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Ametropia
and
Its Correction.

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This paper does not profess to be one of original research into a subject of Medical Science, but rather of observations upon a subject of great and increasing interest and concern to the members and students of the Medical Profession and which is too scantily treated of in the curriculum of their professional education.

The paper is the result of postgraduate study in the University of Vienna and at the Glasgow Eye Infirmary.
Light waves of light travel at a rate in inverse ratio to the density of the medium through which they pass: air being reckoned as the standard with an index of one up to its density, that of glass is 1.5.

Rays when passing from one medium into a denser are refracted, unless they fall upon the surface perpendicular, and if so the ray having passed through the second medium, on leaving it, it will continue the same course as it had before entering it.

The ray $AB$ (Fig. 1) falls upon the surface of the medium $M$ perpendicular and is not refracted either upon incidence or emergence, but when the ray falls otherwise than...
than perpendicularly to the surface it is refracted both upon incidence and emergence. The direction being towards the perpendicular upon incidence and away from the perpendicular upon emergence, and upon emergence it continues in the same direction as it had upon incidence through not in the same straight line. (Fig)

The dark line represents the ray and the dotted line the perpendicular.

The direction and degree of deviation while depending upon the density of the medium as one factor, also depend upon the form of the surface of separation. The foregoing illustrations being relative to a medium whose surfaces are parallel; but with regard to the case of a medium whose surface are at an angle to each other we have
have a different condition, as in the case of a prism.
The perpendicular to a plane surface at the point of contact of a ray is termed the "normal."
A ray falling upon the side of a prism is refracted upward, the perpendicular on incidence and away from it upon emergence.
The lines \( P, P' \) (Fig. III) are the perpendiculars of the surfaces \( AB \) and \( AC \), and the dotted lines are the prolongations of three perpendiculars. A ray \( R \) falling upon the surface \( AB \) at \( D \) is bent down toward the prolongation of \( P \) and on emerging at \( E \) it is refracted away from the continuation of the normal \( P' \).
Hence it is evident that rays in passing through a prism have a total refraction towards the base and
and this phenomenon is of the utmost importance in considering the correction of ametropia, emmetropia, being approximately regarded as prisms with their apices together, and convex glasses, as prisms with their bases together.

While the actual direction of rays is changed the relative direction remains unaltered.

In the case of a medium whose separating surfaces are curved, the perpendicular to any point is rather the prolongation of the perpendicular corresponding to the radius, and therefore rays falling upon such a curved surface and obeying the laws of refraction are bent towards the radii. Let M, Fig iv, be a glass medium having its surface S, curved and its centre...
centre at C. Then any lines drawn from this centre to the circumference are radii and a continuation of these will be perpendicular to the surface at the respective points where they cut. The parallel rays RA will be bent in medium at A towards C, and if continued, will meet at the point where they meet in termed the focus: but the ray RP is itself perpendicular to the surface at A and undergoes no refraction and is termed the principal axis. A ray which passes through the optical centre perpendicular to the surface is in this principal axis. The point C is the optical centre and the focus F being a focus of parallel rays.
rays is termed the principal focus. In like manner rays which are parallel to the principal axis in the denser medium it will upon emergence undergo refraction and pass their focus somewhere upon a prolongation outward of the principal axis. Rays which are known divergent upon incidence will be focused upon the principal axis but at a greater distance from the separating surface than the distance of the principal focus.

![Diagram](image)

The points from which these rays diverge \( K \) and the points at which they meet constitute conjugate foci and the distances of these foci from the separating surface are equal when divergent rays diverge from...
from a point $G$ nearer than the distance of the principal focus they will after passing into the refracting medium still remain directed and never meet and if they be continued backward in the same line that they have assumed after refraction they will meet as, say $P$: the conjugate focus of $G$ will be $P$: this form of conjugate focus is termed negative and is of course upon the same side of the refracting surface: it is not formed of actual rays but of imaginary prolongations of rays, nor is it real but only virtual. When conjugate foci are at equal distances from the refracting surface that distance is double that of the principal focus. In the case of a lens rays
rare which enter it. These
mirror is and upon emergence
are refracted. The surfaces are
generally curved. A lens has
been considered to consist of
two prisms: biconvex lenses
having their bases together, and
biconcave having their apices
together; therefore a biconvex
lens causes rays to be refracted
that they become less divergent
while a biconcave refracts them
so that they become more divergent
and if the rays were parallel
before entering the lens they
will become convergent in the
case of a convex lens and
divergent in the case of a concave lens.

This rule only applies if as
is usually the case, the material
of the lens is more refracting
than the medium in which
it is placed: if these conditions
are reversed the convex lens
becomes a diverging and the
concave...
"Concave lens a converging one. Divers sometimes supercilious in which the lenses are formed of air i.e., they are composed of two curved plates of glass enclosing a cavity which is the shape of a concave lens and contains air. This has the same effect in water as a convex glass lens in air."

It is often stated that rays coming from any certain point may be accurately focused in a point, but this is hardly correct and requires qualification for if some rays fall upon a refracting surface at any considerable distance from its principal axes they will not be accurately focused at a point and will cause indefiniteness of the image. This is termed spherical aberration and can be obviated by the use of diaphragms.
When the eye is at rest and not exciting any power of accommodation, or any power of focusing parallel rays which enter the eye, the focus of these parallel rays is either upon, in front of, or behind the retina, or two different degrees of refractive power may exist in the refracting media of the same eye. These conditions are termed respectively emmetropia, myopia, hypermetropia, & aitigmatism. The three latter conditions being different forms of ametropia.

When a patient comes to us complaining of defective sight, we should note carefully the patient's own history for if he be possessed of average intelligence his statement may be valuable. We must consider the physiognomy, for here we can often gain a valuable hint if indeed not absolute information as to the state
of refraction according to the shape of the head and face, the size of the eyes and pupils and the condition of the cornea. Having paid due attention to these points it is well to adopt some certain and fixed rule for further procedure: these very much and perhaps all are equally good.

Firstly examine the visual acuteness. "Acuteness of Vision is that degree of sight which an eye possesses after any correction of its refraction has been corrected."

In order to do this the patient stands with his back to the light, 6 metres away from the test. The letters have been arranged by Tufton of Wonders upon a scientific basis: the largest type should be read by an emmetropia at a distance of 60 metres, and the smallest, at a distance of 6 metres: me eye. Illustrated
covered and with the other eye.
The patient may be able to read
the smallest or only the largest
type. Let the denominator $D$
represent the distance at which the
type should be read, and the numerator $d$
represent the distance at which
the person is reading, then

$$ V \cdot \frac{d}{D} = \left( \frac{d}{D} \right)^2 $$

and the normal condition would be $V = \frac{d}{D}$. When
a patient cannot read $\frac{d}{D}$ he
may either advance nearer, say to
4 m, and then read $\frac{d}{4}$, or
he may remain at 6 m, and
read such a letter as should
be read at 9 m then $V = \frac{d}{9}$. The
latter method is the better one
to adapt in practice and then
the numerator always remains $d$.
If his sight is so bad that
he cannot read $\frac{d}{60}$ we record
is $V = \frac{d}{60}$, and then discover
if he can count fingers at
a certain distance. Suggest he
can
can do so at a distance of 1 m; we unite $V = \pm 2 m$. For persons $V = 0$ he may for all that be hyperopic he cannot be myopic except to the extent of 0.25 D nor can he be astigmatic. If he be hyperopic he is using his accommodation; he need this only, give him a lens power convex lens 0.5 D and if he can see with this he must be hyperopic for if he were emmetropic it would be impossible to arrange his accommodation so that he could turn the rays which are converged by the glass into divergent so that they may fall upon his retina.

If a patient $V < 0$ he may be myopic, astigmatic, have disease of the fundus, cornea or lens, or paralysis of accommodation or even hypermetropic Mr. Hartridge at Royal Westminster Ophthalmic
Aphaknia Hospital does not include hyperopia as one of the abnormalities which may be indicated by the fact of a person not being able to read 6.

If you are satisfied, however, that hyperopia is not present, give him a weak concave lens and if it improves vision he must be myopic. A better method is to have him hold in his hand Shellen's tubes and discover his near point: if this he nearer than it should be according to his age, he must be myopic but if it is further away than it should be he will be hyperopic.

If he be myopic we may at once approximately discover the amount of myopia by finding the far point: supposing it is at 20 cm. Then we may conclude that 5 D \( \left( \frac{100}{20} = 5 \right) \) is about.
almost the amount of his myopia and that a -5 glass will improve his vision to 6/12 or even 6/9.

It however, Spherical lenses do not improve vision like shall the led to suspect the existence of astigmatism.

The foregoing has reference to cases in which patients present themselves complaining principally of deficiency of visual acuteness; other cases will be treated of under the different forms of (anametropia) ametropia.

Hartridge (4th Ed. p. 52) describes a method of quickly ascertaining whether the defect is due to an error of refraction or to a structural change. I have not seen it mentioned by any author nor have I heard of it demonstrated by any of my teachers here or in Vienna. It seems to be...
the "Pinhole Test". It black
diaphragm with a small perforation
in the centre is placed close
to the eye: through the
perforation a pencil of rays
passes on through the axis of
the refracting media of the
eye, so that the image formed
is clearly defined for all distances.
If the pinhole improves vision,
the refractive system is at fault
but if vision is not improved
we suspect either the transparency
of the media or the retina, to
be at fault."
Hypmetropia represents a condition of refraction of the eye in which the antero-posterior diameter of the eye is, in comparison to the power of the refracting media, too great short. The former however may be due to the former or to the latter condition always of course considering that the power of accommodation is not excited. Therefore rays which are parallel before they enter the eye are made convergent, but only to an insufficient extent and such rays are focused at a point behind the rods and cones of the retina, and consequently a distinct image of the object is not formed upon the retina. In order that rays may be focused upon the retina it is necessary...
necessary that they be more or less convergent before entering the eye, but as all rays are divergent, though those which come from an infinite distance are practically parallel, therefore they are never focused upon the retina in the hypermetropic eye, and a hypermetropic is unable to see distinctly any object either near or far, without bringing into play his power of accommodation so that such an individual is handicapped in the extent of his hypermetropia. The distance from the retina to the point behind it at which the rays are focused, i.e., really the amount of the hypermetropia and measured and registered by what convex glasses
glass which, when placed in front of the eye, would give to divergent or parallel rays such a degree of convergence as that after entering the eye the refracting media through which they pass, would be enabled to focus them upon the retina; thus, supposing the principal point of the eye to be situated 25 cm. behind the retina, a convex glass of this focal length $+D$, if placed in front of the eye, will enable the rays, without the assistance of accommodation, to be focused upon the retina. It is therefore patent that a hypermetropic person without a glass must necessarily have his accommodative power excited, to see even distant objects and much
much more so to see near objects and there can be no doubt that this is the cause of the vast increase during the last few years of the number of young girls who are brought to physicians complaining of severe frontal headache and aching eyes, these symptoms being due to the continual strain which is necessary to keep the ciliary muscle contracted in order to impart to the lens a more spherical surface and consequently a higher refracting power.

To our dispensaries, hospitals and private consulting rooms, come a large number of such patients and in eight cases out of ten they are young school girls who are victims of the "green miasma".
brutal high pressure Education code on the young apprentices in the military and dress-making trade; and it is deplorable to hear well-informed medical men enquire particularly about the condition of the digestive process and alimentary tract, about the catalepsy and age and no reference whatever made to the state of refraction of the eyes. The majority of these patients are dosed with Aminne, Antipyrine, Bromide of Potash and a multifarious host of tonics, but all to no purpose; while the minority of these people fall into the hands of men who have been trained to use the ophthalmoscopes. But what better can be expected so long as it is possible for a man to graduate to...
to the degree of Doctor of medicine in the University of Edinburgh without having heard of the ophthalmoscope without knowing more of hypermetropia than that conveyed in an incorrect definition of the term; such a candidate must however of course have a knowledge of the microscopic pathology of actinomycosis and of the life-history and uninteresting domestic habits of the Vorticella and the Archaeaplorus. A hypermetropia of 3 D and at the age of twenty years instead of having 10 D of accommodation has to use 3 D for distance and has only 1 D remaining and at the age of 45 years will have no accommodation power left and will thus be
by immaturely phreoptic.

Given an emmetrope and a hypermetrope of twenty years of age to $\gamma$ dioptres: both have $-xD$ of accommodation. The emmetrope can accommodate to $xD$. Thus if his accommodation is $10D$, he can accommodate to 11 inches or 10 cm. The hypermetrope more use his $-\gamma D$ to overcome his hypermetropia and will therefore have at his disposal, accommodation force equal to $x-\gamma$ for near objects. His functionalmaximum is equal to $x-\gamma D$ which is to say a man at twenty years has $10D$ lens to this as he is hypermetropic to $3D$ he use $3D$ for distance and has only $\gamma D$ as his disposed for near hand.
again, given a hypermetropia of 2.5D and thirty-five years old: his near point is at 16 inches while a hypermetropia of 5D has no near point, at thirty five years Landolt's observation upon this marks is that if a person is to be comfortable for near at hand he must have in reserve accommodative power of 3D.

In order to correct the hypermetropia we must first measure the amount: we commence by noting the visual acuity of each eye separately and then of both together, remembering that it may even be 0 and yet hypermetropia existing: having ascertained that convex glasses improve vision we run up the trial lenses until we find the glass which gives the best vision; yes when the one of next higher power would make it worse, this glass will

[signature]
The manifest hyperopia should be corrected. It is not advisable to correct the total hyperopia, and it is equally unadvisable to leave the latent uncorrected for. In near hand it is well to correct the manifest and a quarter of the latent; e.g., if a person is hyperopic to +4 D., 2 D. of which are latent might have a +2.5 glass; as age advances, the latent gradually becomes manifest so that periodically the glass may require to be changed.

It is well to correct the total hypermetropia once and for all; this cannot alter; any change which takes place will be in the proportion which the manifest and latent bear to one another. For distance it is not necessary to prescribe glasses unless the hypermetropia be absolute and until this occurs the patient should be warned.
warned not to use the glasses constantly.

In order to test the total hypermetropia the power of accommodation must be paralyzed by instilling drops of a solution of atropine (1/49 in 371). Three in a day, thin such a patient as I have just instanced and who would seem to be corrected by +2D will now require +4D, therefore with +2.5D. will see both after the paralytic effect of the atropine has passed off.

In correcting for accommodation it is necessary to avoid asthenopia, and in the case of persons over thirty years of age it is not necessary to give consideration to their power of accommodation but allow them a convex glass fully correcting the hypermetropia, but under thirty years of age it is advisable to trust to a certain extent, for near-hand, to the power of accommodation.

Thus
Thus, a man thirty years old and H 5 D, requiring to wear his near points practically at 12 inches must have a glass of +8.25 D that is 
+3.25 (\frac{4}{12} = 3\frac{1}{3} or \frac{1}{4}) + 5D = 8.25D

The commonest degree of hypermetropia is 1.5 D or 2 D and is congenital.
The commonest cause is the too short length of the anteroposterior diameter another cause is the condition of flat cornea, and also a deficiency in the refracting power of the lens and aqueous.

Hypermetropia is frequently hereditary and is often a family characteristic. There is a form of acquired hypermetropia which occurs with advanced age and is due to a flattening of the cornea and to a loss of power in the refracting media.

If a patient has good accommodation she
He will not be inconvenienced for distant objects and if the \( \text{H} \) be only moderate he may not even be inconvenienced for near objects but if his accommodation be weakened by disease he will not be able to have it brought into play for any length of time. Otherwise the eyes will ache and "wate" and a pain be developed in the head and the object appear dimmed. These phenomena are termed "accommodative hypermetropia."

The hypermetropic eye is small. The pupil is small and the lens near to the cornea than in the ametropic eye and the anterior chamber is shallow. Accommodation and convergence are intimately associated and excessive accommodation results in a too eminent tension of.
of the converging power and causes strabismus.

Hypermetropia may be manifest or latent. The manifest is that portion of it which may be corrected by a suitable convex glass, and the latent is that portion for which the patient cannot accept a glass. The manifest and the latent together equal the total power. Sometimes the whole is latent and sometimes the whole is manifest. The latent portion becomes manifest when the power of accommodation is paralyzed by atropine. Manifest hyperopia may be either facultative, absolute, or relative. Facultative is a condition in which an object at a distance can be seen clearly either with or without a convex glass. The term is the condition with an
an old person: even his distant vision is unchanged and his hyperopia is "absolute": between these two conditions is a "Relative" stage, and in such a case a person can accommodate for a near object but the effort causes a too great degree of divergence and consequently asthenopia. Hypoasthenopia in relation to the Function of Convergence. A hypoasthenope has to overcome this defect by his power of accommodation and while using this power for distance must keep in at least the Function of Convergence, and it is more than probable that it is this dissociation of functions which is the cause of asthenopia. For instance a hypoasthenope of 2D looking at a distance is not encouraging a yet in accommodating to the
extent of 2D, and has to use a considerable effort in this dissociation and for every linear distance he will employ 2D lines of converging than of accommodating power. Some persons can dissociate these functions without difficulty, while others have much difficulty in so doing, while some do not attempt it but Squint. Orders them of converging strabismus in hyperopia that a person was being able to dissociate; a certain amount of convergence must of necessity accompany the act of accommodation. Given a hyperopia of 3D, he has to use 3D of accommodation for distance and not being able to dissociate, he must converge to 3 metric angles. He therefore faces the object with one and converges with the
The term "and congenital squint" congenital strabismus is often due to congenital lack of dissociative power.

If the vision in one eye is defective so that the eye sees but little and it is not worth while to dissociate it to call it into play, that eye must squint and this is the reason why a concave rule in a child's eye will cause it to squint.

Given a squinting eye which is healthy and not hyperopic: if the squint has existed many years the visual acuteness will be defective. Why so? Schweigger says the dimness is congenital and therefore the eye has congenital defect, he makes no attempt to dissociate; then the dimness is the "cause" and not the "effect", but Donders says the...
The dimness is due to want of use and in this effect not the cause: he terms it “Amblyopia in anopia.” If one eye be more hypopic than the other, it is the less useful and will therefore be the one to squint.

**Myopia** is a form of anopia while derives its name from one of its symptoms, viz. a closing of the eyes: when a myope endeavors to see objects at a distance he frequently half closes the eyelids and at same time assumes a somewhat frowning expression.

Myopia is a condition in which when the eye is at rest, parallel rays or rays coming from infinity are focused in front of the retina, yet the conjugate focus of an object at some certain point nearer than infinity will be upon the retina.
Myopia is seldom congenital but appears and increases during childhood; it does however appear to be hereditary. It is due to the shape of the eye, the antero-posterior diameter being too long, or to the cornea being too spherical and therefore of too high refracting power. The shape of the eye depends a good deal upon the development of the head, myopia occurring in dolicocephalic, in cases of prominent eyeballs and of deep orbits, and it is often started by the excessive use of the eyes for near work; the eyes being conveyed by contracting the internal recti muscles and counterbalanced by a corresponding tension of the external recti. This emphaizes the eyeball so that it bulges at the point of least support, the patellar pole, and thence from a staphyloma.
When this is the cause it will of course tend to increase, unless the cause can be removed. Myopia is very much common among well educated people, students and professional people than among the uneducated and working classes: it is commoner in Germany than in any other country, and in our Birmingham than outside of them.

A patient will be unable to see distant objects well his own can see near hand better. The eye appears full and the pupil large. He rubs his eyelids and frequently has a stooping gait. He may complain of photophobia, of pain and irritation in the eye especially when reading, writing, or seeing in well light. The ciliary muscle is often not well developed or is very weak.
By noting the acuteness of vision it is usually discovered that this is defective. A meniscus glass improves it. The fovea centralis is nearer than it should be according to age, and with the retinascope the shadow moves with the mirror.

To estimate the amount we may find the fovea centralis: suppose this to be at 16 cm. The amount of his defect will be \( 5 \frac{1}{2} \text{ D} \) \( \left( \frac{100}{16} = 5 \frac{5}{8} \right) \) and a glass \(-5.5\text{ D}\) will impart its parallel rays such a divergence as though they came from 16 cm; and this will by the power of the refracting media be then focused upon the retina: it is known that very weak glasses which correct the myopia which must be prescribed.

If the degree of myopia is a low one the patient may be corrected...
Corrected for distance only, but he warned to keep his book or work at least fourteen inches away from his face. In high degree it is better to correct for distance, and for nearhand to prescribe such a glasses as will suit the special requirements of the patient: for instance a pianist patient having 6 D myopia will require a second pair of glasses of -3.5 D because he wishes to see his music book at 40 cm. \( \frac{1}{40} = 2.5 \) 2.5 D and \( 6 - 2.5 = 3.5 \) and with these glases he him for nearer work such as reading and writing use his accommodation. In medium degree of myopia it is well to use the full correction both for distance and nearhand: in the high degree such as I have just mentioned the rule to
subtract from the full correction, the distance at which he wishes to see his work, that of a pianinet hung about 140 cm. and of a chair 33 cm. The spectacles which are thus given to the nurse for reading, writing, and piano-playing and for sewing do not, and are not intended to, make the right clearer, but rather to enable him to keep the respective objects at a greater distance from the face than the child otherwise do.

When the prominence and curvature are very close together it indicates that there is myopia in a high degree and in such a case the glass which corrects will probably not improve the acuteness of vision beyond 2/4 because high degree of myopia are usually accompanied by some disease. The
The correction of myopia does not depend entirely on the prescription of concave spectacles, for, since the disease tends to increase, it must be checked. A myope's desire for reading seems to be excessive and ought to be limited: he should not read or write in artificial light unless it is absolutely necessary and should avoid small print and reading during railway journeys. His papers should be kept at least 14 inches away from the face. When reading with or without glasses, he should sit as upright as possible or at least keep the shoulders back and the neck straight and should endeavour to place his seat so that the light may come from the back or from the left side. The stooping position which may be avoided is said to cause an increased flow.
flow of blood to the eye and to obstruct the outflow by compressing the neck and causes irritation and congestion. The general health must be carefully attended to, and the eyes guarded against and outdoor exercises insisted upon.

Ahspia in relation to convergence. A myopic of 2D has his far point at 50 cm. His accommodation for this distance is nil but he has to converge to 2 metric angles. Here again dissociation is necessary, and if he has not the power he will have a divergent squint because one eye will fix the object by moving inwards and the non-converging eye will thus be divergent.

Astigmatism is a term denoting that no point of focus is obtained and is by far the commonest form of anisotropia, for it accompanies a greater or less extent nearly all cases.
both of hypermetropia and myopia. In this form of ametropia the refractive power of the different meridians of the eye are not alike. The abnormality is generally in the cornea, when in its shape as conical cornea, is due to excrescences such as rhinabae and maculae upon it or to facts. It is both angular and acquired and may be either irregular or regular. In the former variety the difference of refraction occurs in different parts of the same meridian and can hardly be corrected by glasses: in the regular variety id is the meridians remain, while differ from one another in their refractive power. Regular astigmatism may be hypermetropic simple or compound, or it may be myopic simple or compound or it may be mixed.
Astigmatism

Regular            Irregular

Hypermetropic      Myopic

A  Simple          B  Compound  C  Simple  D  Compound

E  Mixed

In the simple varieties A and C, one set of rays either in the vertical or the horizontal, when parallel or coming from infinity, are focused upon the retina, that is to say the eye is emmetropic in one meridian in simple astigmatism, while in the other meridian the rays are focused behind the retina in the hypermetropic, and in front of the retina in the myopic forms.

In the compound varieties B and D the rays in both meridians are focused upon one side of the retina but as different distances from
from the retina. Of course in compound hypermetropic astigmatism they are focused behind the retina, and in compound myopic they are in front of it. In mixed astigmatisms the refraction in one meridian is hypermetropic, and in the other is myopic.

We are led to suspect astigmatism if having tested the acuteness of vision we cannot find a glass which affords any definite improvement, and more so if we seem to obtain a similar slight improvement both with a convex and with a concave glass. When such is the case various surgeons adopt different methods both of testing and of measuring the amount of astigmatism. The commonest tests are the Clock face and sundial or fan; both these tests have for their object the
discovery
discovery of the patient's ability to see lines parallel to one another more clearly than those parallel to another: this fact always seemed to me very unsatisfactory, for why in very few cases could one or a patient positively say which line or set of lines he could see most clearly: in testing him one gets the answer "I think so" more often here than anywhere else. The method I have adopted, contrary to my teachers' method, is the following: it seems the quickest and easiest and is certainly thoroughly reliable. Having been led to suspect astigmatisms I at once take up Placido's Keratometer: it is a round disc made of any polished material, such as china, enamelled iron, or paper mounted upon a wooden disc and varnished, having a
a hole in the centre and
marked upon a handle,
and upon the surface are
black and white circles
alternating and three
quarters of an inch wide.
This is held in front of
the patient's eye, he directed
to look at the centre of it,
and the beam both through the
centre at the eye. The circles
are reflected upon the cornea
and if sharpened the images
of them are quite round and
regular. The refraction in the
cornea cannot be astigmatic
but if they are elliptical
it indicates that there is astigmatism
and also indicates the meridians
in which the greater and
denser curvature exist. If
the eye has not already been
atrophied by this now be
done, and then with the
Retinoscope discover whether the
astigmatism...
astigmatism the simple or compound myopic or hypermetropic, or mixed. Then use the suitable trial lenses in front of each eye and make use of the shadow test until the shadow is reversed, hitting each meridian separately. Supposing we find that the refraction in the vertical meridian is normal and in the horizontal is -- 2D, this would indicate a case of simple hypermetropic astigmatism. Of course the shadows are in the opposite meridian to which the refraction is referable. For instance in the above case the shadows would have its normal direction in the horizontal meridian and the hypermetropia of 2D would appear to be in the vertical meridian. The glasses for correcting astigmatism are ground as segments of a cylinder and the part corresponding to the axis in plane, so that rays passing through parallel to the
the axis are not refracted. In the case just stated the axis would have to be to correspond to the vertical meridian and the glass would be described as \( +2 \text{ D. cp. ax. vert} \).

Given a case of compound hypermetropic astigmatism, the vertical meridian \( 2 \text{ D} \) and the horizontal \( 1 \text{ D} \): a spherical glass of \( +1 \text{ D} \) will correct the horizontal meridian and one degree of the vertical. Therefore to this we add a cylindrical glass of \( +1 \text{ D} \) with its meridional axis vertical. This correction will be made in one glass by the optician. The treatment for myopic astigmatism is arranged upon the same lines as that of hypermetropic.

Given a case of mixed astigmatism, the horizontal meridian myopic \( 2 \text{ D} \) and the vertical hypermetropic \( 1 \text{ D} \): a \( +1 \text{ D cp. ax. horizontal} \) glass.
glass will correct the unilateral hypermetropia, and a $+2D$
glass $+ $ axis, unilateral will correct the horizontal myopia: it is
possible to have this correction combined in one glass, but the difficulty is considerable, and opticians prefer such
a correction to be made in the following manner: give
a spherical glass for the least amount of error in one
of the meridians, and a cylinder of the amount of the refraction of the other meridian. Plus
that of the one meridian which has been corrected by
the spherical glass, and its axis to correspond with the last named meridian.
For instance, in the above case, the correcting glass would be $+1D$ spherical combined with $-3D$ cy: axis vertical. Having found the amount
amount of astigmatism we
can combine pairs of couples
of trial lenses for the manual
correction and then test
the patient with the test
stipus (distant) in the clock
face but it is frequently, if
not indeed generally, impossible
to bring the acuteness of
vision up to $/9$. 