

**How to choose glasses : being suggestions to practical opticians / by Henry D. Noyes.**

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**Publication/Creation**

New York : William Wood, 1880.

**Persistent URL**

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## HOW TO CHOOSE GLASSES.

## SUGGESTIONS TO PRACTICAL OPTICIANS.

## CHAPTER I.

## GENERAL REMARKS ON THE STRUCTURE AND FUNCTION OF THE EYE.

The human eye is nearly spherical and about one inch in diameter. In it we have an optical apparatus whose purpose is to form a clear picture, and we also have a sensitive surface on which this picture or image must be accurately focused. The optical apparatus consists of the cornea and aqueous humor, the crystalline lens, and the vitreous humor. There is a diaphragm placed between the cornea and the eye called the iris, and it is perforated by a round hole called the pupil. It serves the same purpose which diaphragms fulfil in other very optical instruments.

The sensitive surface upon which the image is thrown is the retina, and it is backed by black pigment contained in its outermost layer, and in the membrane outside of it, called the choroid.

We have then in the eye the usual conditions of an optical instrument, viz., a series of lenses between which is an opaque and colored diaphragm, and also in addition a screen behind which is a blackened surface to deaden reflections, and to produce vivid contrast.

The instrument is small and of considerable power—as a whole the optical apparatus is about the equivalent of a half-inch lens. It follows that the image must be small, and it is a real image whose position is inverted as related to the object.

The general form of the eye is shown in Fig. 1. The act of reading requires in the eye the possession of a focusing capacity. This focusing capacity is called the accommodation. It is dependent on early life, and grows less from its years, and is dependent on the diaphragm.

It also happens that the lens of the eye grows less in diameter, and does not notably degenerate until after 30 years of age.

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The act of reading requires in the eye the possession of a focussing capacity. This focussing capacity is called the accommodation. It is strongest in early life, and grows less from 15 years onwards, and at 75 disappears.

It also happens that the keenness of sight grows less in advancing age, but does not notably depreciate until after 50



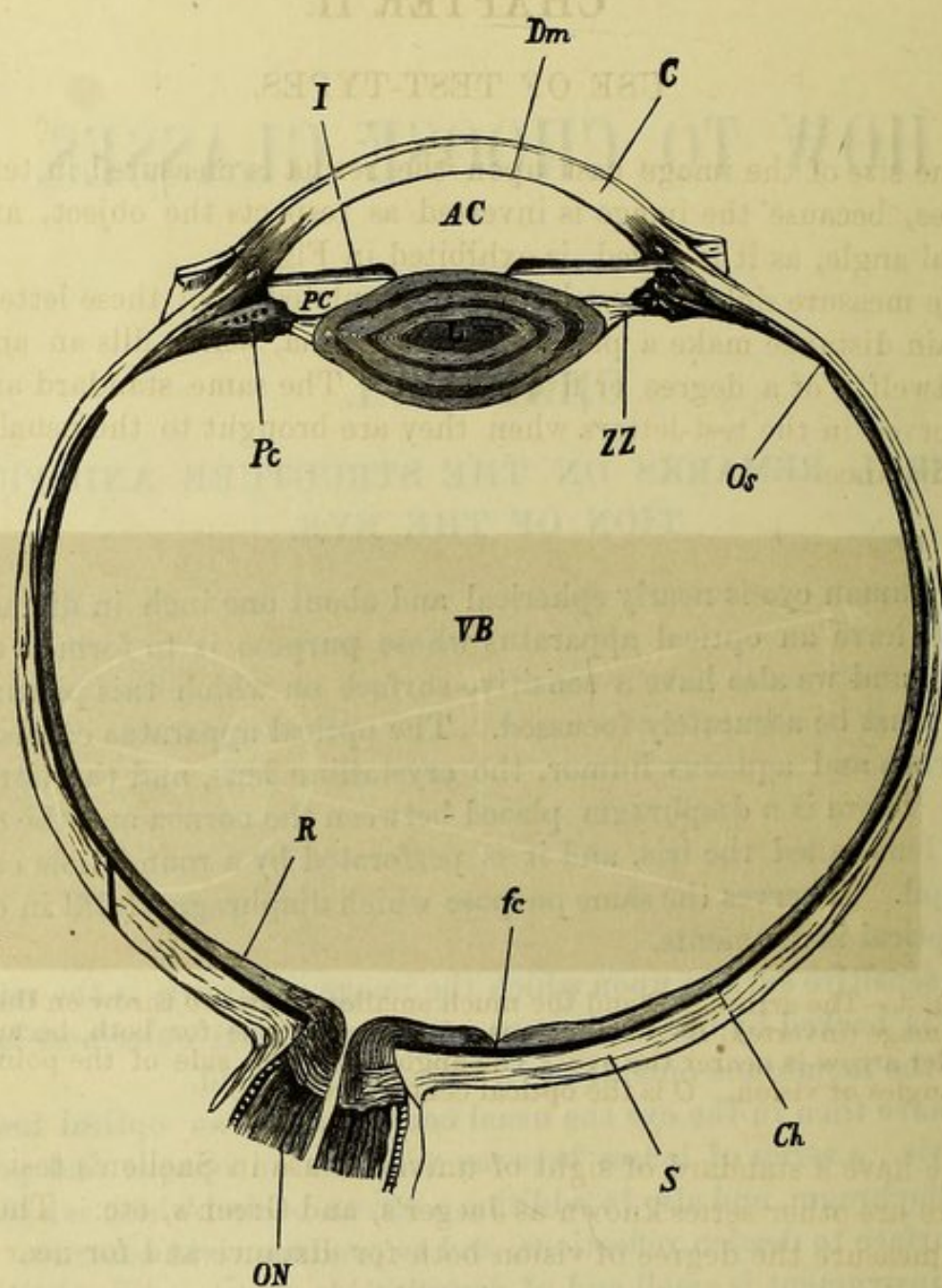


FIG. 1.—*C*, cornea; *Dm*, Descemet's membrane; *AC*, anterior chamber; *I*, iris; *PC*, posterior chamber; *Pc*, ciliary processes; *ZZ*, zonula of Zinn, or suspensory ligament of lens; *Os*, ora serrata; *L*, crystalline lens; *VB*, vitreous body; *R*, retina; *fc*, fovea centralis, or yellow spot; *Ch*, choroid; *S*, sclera; *ON*, optic nerve.



## CHAPTER II.

## USE OF TEST-TYPES.

The size of the image cast upon the retina is measured in terms of angles, because the image is inverted as respects the object, and the visual angle, as it is called, is exhibited in Fig. 2.

We measure sight by test-letters of regulated size; these letters at a certain distance make a picture on the retina, which fills an angle of one-twelfth of a degree or five minutes. The same standard angle is preserved in the test-letters when they are brought to the usual reading distance.

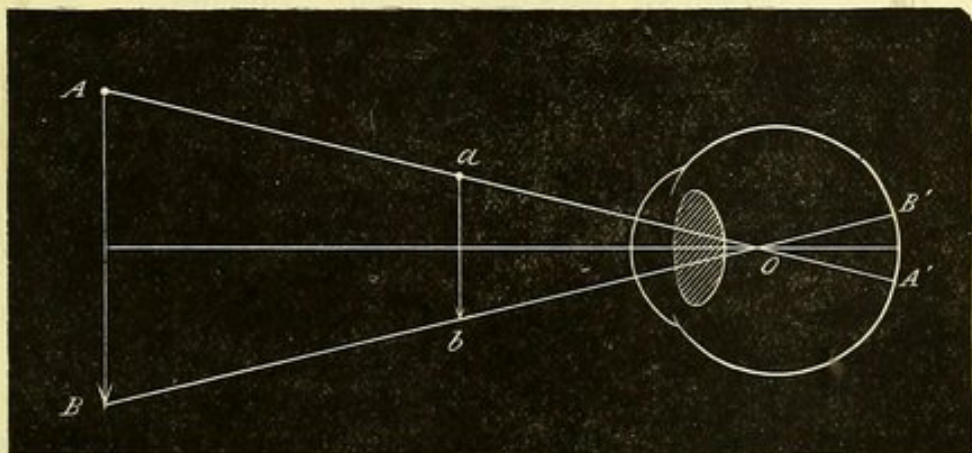


FIG. 2.—The arrow  $AB$  and the much smaller arrow  $ab$  throw on the retina the image (inverted)  $B'A'$ , which is of the same size for both, because the smaller arrow is nearer the eye. The angles on each side of the point  $O$  are the angles of vision.  $O$  is the optical centre of the eye.

We have a standard of sight of universal use in Snellen's test types. There are other series known as Jaeger's, and Green's, etc. These letters measure the degree of vision both for distance and for near work. The only proper way to measure sight is to put test-types at the distance of 20 feet or not less than 12 feet. If we measure by print held in the hand, we have to do with two functions of the eye, viz., 1st, with the keenness of vision, and 2d, with the power of accommodation. We must examine both functions, and deal with each separately. Therefore we first try the person's sight upon the test card at 12 or 20 feet. The letters are arranged in sizes such that the number over the top of each line indicates the distance in feet (or else in French metres) at which they ought to be read. We have letters which should be seen at 200 feet, at 50 feet, at 20 feet, at 12 feet, etc. If a



person sees letters No. XX at 20 feet, his sight equals  $\frac{20}{XX}$  or 1. If at 20 feet he only sees type No. L (50), his sight =  $\frac{20}{L}$  or  $\frac{2}{5}$  the proper amount. If at 20 feet he sees type CC (200), his sight equals  $\frac{20}{CC}$  or  $\frac{1}{10}$ . The degree of sight is always expressed by a fraction. It may be better than 1. If at 20 feet a person reads type XVI (16), his sight equals  $\frac{20}{XVI}$  which is better than 1. If twelve feet be the distance chosen, the type to be read should be XII, and sight would be  $\frac{12}{XII}$  or 1; or it might be type VIII and sight =  $\frac{12}{VIII}$  or  $\frac{3}{2}$ ; it might be XXX and then sight would be  $\frac{12}{XXX}$ .

For reading, the test letters are chosen so that at 1 foot or at 20 inches (half a French metre) a suitable size is to be had. But in reading, while the proper print may be read at the appropriate distance, it also ought to be read at shorter distances, because the accommodation makes this possible. But the amount of accommodation varies at different ages according to the following table:

The type, No. 1 Snellen, or No. 2 Jaeger, may be read by

a person 15 years old at about 3 inches.

"	23	"	"	4	"
"	32	"	"	6	"
"	38	"	"	8	"
"	45	"	"	11	"
"	50	"	"	16	"
"	58	"	"	24	"

This extreme effort can only be kept up for a few minutes; and for older persons some allowance must be made.

If now a person by the test letters at 20 feet does not read the proper line of type, his sight is imperfect. If a person do not read 1 of Snellen at the distance which his age should permit, his accommodation, or his keenness of sight, or both may be at fault.

A person may read No. 1 of Snellen at a nearer point than his age would indicate, but his eye will not be correct, it may be near-sighted, or have some other error.



## CHAPTER III.

## OPTICAL ERRORS OF THE EYE.

We have hitherto discussed the normal eye. It is called technically, in reference to its optical qualities, the emmetropic eye. We now proceed to speak of the optically incorrect eye. But we exclude all cases where the transparent parts have lost their clearness, viz., such as have spots or haziness on the cornea or surface, or in the lens (cataract) or in the vitreous body (see Fig. 1).

It is a popular mistake to call an opacity of the cornea by the name of cataract. True cataract is inside of the eye, not on its surface; it lies behind the pupil and not in front of it.

For opacities just alluded to, spectacles are of no use, and we leave them out of consideration.

Errors of refraction which we deal with are caused by faults in the length of the eyeball, that is, of its optical axis, or by faults in the shape of the cornea or of the structure of the crystalline lens.

The faults in the length of the eye are that the optical axis is too short or it is too long.

We take the optical axis of the correct eye at 22 millimetres (25 millimetres equal 1 English inch); any shortening of this axis constitutes an error which we call hypermetropia or hyperopia—a lengthening of this axis we call myopia. Fig. 3 shows these conditions.

*Hypermetropia*, a state in which the axis is too short, was not recognized properly until Donders discussed it in 1864. It exists in various degrees, and is a fault which belongs to the eye from birth. Small degrees frequently pass unnoticed until middle life, while the higher degrees demand attention at an early age.

*Myopia* is the case in which the eye is too long. It is made so by bulging at its back part. This happens because its coats are weak and cannot bear the pressure which ordinary use causes. Hypermetropia is a state which the eye has had from birth; myopia may exist from birth, but is generally produced at from ten to fifteen years of age.

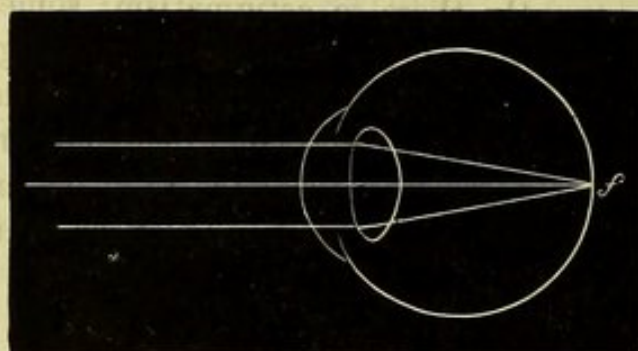
Hypermetropia does not really increase, although it may seem to; myopia does increase for a certain number of years.

*Astigmatism*.—This defect does not concern the length of the eye, but the shape of the cornea, or the structure of the crystalline lens. If we suppose a watch glass to be flexible and to be squeezed by

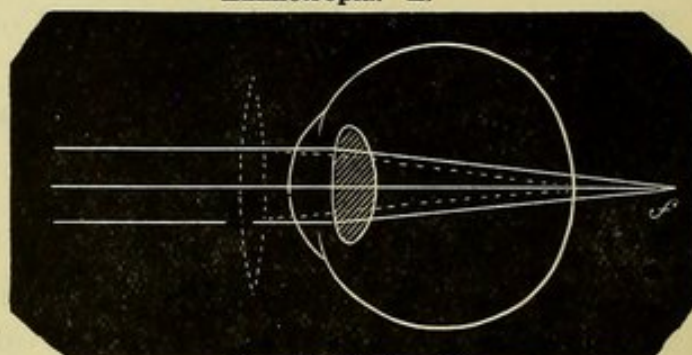


opposite sides of its edge, its shape will be altered so that it will be more convex between the points where the finger and thumb press, than in the transverse direction. The change of shape thus given to the watch glass, is what is really the fact in the cornea in most cases of astigmatism.

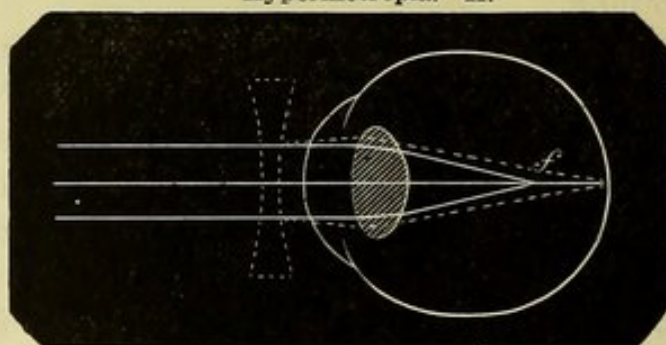
A condition optically similar is caused when the crystalline lens is denser at some parts than it is at others.



Emmetropia. E.



Hypermetropia. H.



Myopia. M.

FIG. 3.—Shows the difference in size of the eyeball in its three principal optical states, and indicates the glasses needed and how they change the course of the rays of light. The middle eyeball is not as short as it might have properly been sketched.

Astigmatism is a condition which usually belongs to the original form of the eye, that is, the person is born with it, although it is sometimes caused by disease.

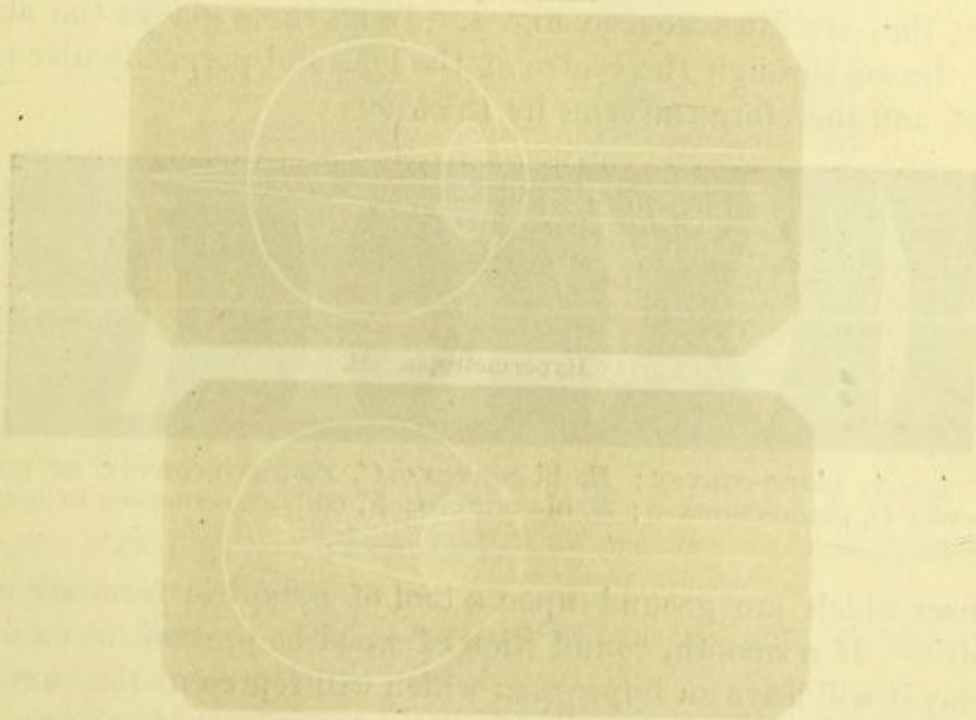
It will easily be understood that astigmatism may belong to eyes of any length of axis, that is, we may find it in persons whose eyes are of correct length, as well as in those in whom the axis is too short (hyperopia or hypermetropia), and in those in whom the axis is too long (myopia).



The above-named optical errors are all with which we have to deal. But it is not rare to find in a given case that the eyes are not alike; one may be correct and the other be incorrect, or each may be faulty and in a different way.

This compels us to always examine each eye by itself when testing the degree of sight by the distant type.

*Crossed eyes* almost always have an optical error. Usually they have hypermetropia; frequently there is astigmatism; sometimes there is myopia; commonly the two eyes are unlike—one eye is generally defective in sight as well as in optical structure. Persons with crossed eyes always use but one eye at a time, sometimes they are almost blind in one eye. Cases of crossed eyes or squint need an operation to straighten them and afterwards need glasses to keep them straight and to learn correct use of them.





## CHAPTER IV.

## VARIETIES OF SPECTACLES.

For correction of optical errors we use the following kinds of glasses, viz., plano-convex, bi-convex, concavo-convex or the positive meniscus; plano-concave, bi-concave, convexo-concave or the negative meniscus; plano-cylindric, either convex or concave, and spherico-cylindric, which may be convex or concave; we also use prisms either by themselves or in combination with the above forms.

Lenses having a surface which is a portion of a sphere are designated as spherical lenses, and are ground by a tool which is a part of a sphere; they are illustrated in Fig. 4. In all these glasses the axis is a line drawn through the centre of the lens and perpendicular to its surface, and therefore traverses its thickness.

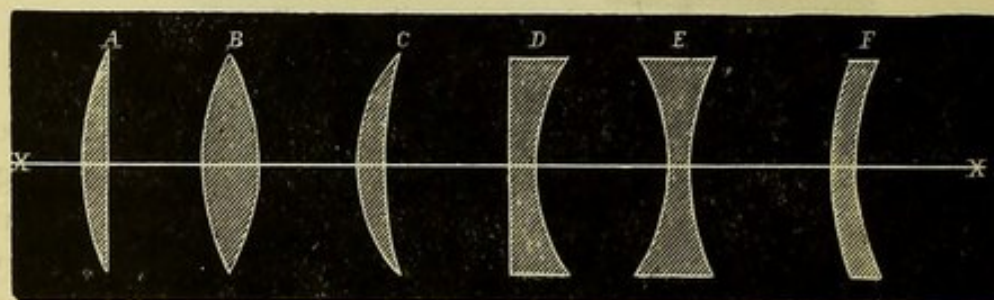


FIG. 4.—A, plano-convex; B, bi-convex; C, concavo-convex or positive meniscus; D, plano-concave; E, bi-concave; F, convexo-concave or negative meniscus.

Lenses which are ground upon a tool of cylindric form are called cylindric. If a smooth, round stick of wood be pressed into a bed of soft clay it will leave an impression which will represent the curve of a concave cylindric glass. If a piece be sliced from the surface of the stick in a direction parallel to its length, this will represent the surface of a convex cylindric glass. For such glasses the axis is a line drawn parallel to the axis of the cylinder from which they are formed. Cylindric glasses when seen in profile do not show their distinctive characters. The following figure, No. 5, represents their appearance seen in face and with square outlines. A line drawn from A to B in each figure is the axis of the glass. In practice the corners are cut off and the glass made elliptical or circular in outline, but the line of the axis is always to be observed. By spherical glasses it is evident that the light undergoes refraction, no matter from what direction or in whatever meridian it may fall. With cylindric glasses it is manifest



that the greatest refractive effect is upon rays which fall transversely upon it, viz., in the direction CD, while rays falling in a plane parallel to AB, which is its axis, are not refracted at all, leaving out of view the prismatic deviation. For rays impinging in planes intermediate between AB and CD, the refractive effect gradually increases from zero to the maximum. If two plano-convex cylinders be joined with their axes across each other, the combination gives the effect of a bi-convex spherical glass with a sharp focus. If a spherical and a cylindric glass be joined the effect is a distorted focus, which is elongated in a direction either parallel to or transverse to the axis of the cylinder.

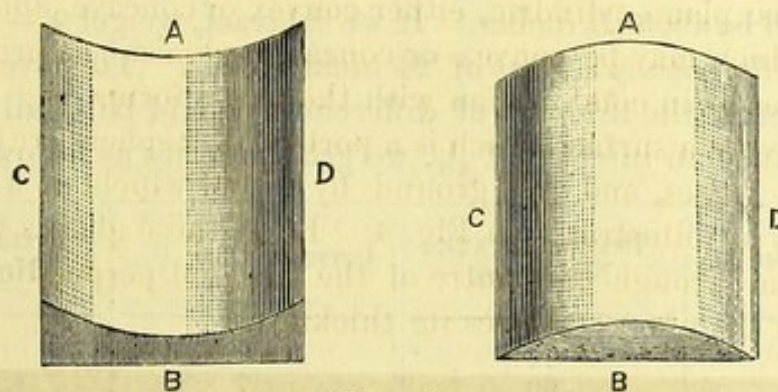


FIG. 5.

Prisms in general use have angles varying from  $2^{\circ}$  to  $8^{\circ}$ , while the oculist's spectacle boxes contain prisms with angles perhaps as high as  $24^{\circ}$ . Their use is to correct faults in the power of controlling the movements of the eyes in their combined action. For instance, they are given in cases of double sight, and in cases of fatigue of the eye-muscles.

Glasses with convex surfaces collect or converge rays of light; they make objects look larger.

Glasses with concave surfaces disperse rays of light, or make them diverge; they make objects look smaller.

Glasses with flat surfaces, such as prisms, neither collect nor disperse the rays, but merely give them another direction as a whole, and not in their relations to each other; they simply deflect the light (prisms of large angles are not considered, they break up the light and cause color).

Both convex and concave glasses have a deflecting influence on light as well as refracting influence; and for this reason objects seen through spectacles appear in a position slightly different from that which they really occupy.

Concavo-convex glasses and convexo-concave glasses are called periscopic; only weaker numbers are ground in this form. Their hollow side must always be next the eye.



Convex glasses are usually denoted by the sign +.

Concave glasses are usually denoted by the sign -.

Glasses are numbered according to their focal length. The object whose image is to be taken must be not less than twenty feet distant: a bright window or lamp, or a house across the street.

The strength or refractive power of a glass is inversely as its focal length; the less the focal length the stronger is the glass. In comparing glasses their numbers must be expressed in fractional form to understand their relations. Thus, a 12-inch glass and an 8-inch glass are correctly represented in their respective power, by comparing  $\frac{1}{12}$  with  $\frac{1}{8}$ . If we put the two together, we say  $\frac{1}{12} + \frac{1}{8} = \frac{2+3}{24} = \frac{5}{24}$ , and the focus will be about 5 inches. If we subtract, we get  $\frac{1}{8} - \frac{1}{12} = \frac{3-2}{24} = \frac{1}{24}$ , the difference is a glass of 24 inches focus. To have a correct series of glasses, the interval of differences should be small and regular. If we take an interval of  $\frac{1}{48}$ , we get the series as follows:

INTERVAL OF $\frac{1}{48}$ .	INTERMEDIATE NUMBERS.	INTERVAL OF $\frac{1}{48}$ .	INTERMEDIATE NUMBERS.
96	72	8	18
48	60	7	14
24	42	6	13
16	36	5	11
12	30	$4\frac{1}{2}$	10
$9\frac{1}{2}$	20	4	9

In the second column are numbers of which many are in frequent use, but they do not conform to a regular series. As we come to numbers as strong as 4, we pass beyond the ordinary needs of sight, and such glasses would commonly be ordered by an oculist. When such strong glasses are worn, the convex glass is made of stronger effect by holding it farther from the eye and the concave glass is made weaker by holding it away from the eye.

Within five years oculists have agreed to introduce the numbering of glasses by the French system of measurement, of which the metre is the basis. A metre equals  $39\frac{1}{2}$  (39.5) English inches. They have also agreed to take as the interval of difference, a glass of one metre focal length, and its decimal subdivisions. The interval they call a dioptre, and they number glasses according to the number of dioptres which they contain, beginning at one and going on to higher numbers. They use the decimal notation, and they write as follows:



DIOPTRIES.	FOCUS IN ENGLISH IN.	NUMBER BY OLD SYSTEM.	DIOPTRIES.	FOCUS IN ENGLISH IN.	NUMBER BY OLD SYSTEM.
0.25	158	∞	5.5	7.18	7
0.5	79	72	6.	6.6	6½
0.75	52.3	48	7.	5.64	5½
1.	39.5	40	8.	4.9	5
1.25	31.6	30	9.	4.4	4½
1.5	26.3	24	10.	3.9	4
1.75	22.5	22	11.	3.6	3¾
2.	19.7	20	12.	3.3	3¼
2.25	17.5	18	13.	3.	3
2.5	15.8	16	14.	2.8	2¾
3.	13.16	13	15.	2.6	∞
3.5	11.2	11	16.	2.5	2½
4.	9.9	10	17.	2.3	2¼
4.5	8.8	9	18.	2.2	∞
5.	7.9	8	20.	1.9	2

In the second column the equivalent glass has its focus expressed with unnecessary accuracy, giving the decimals. The approximate numbers of the old system are placed beside them in the third column. The numbers according to the old system were given from the radius of the glass, and are not the equivalent of the focal length. The great discrepancy in the length of the inch in different countries has been the reason for choosing the French system of measurement. Glasses are ordered at present by the old system and by the new, but the latter will in time exclude the former.

The focus of a positive glass is positive and easily found as explained above:—the focus of a negative or concave glass is negative or imaginary. To find it, the glass must be held before the eye in contact with a convex glass until one is found which perfectly neutralizes it. An object seen through both when the glasses are of the same numbers is not affected in size and it does not appear to be moved when looked at through the combination, and they are moved rapidly from side to side.



## CHAPTER V.

## APPLICATION AND CHOICE OF GLASSES

It may be stated in general terms that the efforts of the optician will be limited to persons who do not speak of *pain* as a prominent symptom, who do not complain of extreme fatigue, and do not have double sight; and finally he will cease his efforts when he cannot, by any glasses, give correct vision for distance. This statement must not be construed literally, but it is mainly correct. For a considerable number of persons he will decline the responsibility of selecting glasses, and recommend them to consult a reputable oculist. Such a person is always a physician. He has the advantage of more thorough knowledge of the optics of the eye; he has at his command the ophthalmoscope, by which he can absolutely decide whether the eye is healthy in its internal parts, and can also closely ascertain the optical state of the eye without the help of the person examined, and he can decide whether the general health affects the eyes.

The optician, like the oculist, will begin by finding out for each eye by itself, the other being screened by a card, whether the person has correct sight for the distance of twenty feet, as determined by the test-types.

Let us follow a precise method; and I shall present a selection of supposable cases which may present themselves, and indicate how they are to be dealt with.

A. PRESBYOPIA.—The person *has* correct sight at twenty feet; but he complains that he cannot read with ease and distinctness. Then give type Snellen I or II or Jaeger 5 to be read. He may see it if the light is strong, but would not like to have it at ten inches, and at twelve inches would dislike to look at it for a long time; or he may see it only at 18 inches, or farther. This case is one of deficient accommodation; it is technically called *presbyopia*, because advancing age is the cause of it: the person will be in middle life. Try the effect of a weak convex glass, say + 48 or + 36 (1D). He says that makes the the print clear, sharp, bright, black, clean, and magnifies it very little. He holds the book at fifteen inches, and can bring the print to ten inches, or carry it to twenty inches. This glass feels comfortable, and gives his eyes relief.

His previous symptoms have been that he was much troubled to read at night, always needed a bright light, outlines of letters would



be misty or double, and he constantly found fault with the bad work of modern printers. If he had had the trouble long, his eyes began to smart and would water, perhaps he got styes, and he was always changing the place of holding his book, but would usually push it off to a distance. He preferred large print, and was much bothered to read bad hand-writing.

When a person has presbyopia and takes convex glasses, he must be allowed to choose that distance for reading, writing, or sewing to which he has been accustomed, and must receive the glass which renders work easy at this distance. He must have a certain range nearer and farther off. At first he may use the glass only at night, or for steady work, or for fine work; afterwards he will use it constantly. Regard must be had to his occupation in fixing the working distance: draughtsmen, engravers, jewellers need a short range; musicians, bookkeepers who handle large ledgers, artists need a long range.

It spares and benefits the eyes to use glasses when the need really exists; it does them harm to make them work when they ought to have help. Suitable glasses will improve the comfort and working power of the eyes. It is impossible to fix an age when persons ought to begin to use glasses. Much depends on the health and on the amount of work required. From forty to fifty is the period within which the necessity commonly declares itself.

The frequency with which glasses should be changed varies greatly. Some will keep the same pair three or four years. After two or three advances, the need is apt to be more frequent. It is, however, important not to make sudden or large jumps. The best plan is to make slight degrees of increase, at moderate intervals; that is, observe approximately the succession of the scale on page 12 by inches, or that on page 13 by dioptries, and renew the glasses once in eighteen or twenty-four months. Great varieties will be found in this matter. Much care must be taken not to give glasses which are too strong, and the person should be discouraged from choosing one which makes him hold print unduly close.

[There are cases where a person sees well at a distance and yet cannot read; such may be moderate degrees of hypermetropia (see the next section), or of astigmatism, or may be paralysis of accommodation, or weakness of the eye muscles, or spasm of accommodation. In such cases the optician will not furnish relief, and the person should be sent for advice to an oculist.]

**B. HYPERMETROPIA.**—1. The person sees distant print well; has sight  $\frac{20}{xx}$ , and can read or work for a time comfortably, say for a few hours, then blur sets in, he has to stop; by resting can go on, rubs his eyes, they feel tired. The person is not yet up to middle life, may be under thirty or under twenty. In testing his distant sight try whether he *can*



see No. XX with + 48, or + 36, or + 24, if he do, he has at least this amount of *hypermetropia*. Let him take this glass or one a very little stronger for near work, and if he be relieved, well; if not, send him to the oculist. Cases of slight astigmatism may have similar symptoms, and it is not always possible without other means to tell just what the condition is.

2. The person does *not* see distant print as he should, he may have vision of only  $\frac{20}{L}$  or  $\frac{20}{XXX}$ , he is using convex glasses for reading—he has used them for some time. Try him with *weak* convex glasses to improve his distant sight. He finds that some such glass gives him  $\frac{20}{XX}$ . That person has *hypermetropia*. If he be over sixty years old, this is merely the usual course of the accommodation and is all right. If he be a person about 40, his hypermetropia is becoming manifest, that is, it has come to the surface permanently, instead of being as formerly under his control and in abeyance.

3. A person, no matter what may be his age, even if very young, has found that convex glasses make him see better for distance, and are necessary for near work; with their aid he is comfortable and sees well for every distance. He wears his glasses all the time and is entitled to have them whether young or old—because he has *decided hypermetropia* and was born so.

4. The person who has worn convex glasses for all purposes finds when he gets older that he needs more aid than formerly in *reading*, he must have a stronger glass. He therefore uses two convex glasses, one which is stronger for near work, and a weaker one for distance. He may have both set in one frame by dividing the glasses into halves, of which the half of the weaker is above and the half of the stronger below. This person having *hypermetropia* is becoming *presbyopic* too, that is, his accommodation is failing to a degree which compels him to ask assistance.

5. A person may have bad sight for distance and find it improved by convex glasses, and they will perhaps be quite strong, viz., from + 10 to + 4 (4D or 9D), yet distant sight will not be  $\frac{20}{XX}$ —may be  $\frac{20}{XL}$  or  $\frac{20}{LXX}$ . He will hold print very close when he reads, whether he uses glasses or not. That person is *hypermetropic*, but the defect in correction of distant sight proves that he has *some other trouble* in addition; it may be astigmatism or may be disease of the optic nerve and retina. He should consult an oculist.

6. A person has had an operation for *cataract*, or his crystalline lens is wanting. He needs strong convex glasses for distance, usually about + 4 (10D), and also a second pair for reading, which shall enable him to see at 8 to 10 inches. This reading glass will be +  $2\frac{1}{2}$  (16D). Sometimes he takes a third glass for middle distances, say + 3 (13D). He has no power whatever of accommodation and must rely entirely on his glasses. By shifting the distance of the glass from his



eye he gets a little accommodative range, because as they are pushed from the eye their effect is increased.

As a rule cataract cases are examined by an oculist, who decides on the formula for the glasses. Frequently they have astigmatism and they do not usually have sight  $\frac{20}{xx}$ .

All the cases described under *B* have *hypermetropia*, and the definition of their case is *that all may or must use convex glasses for distinct sight at twenty feet*.

*C. MYOPIA.*—1. A person does *not have good distant sight*, he sees well near at hand, and may hold a book at the usual distance or bring it close to his face. A concave glass gives him vision  $\frac{20}{xx}$ . If he use it in reading, the book must be held farther than was his custom. That person has *myopia*. He may have the weakest concave glass which will give him  $\frac{20}{xx}$ . In hyperopia the *strongest* glass which will be accepted to permit  $V = \frac{20}{xx}$  is the one to be selected, while in myopia the *weakest* which will correct the sight to  $\frac{20}{xx}$  is to be given. For young persons needing  $-16$  ( $-2.5D$ ) or stronger numbers, it is desirable to wear glasses all the time. They then are on an equality with normal eyes. But frequently they don't choose to do so.

If glasses cause a sense of strain, or make objects glitter and dazzle, if they cause pain, they are not correct and must on no account be given. Very serious harm can be done by giving glasses to myopes which are too strong for them.

2. A person with bad distant sight finds it improved by concave glasses, but vision is not brought to  $\frac{20}{xx}$ , and no ordinary glass will do it. Glasses beyond a certain strength do not improve sight, but provoke strain. That person may have astigmatism, or he may have some of those changes in the inner coats of the eye, the choroid, and retina, which are very common to myopes, or he may have haziness of the vitreous body, etc. He must be content with the weakest glass which can help him. He would do well to consult an oculist.

3. A person finds concave glasses give him good sight, perhaps  $\frac{20}{xx}$ , but he cannot use them long because of fatigue, strain, or discomfort. He may have slight astigmatism or more probably there is weakness in some of the muscles of the eye. He should consult an oculist or go without glasses.

4. A myopic person has pain in reading whether with or without glasses. He cannot read with those which serve him for distance; he may get on better with glasses of about half the strength of distance glasses, which he should use in reading. If this suggestion do not avail he should go to an oculist.

In all the above cases *sight is bad for distance and is improved by concave glasses*, and that constitutes the definition of myopia. It is true that to read they hold a book near, and that is popularly taken



to denote myopia, but many other optical and visual defects compel people to hold work close; such as incipient cataract, haziness of the cornea, disease of the optic nerve, extreme hyperopia, etc. None of these are improved by concave glasses, and therefore are not myopia. This term is strictly not the same as near-sightedness.

To many myopes a combination of concave glasses and prisms is of great use. A certain number are greatly benefited by having an operation on some of the eye muscles, especially is this true of those who have pain in reading or in any use of the eyes.

When myopia rises higher than  $-5$  (8D) it is rare that vision can be made to reach  $\frac{20}{xx}$ . This class of cases are very apt to have serious trouble in the inner structures of the eye. Myopes are more liable than others to detachment of the retina, which means a sudden formation and intrusion of water beneath the retina, a kind of dropsy. It is very injurious to sight and apt to be permanent. These statements show how large a number of myopes need to be cautioned in the use of their eyes, and how many should take skilled advice.

5a. A person has worn concave glasses of medium strength, say less than  $-12$  (3D), and at middle life does not like to use them for reading. He goes without them because his accommodation is giving way. He retains the glasses for distant sight, but at sixty he prefers to reduce their strength, and perhaps he then or soon after, lays them aside entirely. He has by loss of accommodation gained some compensation for his previous myopic thralldom.

b. A person with myopia  $-24$  (1.5D) may not have used glasses at all in reading and only on occasion for distance, at middle life he gets on without trouble in near work, but when past fifty he has signs of *presbyopia*, then he must take weak convex glasses to read, and continue to use concave glasses for distance. The former will be always needful and must at proper intervals be increased in strength. In time all myopia will disappear and his distant sight be good.

6. An old person who has used convex glasses for reading finds that he sees better by holding the book near and laying aside his convex glasses. He will not have good sight for distance as he formerly had. This will have been slowly and perhaps imperceptibly fading. Distant sight may be materially improved by *concave* glasses, yet it will not be made perfect.

This person has incipient cataract which sometimes causes true myopia because the crystalline lens gets a higher refracting index, the cataract is not thick and the pupil is very small as is the characteristic of old age. Such cases are always interesting, and the person gains some notoriety because, as is popularly said, he has "come to his second sight." This case is a special kind of myopia and the vision may remain but little changed for many years. Sometimes one eye is



totally blind by cataract while the other has cataractous myopia or "second sight."

C. ASTIGMATISM.—1. Persons who have *slight* degrees will make no complaint, or not seeming to have defective sight, will complain of pain in their eyes. Such cases will not be suitable for the optician.

2. *Marked* degrees of this error will not see well at a distance, and will hold print near. Spherical glasses may improve distant sight, but not fully correct it. If *concave* glasses be preferred and improve sight, the weakest must be chosen which do any good. While wearing these, bid the person look at a diagram like Fig. 6. This will be of larger size and must be placed at 20 feet distance. Ask him if all the lines seem distinct and precisely like each other, or if some lines seem blacker, more distinct, and longer than others, that is some send their points deeper to the centre. If he picks out certain lines as more conspicuous,

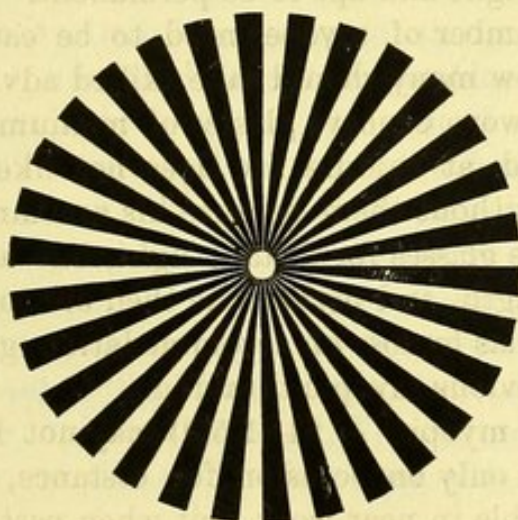


FIG. 6.

he has astigmatism. If the selected concave glasses are pretty strong, there is probably *compound myopic astigmatism*. To find out, take a weak concave cylindric glass and hold it before the spherical, placing its axis transverse to the distinct lines of the diagram which the person has selected. This glass should make a greater number of lines clear; then try a stronger concave cylinder, until one is found which, with its axis transverse to the lines first indicated as the distinct ones of the figure, and added to the spherical concave, will make all the lines or meridians of the figure look clear and precisely similar.

With this combination try him on the test letters; if he get  $V = \frac{20}{xx}$ , and with no sense of pain or strain, the combination is probably correct.

3. But the person may not need a spherical glass, or the one chosen may have been very weak; then try a plano-cylindric glass, either concave or convex, held before the eye, and turned slowly around until it



finds a position in which it makes letters distinct. Mark on the scale which is engraved on the spectacle frame, the place of the axis, and if this glass give good sight, the case is one of *simple astigmatism*, either myopic or hyperopic, as a concave or convex cylinder shall have been preferred.

There is great liability to confound hyperopic astigmatism with myopic astigmatism, especially the simple form. So great is this uncertainty that oculists must often subject patients' eyes to the action of sulphate of atropia (belladonna) to discover the true nature of the error. The patient's accommodation is the cause of the difficulty, and this must be for the time suspended. Opticians would not venture on this proceeding.

4. If the person have preferred *convex* spherical glasses in viewing the test letters, he must be made to take the strongest he will accept, and then be directed to examine the figure of radiating lines at twenty feet. If he selects certain lines as most distinct, add another spherical glass to the one already in use, and attempt to make him adjust his eye to its use. It may be that the added glass blurs the lines which he first picked out, and renders clear, lines in an opposite diameter. The two glasses together, or the one which represents their addition, is to be substituted for the one first chosen. Then a concave cylindric with its axis across the direction of the distinct lines is to be put in front of the spherical, and numbers of increasing strength to be tried, until one is found which makes all lines of the figure clear and similar. This combination should give correct vision, *i. e.*,  $\frac{20}{xx}$  on the test card. This will be *compound hypermetropic astigmatism*.

5. *Mixed Astigmatism* it is hardly needful to discuss; it is infrequent, and difficult without much experience, to make out. This condition and most of the cases of astigmatism will not be profitable to the optician, because he is paid for his glasses, and not for his time or advice. He will prefer, both in his own interest and in that of his customer, to send him to an oculist.

The mounting of cylindric glasses requires much care. It must be done with exactness, so that the axis of the cylinder shall come precisely to the place indicated in the formula. The proper way to designate the place of the axis is on a semicircle laid out in intervals of five degrees. The numbering begins with zero on the left hand of the horizon, and counts upwards and to the right, as the hands of a clock move from nine to three: this gives from  $0^\circ$  to  $180^\circ$ , and  $90^\circ$  will be at the top. Both eyes are to be notated alike, and the glass is supposed to be before the eye of the patient as he looks through it. Cylindric glasses were formerly cut circular; now they are made oval like



ordinary glasses, and if a mistake is made in placing the axis, the glass is useless.

In mounting prisms, the base of the prism is to be placed in a certain position, as called for in the oculist's formula; and if this be not on the horizontal, as is most common, the scale of degrees used for astigmatism will express all needs, with the proviso that the degrees must be written for the whole circle: the lower half will begin on the right at  $180^\circ$ , and go around to  $360^\circ$ , following the hands of a clock dial.

It has been said that each eye must be examined by itself. It follows that the glasses given will sometimes be unlike. If the difference be not more than  $\frac{1}{16}$ , usually there is no difficulty, but cases differ from each other very much in this regard.

The determination of what glasses a person needs can be made by the ophthalmoscope, an instrument which shows the interior of the eye. It cannot tell anything about the accommodation, and is, therefore, of no use in presbyopia; but for strictly refractive errors, hypermetropia, myopia, and astigmatism, it reveals the true condition without any help of the patient. This enables one to select a glass which shall be nearly correct, without being dependent on the intelligence, the powers of observation, or the honesty of the patient. It helps one out of the difficulties which the accommodation causes, and enables one to examine children whose restlessness and incapacity would defeat the usual method by trial glasses. Hence the oculist has an advantage which the optician does not have: the former stands to the latter in the relation of the physician to the apothecary; the former charges for his advice, the latter sells his wares.

Moreover, the ophthalmoscope tells whether the inside of the eye is healthy. It brings to view the optic nerve and retina; it shows the vitreous body and lens. Hence, all cases of cataract, and of so-called amaurosis, are explained by this instrument.

But the ophthalmoscope is not an easy instrument to use. It requires thorough knowledge of physiological optics, and of diseases of the eye, and a large experience. Only a well-trained observer can depend upon his examination and its results. It is, therefore, of no service to go through the form of using it unless there has been long and careful study and practice with it.

By observance of the above suggestions the optician will be able to furnish a large number of persons with helps to sight, both to their advantage and to his own profit. It is no derogation of his functions to state that not a few cases should be sent to the educated oculist to get adequate advice. Modern science has greatly enlarged the useful application of glasses, and carried the knowledge requisite to a full understanding of the subject, beyond the opportunities of opticians to



learn. It rests with them, however, to supply the glasses, and they have the strongest reasons to oppose all chicanery, pretense, and charlatanism. If in trade the only sound basis is honest dealing, much more is honest, not to say skillful, dealing to be expected, in so vital a matter as the preservation of sight.

NEW YORK, 233 Madison Avenue.