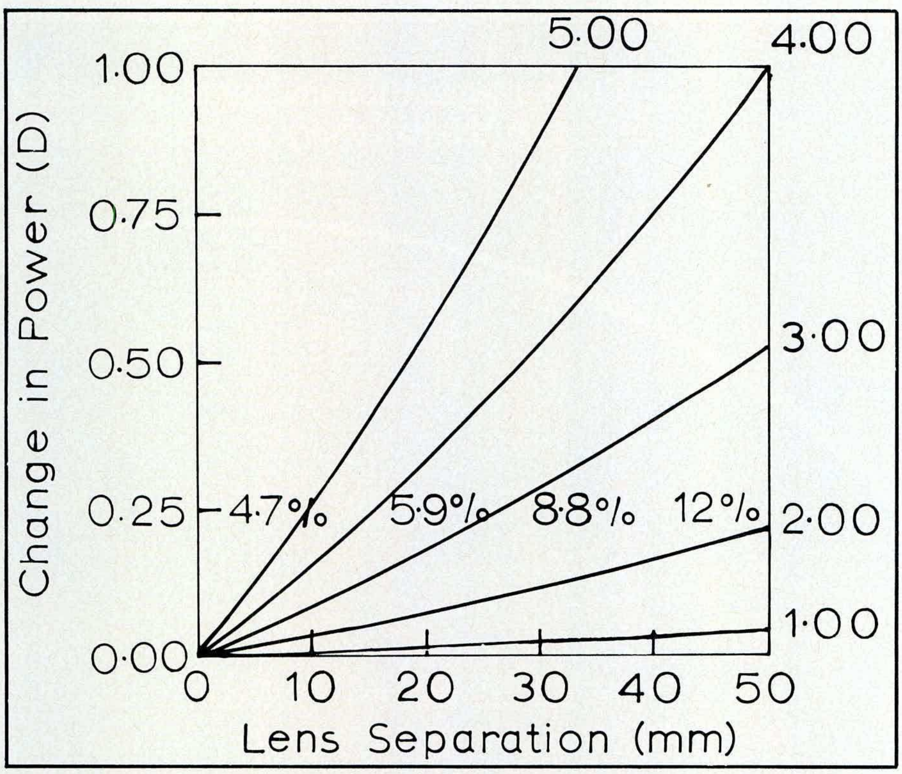


*Fig. 2 Relationship between change in back vertex power of the magnification unit and the lens separation for lens powers of 1.00, 2.00, 3.00, 4.00, and 5.00 D. Percent magnifications associated with a back vertex power of + 0.25 D are shown for each power except 1.00 D.*

(5). Because the back vertex distance is different in individual cases, the relatively small amount of magnification generated by the back vertex power (i.e., by the "power factor") has not been included. The percent magnification value shown next to each graph, except that representing 1.00 D, represents the effect of the lens separation that produces a back vertex power change of 0.25 D. Had the magnification produced by the back vertex power been included, the values would have been slightly higher.

From the family of curves presented, it is seen that the combinations consisting of the lowest powers yield the greatest amount of magnification before the 0.25 D limit is reached. On the other hand, the low power lenses need a relatively greater interdistance to produce the same amount of magnification, which is technically awkward. The ideal lens power for the present purpose would appear to lie between the extreme values shown; thus a combination of a +3.00 D lens and a −3.00 D lens would appear most suitable.

The device was originally designed for simple aniseikonia tests of the type referred to in the introduction, and for the demonstration of space distortions. However, it can obviously be turned into a variable loupe or telescope for subnormal vision testing. For these higher magnification powers, the negative trial lens would, of course, have to be of much higher denomination than the plus lens.

**References**


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Acknowledgement
The author wishes to thank Douglas Gregory for designing and constructing the variable magnification trial lens holder.



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