Eye Defects

ARMY MEDICAL LIBRARY

FOUNDED 1836

WASHINGTON, D.C.

# EYE DEFECTS;

## HOW TO DETECT AND CORRECT THEM.

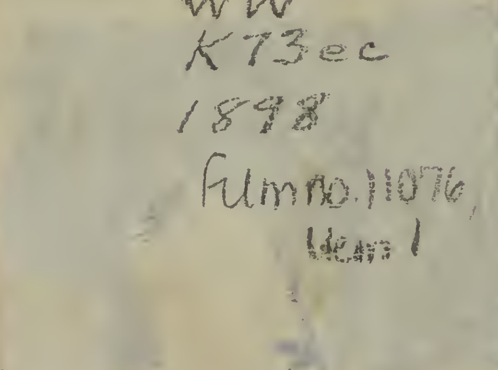
R H KNOWLES, M. D

Published by
THE SPENCER OPTICAL MFG. CO.
15 Maiden Lane New York, New York

# "AUDEMAIR"

# OCULIST'S TRIAL LENSES.





# PREFACE.

The following pages will have for their object the method for testing the sight with the view of prescribing spectacles and eye-glasses. It is therefore necessary for a better understanding of the subject to have this elementary knowledge of optics, as without this knowledge, elementary though it may be, no one will expect to succeed. The maxim "There is no royal road to learning" applies to the science of Optometry as to other sciences.

In no trade or occupation does mankind rely on the skill of an untaught artist and in Optometry no one will presume that knowledge is intuitive. Therefore it will be necessary for the student to read carefully the details set forth in this book in order to profit by it with the assurance that he will be repaid for the effort, as this work gives all the correct information relative to adjusting lenses to the sight.

THE business of the Spencer Optical Manufacturing Company, established nearly a third of a century ago, has grown rapidly and steadily since, and owes its success to the business principles upon which it was founded, fair and square dealing, and the best goods at the lowest prices.

On another page we give an illustration of the Company's works at Newark, one of the largest of its kind in the world, containing 40,000 square feet of floor room, the most improved machinery, and a capacity for 600 skilled workmen.

Our interest has always been in elevating the standard of the trade.

---

The Spencer Optical Institute offers immense advantages to those who desire to enter into a profitable business.

Our courses of lectures on practical optics are complete, thorough and non-classical.

---

Write for Prospectus.

# List of Abbreviations Used in This Work.

D — Diopter.
Ax — Axis.
C. or Cyl — Cylindrical.
CC — Concave.
CX — Convex.
S. or Sph — Spherical.
— — Concave.
$+$ — Convex.
⊃ — Combined with.
° — Angle Degree.
△ — Index Degree.
℞ — Recipe, take.
O. D — Oculus Dextra. Right eye.
O. S — Oculus Sinistra. Left eye.
P. D.—Pupilary distance. The distance between the centers of the two pupils.
$\infty$ — Infinity 20 feet or more.
M M — Millimetre, 25 to an inch.
Dcx — Double Convex.
Dcc — Double Concave.
Plcx — Plano Convex.
Plcc — Plano Concave.
Pcc — Periscopic Concave.
Pcx — Periscopic Convex or Meniscus.
H — Far sight, Hypermetropia.
M — Near sight, Myopia.
L. E — Left eye.
R. E — Right eye.
Cat — Cataract.

# PRESCRIPTION WORK.

OUR Prescription Department is the best equipped of any in this country, and is entirely up with the times. We have spared no expense in keeping our facilities always a little ahead of the demand to insure promptness and high-class work. By employing only the best skilled specialists in the mechanical department, and by the use of modern appliances and machines, we have kept this department up to the highest degree of efficiency. The clerical force of this department has always been selected with reference to adaptability and accuracy, and the greatest care has been maintained to insure perfection in all prescription orders, no one being more appreciative of the importance of infallibility in this specialty department than ourselves; hence we feel gratified at the most cordial support by the trade in maintaining the department, as we could not keep a score of skilled grinders and the large clerical force going if it were not for the combined support of the successful opticians. We carry in stock tens of thousands of compound lenses for the purpose of quick fitting, in order that our patrons may not be inconvenienced by delay. Our rule of procedure is to mail the finished goods same day received. Having been located in Maiden Lane in this line for over thirty years, we have had the opportunity of studying the wants, needs and requirements of the trade, and we are now in a better position than ever to comply with the requirements of the most exacting. The prices on prescription lenses will be found to be most liberal, and the work will be kept up to the high standard for which we have fought, and we are with you for perfection in every detail of prescription work. We also announce that our prescription department will be kept up to the highest point of perfection in detail, accuracy of execution and promptness in delivery that it is possible to attain, and we are determined to merit the continuance of the most liberal patronage which has been accredited to us in the past.

Buying from the manufacturer, or maker of goods, means everything to the purchaser, for it is in itself an insurance against inferior goods and exorbitant prices, while the customer reaps an immediate benefit from improvements in the manufacture of the goods.

Our success is due entirely to the appreciation and patronage of our friends. This we acknowledge gratefully, and beg to state that in the future as in the past we shall try to treat our customers fairly and honestly, giving them value for value in every instance, and always open for suggestions as to changes in our goods for the better from all.

Soliciting your continued patronage, or initial order, we are,

Yours respectfully,

**SPENCER OPTICAL MFG. CO.**

# CHAPTER I.

## ANATOMY OF THE EYE.

Our first thought relative to eye-sight turns naturally to the eye anatomically: note its location, appendages, construction and functions, so that we may know how to assist eye-sight when such assistance is demanded; thereby correcting the various errors of Refraction, relieving failure of accommodation and the faulty motor adjustments, and secure that comfort found only in the normal or perfect state.

The Eye is a spheroid or globe-like body placed in the orbit as a sentinel to give the first alarm at the approach of friend or foe, and from its lofty position views with delight the ever changing panorama of the variety of scenes which each season displays, the beautiful proportions of nature and the numberless worlds all around us rolling through the vast expanse, giving the whole body that joy and gladness for which we as human beings strive and live.

The orbits are lined with beds of fatty tissue for the purpose of protecting the eyeball from injury ; this fatty tissue is contained in a thin membranous sac called Tenon's capsule, which allows the eyeball to rotate freely upon its axis, and while the directions of the axes of the orbits diverge, the axes of the eyes slightly converge. The other means for protecting the eyeballs are the eyebrows, lids and lashes.

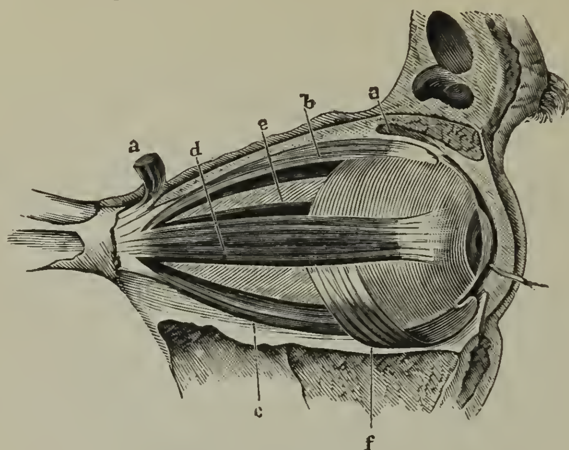
The appendages are the tear glands, sac and tear duct, the muscles which control the movements of the eyeball, the membranes, nerves and blood vessels.

Leaving aside the tear glands, sac and duct, we will consider the other and more important appendages, namely, the muscles, nerves and the blood supply.

The six muscles which rotate the eyeball in its various directions are divided into two groups : the four recti, superior, inferior, internal and external; and the two oblique, superior and inferior.

These muscles, with the exception of the inferior oblique, have a common origin on the lesser wing of the sphenoid bone and all of them are inserted into the outer coat of the eye. All of these muscles, with the exception of the superior-oblique and external rectus, are controlled in their movements by the motor-oculi nerve which causes the eyeball to rotate inward and from this fact these muscles are termed the muscles of convergence. The motor-oculi nerve also controls the circular fibres of the muscle of accommodation, the sphincter-iris, in its effort at accommodation, so that it follows that the eyeballs converge proportionately to every act of accommodation whenever we are called upon to examine an object at the near point.

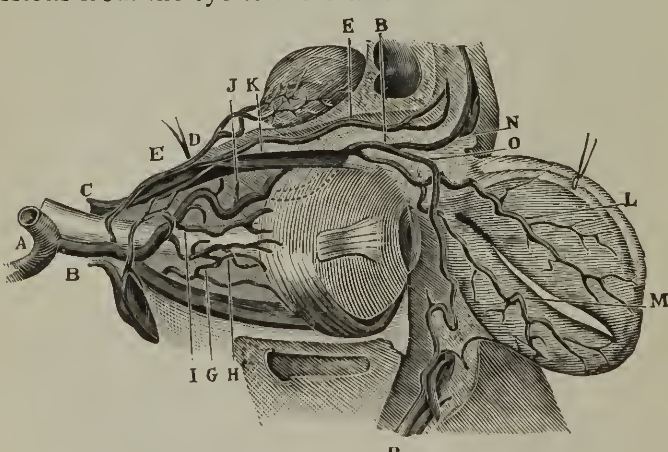
Filaments of the sympathetic nervous system assist in flattening the crystalline lens while the attention is engaged at the distance or remote point.




THE MUSCLES OF THE EYE.

The patheticus nerve controls the movements of the pulley-like muscle, the superior oblique, and the abducens nerve controls the external rectus.

Finally the optic nerve, which is a nerve of sensation, transmits impressions from the eye to the brain.




THE BLOOD VESSELS OF THE EYE.

The eye depends upon the ophthalmic artery and its branches, the long and short ciliaries and central retina, for its vascular or blood supply.

The eyeball consists of three coats or tunics and three humours.

The three tunics in their order are the sclerotic, which is the hard white, nearly bloodless coat into which the several muscles just enumerated are inserted; the transparent continuation of this tunic in front is the cornea. The choroid is the second coat, which is very vascular and full of pigment, the purpose of which—like the darkened chamber in the camera—is to render the rays of light which form the image in clearer and plainer outlines. The iris, which is made up of muscular processes of the ciliary body, is a part of this tunic, and the aperture through which is the pupil.

The retina is the third and sensitive coat and consist of two membrana-limitans, fibrous layers, vesicular, granular, nuclear and pigmentary layers, together with the rods and cones which lie imbedded in the pigmentary layers next to the choroid coat, the most important layer of which are the rods and cones, as these are the percipient elements of the retina. These little bodies are everywhere described within the retina, perfectly so at the macula-lutea, which becomes the sight area from this fact. At the point where the optic nerve perforates through the three coats and becomes the optic disc, the rods and cones are wanting altogether and from this fact the optic disc is sometimes called the blind-spot of Maryiotte.

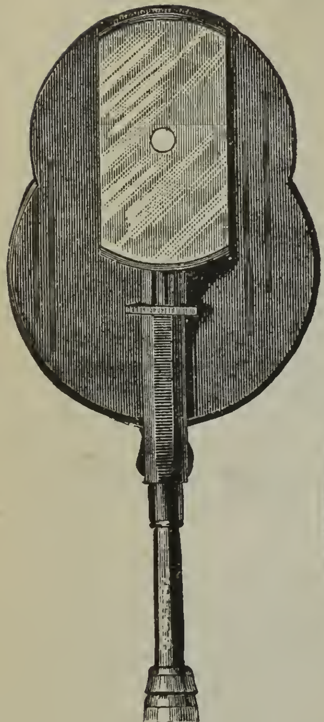
The Humours or intra-ocular fluids are three in number and serve the three-fold purpose of maintaining the form, transparency and elasticity of the eye. The Aqueous Humour lies immediately behind the cornea and occupies the anterior and posterior chambers of that portion of the eye; the Aqueous Humour therefore occupies one-fifth of the entire contents of the eye. It is a secreting fluid, so that if any of the contents are lost it will be replaced in a short time.

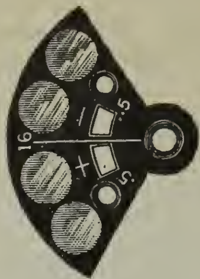
The crystalline lens is one-fifth of an inch in its axial diameter and one-third of an inch transversely. Its greatest convexity is at its posterior pole. In childhood the lens is globular when removed from the capsule which surrounds it and the convexity of the lens is due to the flattening effect produced by the capsule which encloses it and in turn the ciliary body or muscle of accommodation surrounds the crystalline lens with its capsule. The lens is held in its place by means of a suspensory ligament called the Zone of Zinn and the spaces between the anterior and posterior zones is called the canal of Pettit. The muscle of accommodation is held to its bed by means of another ligament, the canal of Schlemm, upon which, when the muscle of accommodation contracts upon its origin, the muscle will remain firmly fixed and immovable.

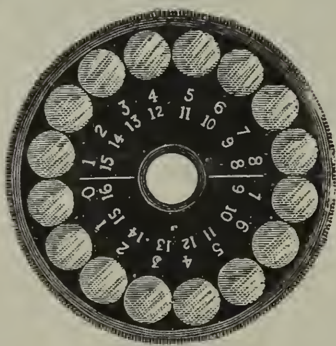
The Vitreous Humour occupies four-fifths of the entire contents of the eye and is surrounded by a thin transparent membrane called the hyoloid membrane.

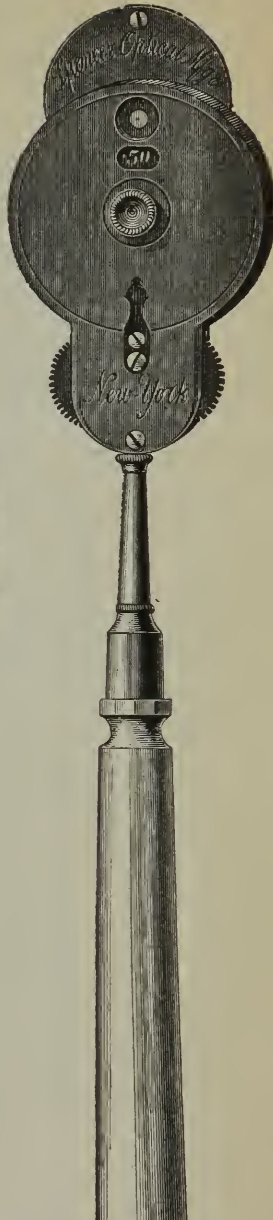
Much has been written relative to the inverted image focused upon the retina and a few theories have been advanced explaining why the image appears in its proper position, but when we consider the fact that we see the image itself and not the inverted image focused upon the retina as is the case when looking at the inverted image upon the ground glass in the camera, we will have no difficulty in understanding the phenomenon.

## DR. LORING'S OPHTHALMOSCOPE.










With Rectangular Mirror swung on two pivots, so as to tilt both ways, to an angle of 20 or 25 degrees. Revolving disc back of the mirror contains 15 lenses on the metric system, the plus being numbered in white and the minus in red. Immediately over this disc rotates a quadrant around the same center, and contains 2 plus 2 minus lens. The quadrant enables one to make any combination possible. These combinations are all figured out on a third row of figures running around the disc. This is a new feature, which prevents mistakes and saves much time. With condensing lens, 1½ inches in diameter. All packed in a fine calf skin case, metal bound, for $7.50.

## PAYNE'S IMPROVED OPHTHALMOSCOPE.

Every physician knows the inconvenience and difficulty of making a correct diagnosis and estimating the errors of refraction without some device of this kind, for constant removal of an instrument from the observer and the observed eye is apt to interfere in securing a perfect rest of one's state or accommodation. With Payne's Opthalmoscope this difficulty is obviated by a mechanism connected by a cog gear, with a small milled ratchet, which needs only a touch of the finger to bring the lenses before the aperture without removal from one's eye. Errors can be estimated with this instrument as low as 0.25 of a diopter. The discs are enclosed in a cylinder to protect them from dust, injury, etc.

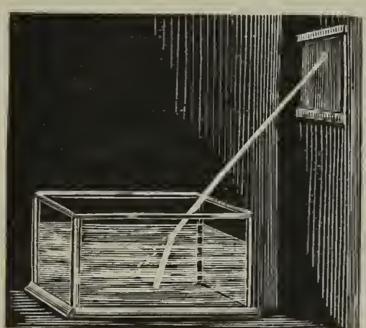
Price complete, in a fine calf skin case, with nickel plated trimmings and condensing lens........................................ $10 50

## CHAPTER II.

**ELEMENTARY OPTICS.**

Under this heading we consider the laws of refraction, the media we employ for refracting purposes and finally the subjective method for making an examination of the eyes by means of the lenses found in the trial case.

Refraction applies to rays of light travelling in an oblique path in passing from a rare to a denser media, will bend in a line toward the perpendicular.



REFRACTION.

A Media is a transparent substance and the power which it has for bending rays of light is called its index.

The media which we employ for refracting purposes is glass, found in the trial case in the form of a lens, which is defined as a transparent substance, glass and pebble chiefly, through which, when an object is seen, it will increase or decrease in size. There are two general sets of lenses, spherical and cylindrical. A spherical lens is a segment or section of a sphere and focuses in all meridians the same, while a cylindrical lens is a segment of a cylinder and focuses in only one meridan. Both spherical and cylindrical lenses are practically two prisms united; in the convexes (symbol, +) the bases are joined and in the concaves (symbol, —) the apices are united. Rays of light bend toward the base in prisms, so that in the convex spherical lenses it will readily be seen how the ray of light cone, and in the convex cylindrical lines the rays of light, are focused to a line. In the concave spherical lenses, rays of light are dispersed equally in all meridians and in the concave-cylindrical lenses the rays of light are dispersed in only one meridian.

Convex spherical lenses are thickest at the center with thinner edges. There are three general forms, sections of which are shown in Fig. III. No. 2 represents a biconvex, +, positive or double convex lens, both sides convex. No. 3 a plano-convex, plane on one side, convex on the other, and No. 6 a concavo-convex, also called periscopic convex, and meniscus, one side being concave and the other to a greater degree convex.

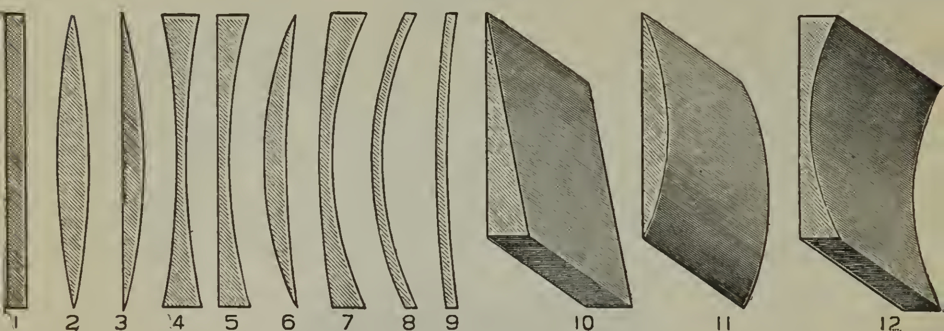


FIG. III. SHOWING FORMS OF LENSES.

Concave lenses are known as negative, dispersive or minifying glasses, and are denoted by the sign — (minus), the number written after denoting their strength. We also have three forms of concave lenses shown in Fig. III.: No. 5 representing plano-concave, plane on one side, concave on the other; No. 4 double concave or biconcave, both sides concave, and No. 7 convexo-concave, or periscopic concave, one side being convex and the other concave to a greater degree. We have learned that all forms of convex (+) or positive lenses are thickest at the optical center or where rays pass through without being refracted or bent in their course, while concave (—), negative or minifying lenses have thinner centers and thicker edges. This being the case and knowing that rays are always bent toward the thickest or densest part of the lens, we can easily understand that when they leave the concave lenses they diverge as though they had just started from some point near it. This point from which it makes rays appear to come is called the focus of the concave lens, and the distance of this point from the lens is its focal distance. As illustrated in figure IV., rays coming from a point fall on the lens and pass out from it as though they had come from the focus F.

We have mentioned six forms of spherical lenses (the word spherical is derived from sphere, globe or ball, and a spherical lens is the segment of a sphere, the refractive power depending on the curvature), but there are yet two forms to mention, known as cylindrical, for the correction of an error due to a misshapen cornea (astigmatism)—called cylindrical lenses because they are practically segments of a cylinder with the axis of the cylinder at right angles to the refracting surface. They are generally plane on one side with the refracting surface on the other, and may be either

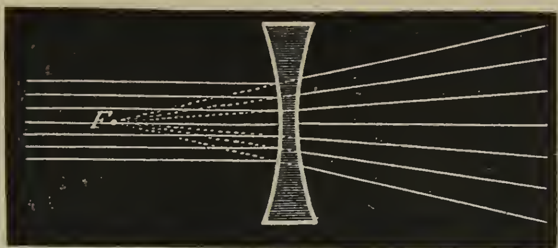


FIG. IV.

convex or concave. You will remember that the lenses of which we have spoken are all spherical, having the same refractive power in all meridians, so that the rays are either brought to a positive focus as in a convex or diverged as in a concave lens. In studying the action of a cylindrical lens we consider all the rays as passing in two principal planes at right angles to each other. The rays are so bent that in the convex cylindrical lens they will focus at a positive point, forming a line, and not a single point or image, as in a spherical lens. We have defined a cylindrical lens as a segment of a cylinder ; if we take a cylinder of glass with the axis running through the center, and cut off a section parallel to its axis, the rays of light that pass through in a plane that is the same as the axis will not be refracted or bent ; but all those passing at right angles or the opposite direction to that plane will either be convergent or divergent, according to the refracting or bending power of the glass and the amount of curvature. Theoretically spherical lenses are segments of a sphere or balls of glass of various diameters. The strength of a lens is due to its curvature. A segment of a sphere two inches in diameter will have a focus of two inches, and a segment of a sphere five inches in diameter will have a focus of five inches, but of couse we do not cut our lenses from glass balls but grind them instead from pieces of glass or quartz by the segment of a ball, the power of the glass depending on the radius of curvature. Cylindrical lenses are ground and finished with a cylinder instead of the segment of a ball. If the outside of a cylinder is used the lens will be a concave cylindrical, and when the concave side of a section of the hollow cylinder is used the lens will be a convex cylindrical. The axis of a concave lens passes along the lowest part of it. Fig. III. No. 12. The axis of a convex lens passes along the highest part of it. Fig. III. No. 11. These are easily determined by moving the lens up and down and finding by its gradual turning that line where there is no action at all. As long as the object seen through the lens moves when the lens is moved the axis is not found. As will be seen in another part of our work, spherical lenses possess a common center, from which the optical lines radiate in all directions. There is only one optical line or axis in a cylindrical glass; objects seen through this line are either lengthened as in a concave or shortened as in a convex, both lenses being in the same axis.

If you will take two cylindrical lenses of the same strength, both concave or convex, and place the axes, one vertically (or at 90°) and the other horizontally (180°), you destroy the cylindrical action and have the strength of a spherical lens. If both cylinders are minus two, the action will be equal to a spherical minus two. If you place over these lenses a plus two, you produce a lense that has no refractive power whatever, a plano in fact.

If rays of light pass through a piece of glass without curved surfaces, they will not be brought to a focus, but pass from it divergent, parallel, or convergent, as they entered it. As we have said before, in another part of our work, the strength, refractive or bending power depends upon the curvature, and not upon the thickness or density of the lens. The refracting power of a lens is its power of bending rays from their course, or focusing them. You can easily understand that the weaker lenses, or lenses with less curvature, have less refracting power and greater focal distance, while the stronger lenses have more curvature, greater refracting or bending power, and shorter focal distance or point where rays are united.

The number of a lens indicates its focal distance or its refractive or bending power. There are two ways of numbering lenses: the inch system and the metric or dioptric system. We will first speak of the inch system of numbering by the refractive power, which has for its unit a lens with the focal distance of one inch; according to this system, where the standard or unit equals one inch, a lens of two inches focal distance will be only one-half as strong in refracting or bending power. All the weaker lenses in proportion are represented by smaller fractions, as a ten-inch lens equals one-tenth, a thirty-inch lens equals one-thirtieth. In the inch system for numbering the focal distance, lenses are designated by the number of inches in their focal distance, or the number of inches from the center of the lens to where the rays are united or focused; these rays coming from a distance not less than twenty feet. Of course this applies only to convex lenses. Parallel rays falling on a concave lens pass from it divergent as though they had just started from some point close to the lens, consequently the emergent rays are not united or focused; the focal point being where the rays seem to have started from, and the distance in inches from the center of the lens to this point is the focal distance or number of a concave lens. If a two-inch lens has a focal distance of two inches it will have a refracting power of one-half, and a lens with a focal distance of forty inches a refracting power of $^1/_{40}$. When lenses are combined, we have to deal with their bending or refracting powers; if a lens with an eighteen-inch focal distance and another of a thirty-six inch focal distance be placed together, it would be somewhat difficult to find their equivalent by their focal distances; we must add their refracting power. We know that the eighteen-inch lens has a refracting power of $^1/_{18}$, and the thirty-six inch lens a refracting power of $^1/_{36}$; $^1/_{36}$ added to $^1/_{18}$ equals $^1/_{12}$; the combined refracting power being equal to a twelve-inch lens. You can see how tedious, not to say difficult, it is, to add to or subtract by means of fractions.

The Dioptric or Landolt's system for numbering lenses was adopted by the ophthalmological societies which convened at Heidelberg, Germany, in 1875. It takes for its unit of measure a lens with a focal distance of one metre, or 39.37 inches English measure, and calls its refracting power one diopter (also called dioptry, dioptre and dioptric, and represented by the abbreviation D.); this system gives us a series of lenses of one diopter between each glass, but for practical purposes other lenses are needed, for which we employ the fractions of a diopter to make the regular series weaker or stronger. For instance, we need a lens between 1.00 D. or forty-inch lens, and 2.00 D. or twenty-inch lens. We can add a .50 D. to a 1.00 D., giving us a 1.50 D., equal to twenty-four inches, or should we need a lens weaker than that of one D. we may divide it and have a lens of $\frac{3}{4}$ or .75 D. and $\frac{1}{4}$ or .25 D. For all practical purposes we may consider one D. or metre as forty inches, though it is really equal to 39.37 inches; then we can readily find the focal distance of a lens in inches by dividing 40 by the number of the D., or we can find the number of the D. by dividing 40 by the number of inches; thus, the focal distance of a lens of five D. will be equal to forty divided by five, which equals eight. By this system we can easily find the refracting power of a combination by adding or subtracting the numbers in D. which enter into it. In the following table we give a comparative list of the dioptric and inch systems:

LANDOLT'S SYSTEM.

| Dioptric. | English. | Value in inches. |
|---|---|---|
| .12 | 320 | 314.9480 |
| .25 | 160 | 157.4740 |
| .50 | 80 | 78.7370 |
| .62 | 60 | 65.6150 |
| .75 | 52 | 52.4631 |
| .81 | 48 | 50.4050 |
| 1.00 | 40 | 39.3685 |
| 1.12 | 36 | 35.4326 |
| 1.25 | 32 | 31.4948 |
| 1.50 | 26 | 26.2466 |
| 1.75 | 22 | 22.4963 |
| 2.00 | 20 | 19.7840 |
| 2.25 | 18 | 17.4971 |
| 2.50 | 16 | 15.7474 |
| 2.62 | 15 | 15.0280 |
| 2.75 | 14 | 14.3106 |
| 3.00 | 13 | 13.1228 |
| 3.25 | 12 | 12.1130 |

| Dioptric. | English. | Value in inches. |
|---|---|---|
| 3.50 | 11 | 11.2481 |
| 4.00 | 10 | 9.8421 |
| 4.50 | 9 | 8.7485 |
| 5.00 | 8 | 7.8737 |
| 5.50 | 7 | 7.1579 |
| 6.00 | 6½ | 6.5614 |
| 6.50 | 6 | 6.0557 |
| 7.00 | 5½ | 5.6240 |
| 8.00 | 5 | 4.9210 |
| 8.50 | 4¾ | 4.6300 |
| 9.00 | 4½ | 4.3743 |
| 9.50 | 4¼ | 4.1400 |
| 10.00 | 4 | 3.9360 |
| 10.50 | 3¾ | 3.7500 |
| 11.00 | 3½ | 3.5789 |
| 12.00 | 3¼ | 3.2807 |
| 13.00 | 3 | 3.0285 |
| 14.00 | 2¾ | 2.8120 |
| 16.00 | 2½ | 2.4650 |
| 18.00 | 2¼ | 2.0871 |
| 20.00 | 2 | 1.9684 |

For the reason that the inch measure differs; for instance, one metre or D. in France is equal to 37 inches; when we order a + 20 we find them to be + 22, it is therefore necessary for the optician to remeasure all of his lenses if imported. We will now speak of the various methods for measuring or testing the strength of lenses. But before telling you how to find the strength or number of concave or convex lenses, we will tell you how to find whether it is concave or convex. If you take a lens and look through it at an object, and if when the lens is moved the object moves in an opposite direction it is a convex sphere; if the object moves with the lens in the same direction with the lens, it is a concave sphere. One of the simplest methods for measuring convex lenses is to take a ruler 60 inches in length and fasten a white card at zero; place this 20 feet distance from some conspicuous object, a window or railing will do; your card is placed upon the farther end of the ruler; you now move your lens to and fro until you have a well defined image of the window or railing or whatever it may be; this image is always inverted, the reason for which we have explained in speaking of convex lenses; as soon as the figure shows clearest you count on the ruler the number of inches from the lens to the card, which will be the focal distance of the lens, also its number in inches. There is also an easy method of finding the strength or number of concave lenses; if you take a concave lens and a sheet of paper at a certain distance from a gas jet or bright light of some kind and gradually draw the lens from the paper you will see a dark center and a very bright circle around this, increasing in diameter as you draw it away. Now place the lens on a sheet of paper and draw a pencil around the lens describing a circle equal to two of the lenses; we will draw the lens from the paper till the shadow is just double the size of the lens, and this distance from the lens to the paper will be its focal distance or number in inches. This method has no practical value, but is useful sometimes in approximating the number. But we measure convex lenses very accurately by means of the ruler and card, and use them for measuring concave lenses by neutralizing them. As we have explained before, a concave lens and a convex lens of equal refracting power placed together will have no refracting power, or the same as plane glass. If you have a concave lens of which you do not know the number, place before it different numbers of convexes until you find one that makes them both together appear to be plane glass, then the number of the convex lens will be the number of the concave lens. The number of a concave lens may also be found by combining it with a stronger convex and then finding the number or focal distance of the weaker convex; for instance, the concave and stronger convex together are found equivalent to + 1.00 D.'s, and the number of the convex lens is + 7.50 D.'s; then + 7.50 D.'s subtracted by — 1.00 D.'s equals + 6.50 D.'s. Among the other and more accurate methods of measuring lenses is Spencer's Foco-metre, and the measuring box for optical lenses. Other instruments have also been devised for this purpose. The strength of the lens tested is read directly from the scale attached to the instrument in all.

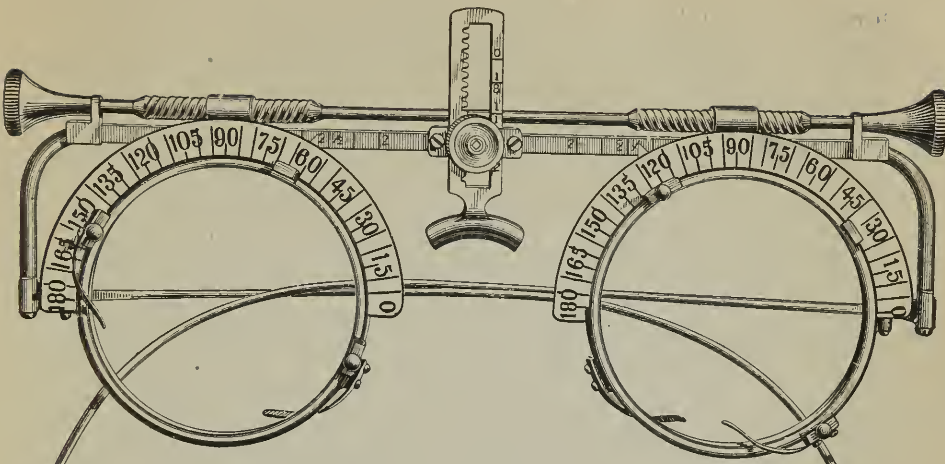
As referred to in another part of this book, every lens, whether convex or concave, has a place where rays pass through without being refracted or bent, called the optical center, and nothing is of more importance to the optician than to be able to find the optical center of a lens. This optical center should always be in the center of the lens, but in too many instances it is not, and no matter how painstaking you may have been with your patient in adjusting the lenses, they will not be satisfactory if the optical center is not in the center of the lens, and the center of the lens in the center of the pupil. To find this center you must draw a straight line across a sheet of paper and have this about four feet from you; then take the lens in your hand, shut one eye and look at the line with the lens at the same time above or below the lens. You will notice, as you move it backward and forward, that the line is broken and part of it seems to be carried with the lens; you now move the lens so that both parts of the line seen through the lens and above it are together and unbroken; mark this line with ink, and it will be the optical line; but as yet you have not determined the optical center; turn the lens at right angles and the place where the two lines cross is the optical center of the lens.

It is sometimes necessary, in order to overcome certain motor defects to decenter spherical lenses and cause them to act like weak prisms; to do this correctly it is necessary to find the optical center, then put the zinc pattern as much as desired to one border of the lens; that border of the lens nearest the center is the base, and any order "base in" or "base out" is correctly filled if you place this part towards the nose or temple according to order. Any lens has the effect of a decentered lens or weak prism if the optical center is not in the center of the pupil.

Glass of which lenses are made is an artificial substance composed mostly of silica, soda, lead and lime; the quality and clearness mostly depending on the proportion of these ingredients, and every optician should be well informed about the different qualities of lenses, and be able to determine their various grades. Lenses of the first quality contain a large amount of lead, the larger its quantity the brighter and clearer the lens, which cannot be distinguished from pebble by looking at the two together. The second quality of lenses contain no lead, and have a greenish tinge, and are harder than the better quality, and many physicians think preferable for cataract lenses. The best means of comparing lenses is to place them edgewise between your fingers and hold towards the light; you will then see the difference in color of these lenses better than by placing them on white paper. First quality lenses should be colorless like pebble; if they are of a greenish tinge they belong to the second or some other quality. There are other things to notice besides the color. A good lens is polished, correctly centered without flaws; to find flaws, streaks, etc., you must hold the lens at an angle of 35° to 40° in a strong light; then we shall be able to see the smallest bubble or scratch in or upon the lens.

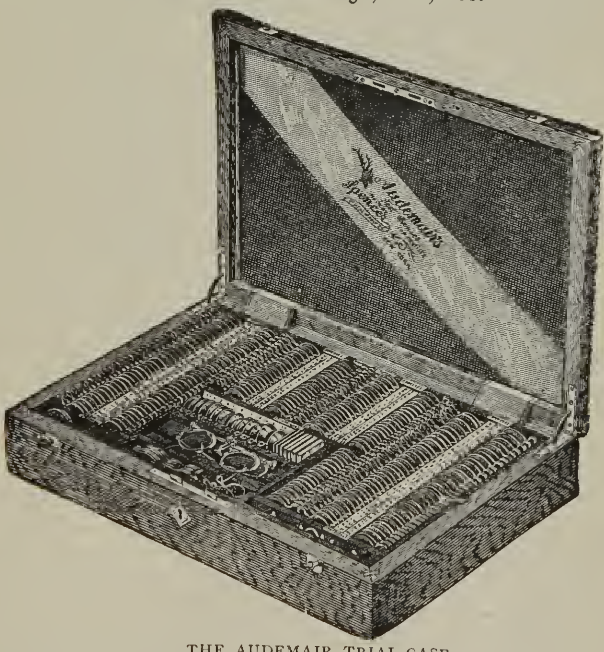
Among the various instruments for detecting and correcting errors of refraction, such as the almost numberless kinds of optometers, etc., none seem to fulfill the needs of the refractionist, or are so accurate as the Test Case, an illustration of which is given on page 19. Tnis contains a collection of all the lenses known to optical science for the correction of all errors of refraction, various discs, prisms etc., etc. A complete test case should contain 38 pairs of convex and 38 pairs of concave spherical lenses, 24 pairs each of convex and concave cylindrical lenses, prisms, a stenopaic slit and pinhole disc, an oxidized disc, colored lenses and two trial frames, one for spherical lenses only, and the other with graduated arcs for determining the axis of cylinders, and spaces for two pairs of lenses. In the Figure on page 19 is shown Spencer's latest improved Trial Frame; an important feature of which is its lightness, weighing as it does little more than an ordinary spectacle. A right and left hand triple threaded screw moves the lenses uniformly together or separately. And when you have the pupil in the center of the arcs, the little pointers on the nasal side of the lens-holder points to a number on the square bar just beneath the screws moving the arcs, showing the distance from the center of one pupil to the center of its mate; for instance, a prescription reads P. D. $2\frac{5}{8}$ inches, which means pupillary distance, or distance between pupils $2\frac{5}{8}$ of an inch; and in fitting the spectacle or eyeglass you must have the optical center of the lenses in the center of the pupil, or in other words the optical centers of the lenses must be $2\frac{5}{8}$ of an inch apart. The bridge in this frame with cork nose rest slides up and down by rack and pinion adjustment, registering the height of crest above pupillary line. On the upper half of the arcs you will notice numbers from right to left, commencing with 0. These are the

## TRIAL FRAME.




SPENCER'S NEW AND IMPROVED TRIAL FRAME, ABOUT ½ THE WEIGHT OF OTHERS.

degrees of the half circle; a cylindrical lens with the mark of its axis pointing to the first line above o would be at an axis of 5°, two lines above, 10°, and three lines above would be at an axis of 15°, etc., etc.



THE AUDEMAIR TRIAL-CASE.

On the right hand side of the Test Case are 38 pairs of lenses that are known as convex, +, or positive and are double convex in form; they have various refracting powers from $^1/_{320}$ to $\frac{1}{2}$ inch, or from 0.125 D. to 20. D. These lenses have thicker centers and thinner edges; or we may say that they are composed of a number of prisms with their bases in, and as rays of light are always bent towards the base of a prism, rays in a convex lens will be refracted toward the center, the amount of refracting or bending power depending on the amount of curvature. These lenses are used in those errors of refraction which are due to a deficiency in the refracting media, or the refracting power may be normal and the relation of the parts abnormal. For instance, in presbyopia or old sight, the eye may be normal in shape but the crystalline lens has lost or is losing its former elasticity, consequently it has not the power of becoming convex enough or of exercising sufficient refracting power to bring rays from the near point to a focus on the retina. Again, the refractive media, crystalline lens and cornea may be normal and some abnormality in the shape of the eye demand the use of convex lenses. This is the case in hypermetropia or far sight; the eyeball is too short in its antero-posterior diameter, bringing the retina so close to the crystalline lens that it is impossible for it to exercise sufficient bending power to bring the rays to a focus upon the retina, consequently the rays are brought to a focus at a point behind the retina. In both these cases convex lenses are indicated to assist in bending the rays of light. In the right of the center of the case are 22 pairs of plano-cylindrical-convex lenses, plane on one side and a convex cylinder on the other. What we have said in another part about convex-cylindricals applies here, so it is unnecessary to dwell upon their properties to any extent. A cylindrical lens exercises bending power on rays of light entering at right angles to their axis, while rays passing through other parts are not refracted. For instance, if we take a +1.00 D. lens from the case and a cylindrical lens of the same power and kind, we find that if the spherical lens be held at 40 inches from a screen and in front of a gas jet or lamp, a perfect image will be formed on the screen, but the cylinder will bring to a focus only those rays that enter at right angles. The cylindrical lens exercises the same bending power as a spherical in one meridian only, while the spherical has the same bending power in all meridians. These lenses are used in an error of refraction where the condition of the eye is such that homocentric rays of light, whether convergent, parallel, or divergent, are brought to different foci. It has no relation to the length of the eye, only to unequal refracting power of the media. (See Astigmatism.) The axis of a cylinder is designated on trial lenses in two ways, either by having the two edges parallel to its axis, ground glass, or the more preferable way is the one with a short line scratched in the line of its axis. It is thought that ground glass cylinders, especially if the margins are wide, prevent the refraction of some of the peripheral rays which might be conducive to good vision, and it is reasonable that as the glasses you prescribe will not be partly opaque it is useless to make the test by means of them. The plano-cylindrical concave lenses are in the left side of the center. There are also 22 pairs of these lenses, having various refracting powers, from $^1/_{320}$ to $^1/_5$. On the extreme left are concave,—, spherical lenses, consisting of 38 pairs; these are used for the correction of myopia or near sight, due to a lengthened condition of the eyeball so that rays come to a focus before they reach the retina. In this chapter we wish simply to acquaint you with the positions of the lenses in the test case and the correct method of their employment, and refer you for more comprehensive instruction to the chapters on Errors in Refraction. In front of the concave cylindrical lenses in the left center are 20 $\underline{\wedge}$ prisms with angles from 1 to 20 degrees. A prism is a wedge-shaped piece of glass with two plane surfaces inclined toward each other. They reflect rays and do not cause them either to converge or diverge. They have therefore no foci and cannot form an image. The rays are always deflected toward the thickest part or base. They are employed for muscular insufficiencies.

We will now in as brief a manner as possible tell you how to use prisms. We have said that prisms are used in muscular insufficiencies. Diplopia is a failure to see one object, but, instead, there are two; the two objects may be crossed, that is, the right light object is seen by the left eye, and the left light by the right eye—this is known as crossed diplopia or double vision—or the light may be separated, seen on the same side as the eye; this is known as homonymous double vision. In testing the muscles with prisms you must have a candle flame as your test object, which should be at a distance of 20 feet from the patient. You place in one side of your trial frame the ruby disc and nothing in the other side. If the double vision is constant there will be two flames, one red and the other white; if the flames are displaced laterally the internal or external muscles are deficient, and if they are seen one above the other the trouble is due to the superior (upper) and inferior (lower) recti muscles. There are two other muscles that may be concerned in double vision, *i. e.*, the upper or lower oblique muscles; the flames will then be one above the other and to one side. You can in this manner decide quite readily what muscles are involved. We must now find out how much muscular insufficiency there is: this we will do by leaving the red disc before the eye and placing a weak prism before the other and gradually increasing the strength until both flames are fused. The base of the prism is over the muscle involved. The number of the prism fusing both into one, divided by two, will give the amount of deviation. There is also a condition known as asthenopia, which may require the assistance of prisms, although there may not be double vision. To find the proper strength you must test the power of the muscles by the prisms. You cover one eye with the red disc and leave the other uncovered as before. Begin by testing the power of the internal rectus. The patient watches the candle flame while you commence with a weak prism with its base outward; if there is still one candle you increase the strength until you ascertain the strongest prism with which the patient can see one flame; this will give the power of that muscle, it should be able to overcome from 25 to 35 degrees. Now place the ruby disc before the eye you have just examined and try the internal muscle of the other eye in the same manner; test the strength of the external rectus muscle by commencing with a weak prism and finding the strongest that will leave but one candle flame, which will be its power; the same should be done with the other eye. Normally this muscle will be able to overcome about 8 degrees, and the other muscles—the inferior and superior—about 3 degrees. If we find in testing the muscles in the above manner that they cannot overcome the proper prism, there is weakness in the muscle tested; therefore if we find that the external muscles that diverge the eyes will not overcome an eight degree prism, we have weak external muscles or muscular asthenopia, and we may order prisms for their relief. If we have tested each muscle separately and found that they overcome but a four degree prism when it should have been eight, there is an insufficiency of four degrees in each eye, making eight degrees in all. Divide the amount in degrees of insufficiency by two, and this we apportion equally between the eyes; therefore, if there is eight degrees, this divided by two will give us four, and four equally divided between the two eyes will give us two degrees for each eye, the number which should be prescribed. We obtain the effect of very weak prisms in slight degrees of muscular weakness by having the glasses which correct an error in refraction, decentered. A number of very important adjuncts to the test case will be found in the front part, to the right of the center. Taking the first, as we proceed from right to left, we find a disc of oxidized metal without an aperture; this is used to cover one eye while we are testing the other (each eye should invariably be tested separately). Next is the ground glass disc; this is used for the same purpose, and while it prevents the patient from seeing with the eye it covers, it does not obstruct the light, therefore the pupil remains in a normal condition, for, as you will readily understand, when light is shut off from the eye, the dilator-iris makes special efforts to admit all the light possible, consequently the pupil becomes dilated to so great an extent, by using the oxidized disc, that the proper correction is interfered with when you test that eye.

In testing for astigmatism you can determine it by means of the radiating lines known as Javel's test, Green's test with radiating lines in the form of a clock face, and by Spencer's Test Chart for astigmatism, which is composed of large letters made up of black and white lines running at various angles, but you can confirm the results of your examination with the stenopaic slit. This the next disc we come to, as we proceed from right to left, is simply a disc of metal of the same diameter as the test lenses with a slit in the center, about ¾ of an inch long and about 1 mm. in width; this you can easily understand, will cut off all the rays in every meridian, excepting the one in which the slit is. Now if you place a stenopaic slit before the eye and direct the patient to look at the distance chart 20 feet away, gradually turning it from right to left until you find the position in which the patient has the best vision, if he reads the 20 foot line at 20 feet his vision must be normal in that meridian, and he will see all the lines alike on the astigmatic chart; but if he does not see all the lines alike in the meridian in which you found he has the best vision, you must add a convex or a concave spherical lens until all the lines are equal, then turn the slit at right angles to this and add concave or convex sphericals as before, until vision is normal. If you require a lens over the slit in each line and one is stronger than the other, the weakest lens will be equal to the refraction of the meridian in which he has the least error, and the stronger that of the greater meridian of error; the astigmatism of course is in the meridian in which we require the stronger lens, and the difference between them will give you the amount of the astigmatism.

Next to the stenopaic slit is a metal disc oxidized, with a minute aperture, known as the "pinhole disc," this disc excludes all peripheral rays and admits only those that pass through the optical axis of the eye. Whenever the patient is found to have imperfect vision this disc should be tried; one eye must be covered by the ground glass disc. You place the pinhole disc before the other eye, be particular and have the perforation in the center of the pupil, direct the patient to look at the distance chart and if vision is improved by looking through the pinhole, it can certainly be improved to an equal or greater extent by the correction, but if they do not appear any more distinct, it is not possible to improve the vision very much with any lens, the defect being due to some abnormality in the eye that is not corrected by lenses. The other discs in the test case are the smoke, blue, neutral tint, plano and ruby, the use of which it is unnecessary for us to dwell upon at this point.

We have said all that is necessary about the contents of the Spencer Trial Case, and will in as brief and as comprehensive a manner as possible, show you how to proceed to determine and give the proper correction for an error in refraction. It has been found that letters one-third of an inch high can be made out by people with good sight at a distance of 20 feet, twice as large at 40 feet, three times as large at 60 feet, and half as large at 10 feet.

**G C L U Y**

SIZE OF LETTERS THAT SHOULD BE SEEN BY THE NORMAL EYE AT 20 FEET.

**B D 4**

THIS SIZE SHOULD BE SEEN AT 40 FEET BY THE NORMAL EYE.

These letters were devised by Snellen, for the purpose of proving Jaeger's Theory that the eye will subtend an angle of one minute of a degree. These letters are arranged in five minute

THIS SIZE SHOULD BE SEEN AT 200 FEET BY THE NORMAL EYE.

squares so that the details of the letter must be seen in order to make out the entire letter. Over each line of the test type is marked in the Roman notation the distance at which they should be seen by a normal eye ; for instance, over the large A at the top of the Spencer distance chart are two CC. which mean that that letter should be seen at a distance of 200 feet from the card.

Over the third line from the bottom are two XX. which means that this should be read at 20 feet by a person that has no error of refraction for distance. There are two other lines below this for 15 and 10 feet respectively ; but these are seldom used for testing distant vision for the reason that rays coming from an object nearer than 20 feet are divergent and consequently require an effort of the accommodation to bring them to a focus upon the retina. But all rays coming from a distance of 20 feet or more are for all practical purposes considered as parallel rays. A figure with projecting arms like the letter E turned in various directions has been devised for those who are illiterate or do not know the letters, which are known as illiterate test type or pot hooks. It is very important that direct rays shall not shine in the eyes of the person you are testing. In determining an error of refraction you should in every case first test the distant vision ; first direct the patient to read the smallest line of letters which he can see on the test card, which should be at 20 feet, each eye separately ; find if there is any difference in the refracting power by covering the left eye with the ground glass disc and, leaving the right eye uncovered, find the smallest line that he can read with the right eye alone ; then place the ground glass disc before the right eye, try the left in the same manner ; if he can read equally well with either eye, the refracting power of both eyes are equal. Care must be taken not to make pressure on either eye while they are being tested, as this would probably dim the sight and interfere with the correction. The number above the line of letters that can be read and the distance at which they are read gives the acuteness of vision, the distance being the numerator and the number the denominator ; for instance, if, with the left eye covered, your patient reads the 20 foot line on the distance chart at 20 feet, his vision is said to be for that eye $\frac{20}{20}$ equal to 1, or normal, but, with the right eye covered, he can only make out the line marked 40 at the same distance, his vision for this eye is said to be $\frac{20}{40}$ or ½ of what it should be. The twenty foot line may be made out at a distance of 20 feet with either eye and yet the same person may be unable to read the line that should be read at 14 inches, which shows some defect in the focusing power of that eye. To illustrate, you test the eye of a patient and find that he sees on the distance chart all that should be seen at that distance, you now find that he is unable to read the line on the near chart at 10 inches which should be read at that distance, which shows you that there is some defect in the focusing power of the refractive media ; in this case the near point will not be as near the eye as it should be normally, but you will find in most cases that they can see the ten-inch line at a greater distance than ten inches from the eye. If this near point is 16 inches from the eye and the patient is unable to read it when it is brought nearer, it shows that the eye cannot focus rays from any nearer object. There are only two conditions in which this near point recedes and leaves distant vision normal, these are hypermetropia (far sight) and presbyopia (old sight) ; the first is due to a shortening of the antero-posterior diameter of the eyeball, and the latter to a flattening or inelasticity of the crystalline lens. You will meet with hypermetropia first, mostly in young people, while presbyopia is due to age, and begins to be troublesome about the 42d or 45th year. If a patient is presbyopic and vision for distance is normal, the convex lens will blur objects seen at the distance. In presbyopia you should give a convex lens with which a patient can read the smallest line on Spencer's Near Vision Chart at a distance of 14 inches.

To recapitulate the subjective method for making an examination of the eyes, with the view of prescribing lenses, note the following :

In making an examination of the eye subjectively with the view of improving the patient's eye-sight, adjust the trial frame, cover the left eye with the oxidized disc and then direct the attention of the uncovered right eye to the large type located 20 feet away; note how many letters the patient can read before


By courtesy Jewelers Circular Publishing Co.

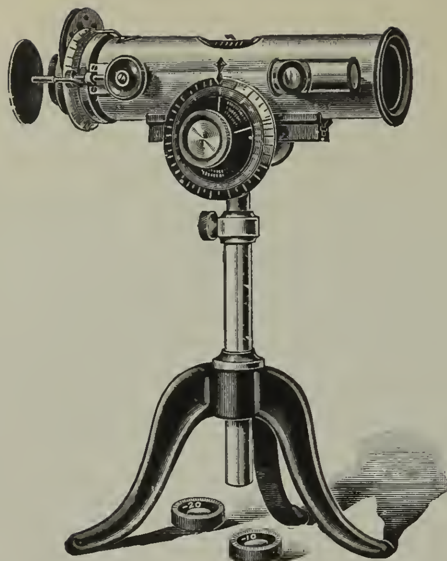
OPTOMETRY.

adjusting any kind of a lens before the right eye. Try first a convex sphere, and if this blurs, try a concave sphere. If astigmatism is suspected, direct the attention of the right eye to a chart with lines radiating in every meridian of a circle, such as the chart with the clock dial delineated thereon. Note as to whether some of the lines are not blacker than the others. If some of the lines are blacker, place a cylinder with its axis at right angles to the blackest lines, and employ that cylinder which will render all of the lines equally black ; and if more letters can be read upon the large test type, the patient is astigmatic and so we supply that cylinder which will give the best vision, and if spheres will aid the vision, we add additional spheres. Try the left eye in order, taking the same steps as with the right eye ; then try both eyes with the correction together, make such modification as you see fit and finally try the accommodation, both eyes together. If the patient is presbyopic, add convex spherical lenses, according to Donders' law for reading.

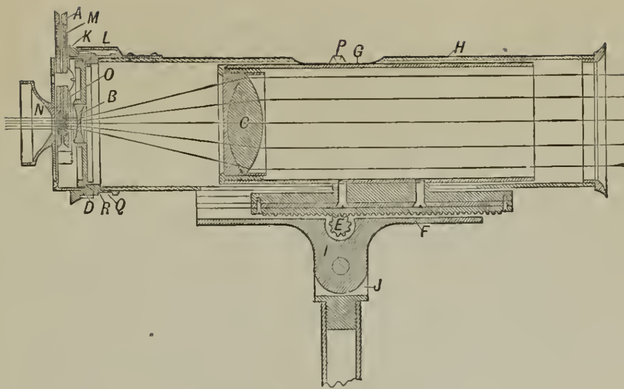
## De ZENG'S REFRACTOMETER.—OPTICAL AND MECHANICAL CONSTRUCTION.

The construction of the Refractometer, as shown in the accompanying cuts, consists in the nickeled or lacquered brass tubular casing H, approximately $2\frac{1}{8}''$ in diameter and $8\frac{1}{2}''$ long, mounted upon the bracket I, and pivoted to the upright pillar J, which is supported below, either upon a three-legged oxidized iron base or an adjustable wall bracket.

The upright support or pillar J has a vertical adjustment of approximately 9″, and an oblique and horizontal adjustment at its point of contact with the bracket I, giving to the tube H a universal adjustment. The front end of the tube H is left open, while at its rear end there is arranged a rotatable head D, carrying within it a negative eye-piece B This eye-piece consists in a bi-concave sphere of approximately 20 dioptries focus, and is accurately centered and adjusted within its cell as shown. The head D is provided at its circumference with a circular rack into which meshes a pinion carried on the back end of an arbor which is driven from its front end by a milled head, and through the revolution of the pinion a rotation of the head D is obtained about its cylindrical axis. The degree of rotation of the adjustable head D is recorded by means of the graduated beveled ring or scale K, lying around about it, with which scale co-operates the index L, secured to the upper side of tube H. This scale and index denote at any point of rotation of the head D, the axis of the cylindrical lens which may be exposed at the aperture in the eye-piece. Pivoted within the rotatable head D are two revolving discs or lens carriers A, having within them apertures in which are arranged the concave cylindrical lenses M, with their axes set at right angles with the radii of the discs containing them. These two discs or lens carriers A have their edges milled and are inclined towards each other, and are provided with figures on their front faces indicating the power of the cylindrical lenses contained in the apertures in the opposite side of the disc to them, so that the power of the lens exposed at the aperture in the eye-piece N may be readily determined. These discs A are also provided with spring stops O, for indicating the correct position of the lens when exposed at the eye-piece. The cylindrical lenses contained in the discs are of a negative quantity, and are arranged as follows : In the back disc O, 1.50, 3, 4.50, 6, 7.50 and 0.12. In the front disc O, .25, .50, .75, 1., 1.25 and S (stenoptic disc). Through this arrangement the power of any lens in one disc can be added to that of any one in the other disc, and as a result combinations equivalent in power to all the cylindrical lenses from 0.12 to 1.37, inclusive, can be formed in divisions of eighths, and those from 0.25 to 8.75, inclusive, can be formed in divisions of quarters. Sliding within the main tube H, is an inner tube G, constituting a lens carrier, having celled within its rear end the convex achromatic objective C, being open at its front end. This tube G is graduated on its upper side in dioptries and fractions thereof, and the scale so formed indicates Myopia as the refractive error and concave spheres for its correction. The range of the scale is from zero to 9. D, inclusive, and is subdivided into quarters, halves, three-quarters and whole dioptries. The movement of the tube G along its cylindrical axis is provided for by the attachment to its lower side of the diagonal rack F, into which meshes the spiral pinion E, journaled in the bracket as



shown. The ends of the arbor carrying the pinion E are provided with milled heads or hand wheels by which the pinion is revolved. There is also a graduated circular vertical dial attached to the right extension of the same arbor, denoting Hypermetropia and Myopia, or convex and concave spheres, respectively, the range of the convex numbers being from zero to 18. dioptries, inclusive, and that of the concave spheres being from 0 to 1.50 inclusive, the continuation of these latter numbers being upon the scale of the tube G, already described. The indicator to the vertical dial described is attached to the side of the main tube H, directly over it. All of the plus effects obtained with the instrument are indicated in the red figures upon the circular vertical dial at right side of the instrument, and the minus in white figures, both on the circular vertical dial and the inner sliding tube G. An oblong opening is made in the top of main tube H, at its center, through which the previously described minus scale on top of inner tube G is exposed to view. Projecting into this oval opening and co-operating with the scale there exposed as described, is the arm of the indicator P. This indicator is adjustable and is provided on its lower opposite side with a small white line which co-operates with the radiating white lines from a small range scale of from three to six meters, inclusive, fixed to the tube H, immediately below the indicator P, and through the adjustment of the indicator P, with relation to the scale already described, the instrument may be arranged to perform accurately in either a three, four, five or six meter range. Attached to the right side of the tube H, near its front open end, is a guide or finder, composed of a small tube having a convex lens celled within its front end, a plain mirror set at an angle in its rear end, and a ground glass screen in its side. Fixed upon the ground




LONGITUDINAL SECTION.

glass screen of the finder there are two intersecting right angle lines, at the contact of which the test card will appear when the said card is centrally located within the visual field of the Refractometer. Running within the annular groove Q, in the screw threaded sleeve R (securing the rotatable head D to tube H), is a semi-circular spring clamp, forming, with an extension arm and circular metallic disc, a reversible and detachable eye-shade, capable of being adjusted through its eccentrical arrangement to accommodate various pupillary distances. Through the relative adjustment of the movable convex achromatic objective C, with the stationary negative eye-piece B, all the spherical equivalents from plus 18.D, to minus 9.D, inclusive, are obtained at the eye-piece, and are recorded upon the revolving and sliding scales, respectively. Owing to the range of the negative scale being limited to 9.D, there are two auxiliary caps accompanying the instrument, one containing a minus 10.D, S, and the other a minus 20.D, S, which may be placed over the eye-piece when required, and through their application the said negative scale can be raised to either 19.D or 29.D.

By reason of the instrument's optical construction it has an amplification of two and one-third diameters, and in consequence of this the test types furnished with it are reduced to three-sevenths of the size of the Snellens' letters, so that the visual acuity may be reliably estimated with the instrument.

## SUGGESTIONS IN TESTING.

The best method employed in testing with the Refractometer is what is known as the "Fogging System." This system consists in over-correcting a Hypermetropic eye with a convex sphere or under-correcting a Myopic eye by the application of a concave or convex sphere of such power as to render all the lines and letters in the test type deeply blurred, that the accommodation may be relaxed and the hidden or latent error be developed and measured with the manifest.

Through the application of this system in the use of the Refractometer, its high condensing properties admit sixteen times the volume of light to the retina under Myopic conditions that is admitted under similar circumstances when a like test is made with the trial case; and owing to the increased retinal stimulation to the ciliary muscle towards relaxation, due to the large volume of light at a focus before the retina, the Refractometer develops and measures more latent error than any other instrument not supplemented by a mydriatic.

First set up the instrument in a direct line from the test card and in accordance with the range for which it is already adjusted. Next see that it is set at zero for both spheres and cylinders, that no focus whatever may be existing when the test is begun, and that the test card appears in the center of the visual field of the Refractometer, using the cross hairs on the ground glass screen of the finder as a guide. Now adjust the eye shade to cover one eye, *while the brow of the other eye touches the eye-piece throughout the test.*

Turn the focusing adjustment to either the right or left until the test card is seen most distinctly, from which point turn it towards higher numbers among the red graduations or lower ones among the white, as the case may require, until all the radiating lines constituting the astigmatic fan at the top of the card are completely fogged. Then turn the focusing adjustment slowly back toward the point at which the card was most distinctly seen, requesting the observer to *name the line or lines in the fan which may first appear to begin to clear*, that the presence or absence of astigmatism may be detected and its meridian located.

If all the radiating lines appear to *clear uniformly there is no astigmatism*, but if some appear to *clear sooner than others*, *the eye is astigmatic.*

When all the lines in the fan clear uniformly, the registration of the *highest figure* that can be obtained among the graduations in *red* or the *lowest* among the *white* (as the case may require), with which the small letters on the test type can be distinctly seen, will indicate the nature and amount of defect present, and the kind and power of glass to be prescribed for its correction, it being simple Hypermetropia if the numbers are *red* and simple Myopia if they are *white.*

Should one or more of the lines in the fan *clear before the others*, the point at which they are first seen normally distinct should be noted, and the blurred lines (usually at right angles with them) *rendered equally distinct only by the employment of the cylindrical lenses as follows :*

Rotate the head of the instrument to a point where the indicator *to the "Axis Register"* shall stand *opposite* to a graduation thereon agreeing with the *meridian occupied by the blurred lines*, bring the cylinders to the eye-piece, beginning with front cylinder disk containing the weakest numbers. Revolve it to the right until through the use of one disc or both, a cylindrical power is obtained at the eye-piece which will render the fan uniform to the eye.

After securing a uniformity in the definition of the radiating lines as described, throw them all back into the fog, that on bringing them out again any under or over correction for the astigmatism may be detected. If under corrected, the same lines which came out of the fog first in the first instance will come out first again. If over corrected, the lines lying approximately at right angles with those first appearing to clear will clear first. If any difference exists, correct it as described before proceeding.

The power and axis of the cylinder thus obtained should be verified, before completing the astigmatic test, as follows: Direct the attention of the observer to the letters beneath the fan that may appear distinct while a change in the power, or axis, or both power and axis, of the cylinder previously selected is made, and note carefully *which cylinder and what axis* produces the *clearest definition* on the smallest letters that can be clearly read and is most acceptable to the eye.

*Always prescribe the very weakest cylinder which will correct the difference in the appearance of the radiating lines in the astigmatic fan, and gives the best vision upon the letters.*

The figures engraved upon the faces of the revolving discs containing the cylinders, indicate the power of the cylindrical lens exposed at the aperture in the eye-piece *when the click of the spring stop tells the proper position and they stand directly opposite the 180 degree graduation on the "axis register," below them.*

Should the lenses in both discs be exposed at the *same time*, their power should be combined and the equivalent expressed as one lens.

In the employment of the spherical numbers (either with the cylinders or without them) always endeavor to obtain the very highest plus in Hypermetropia and lowest minus in Myopia that good vision will permit. In the observance of this rule the Refractometer will give perfect results.

In making additions for Presbyopia the following table will be found serviceable:

| | | | | | | |
|---|---|---|---|---|---|---|
| 38 to 40 years of age | ---------- | add + | .50 | Spherical. |
| 40 " 42 " " | ---------- | " | .75 | " |
| 42 " 44 " " | ---------- | " | 1.00 | " |
| 44 " 46 " " | ---------- | " | 1.25 | " |
| 46 " 48 " " | ---------- | " | 1.50 | " |
| 48 " 50 " " | ---------- | " | 1.75 | " |
| 50 " 52 " " | ---------- | " | 2.00 | " |
| 52 " 54 " " | ---------- | " | 2.25 | " |
| 54 " 56 " " | ---------- | " | 2.50 | " |
| 56 " 58 " " | ---------- | " | 2.75 | " |
| 58 " 60 " " | ---------- | " | 3 00 | " |
| 60 years and upwards | --------- | " | 3.00 | " |

The range of the accommodation in Hyperopic eyes is equal to the difference between the highest plus and the lowest plus or strongest minus with which uniform vision is maintained, while in Myopes it corresponds to the variation between the strongest and weakest minus. This test can be much more quickly and reliably made by the Refractometer than in any other way. The range of the spherical and cylindrical numbers in the Refractometer is wider than that of the most complete trial case and it is therefore obvious that with it every form of astigmatism—simple, compound and mixed, as well as Hypermetropia and Myopia, can be measured. In point of design, finish, quality of workmanship and material used the Retractometer is unsurpassed, and every instrument is guaranteed to be absolutely accurate and free from optical or mechanical imperfections of any sort. All of the lenses are made from the finest quality of optical glass and so ground as to insure freedom from both spherical and chromatic aberration, giving a clear, open field of vision.

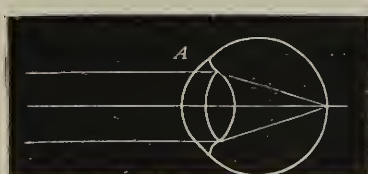
To the busy and progressive refractionist the Refractometer is an indispensable instrument, in that it is quick, accurate and reliable in the simplest and most complicated cases. No astigmatism can escape detection in the use of this instrument, for, owing to its amplification, slight errors are as manifest as are the more pronounced ones by the employment of other means.

Cases having low visual acuity and consequently difficult to refract, are also readily determined by the Refractometer, for which reason it is especially recommended

# CHAPTER III.

**EMMETROPIA.** Having discussed the various kinds of lenses, all of which are employed for a definite purpose, it becomes us at this point to enter upon an examination of the several conditions with which we are called upon to deal, requiring the use of spectacles and eyeglasses.

In order that we may comprehend the meaning of Errors of Refraction, it will be necessary for us to understand first a perfect or normal condition of the eye, as it is our purpose in making an examination of the eyes to discover whether eyesight is good or bad, for other things being equal, vision will be perfect or imperfect, normal or abnormal, and so in the order of analysis we will discuss perfect or normal vision first, under the heading of Emmetropia. This term is defined as a state or condition of the eyes in which the rays of light from the distance point called infinity, located at a range of twenty feet, will pass through the transparent parts of the eye and focus upon the retina with the accommodative or focussing apparatus at rest. The eye will then be nine-tenths of an inch in its axial diameter and perfect in shape ; in other words, it is an emmetropic eye, performing perfect functions relative to the laws of light, etc., etc.




A—EMMETROPIC OR NORMAL EYE.

It is said by reliable authority that only twenty per cent. of the human eyes are in emmetropia.

The methods adopted for determining emmetropia or normal vision are the subjective and objective. The subjective method is carried out by means of the Trial Case and Refractometer, and by this means we largely depend upon the statements made by the patient, so that if the patient can read the Snellen's-test-letters down to the twenty foot line we know that he approximately is normal, leaving aside all latencies in our calculations, and we express the fact by the fraction $\frac{20}{20}$, the numerator in this fraction expressing the distance and the denominator the kind of letters read.

The objective method for determining normal vision or emmetropia is by means of the ophthalmoscope and the skiascope.

We should satisfy our minds with the fact that the vision is either normal or abnormal, subjectively and objectively, and having settled that point, we then make a trial of the accommodative apparatus for reading.

An eye that is in emmetropia will not require lenses, only in cases when the crystalline lens has become inelastic from progressive hardness, as it is in old sight, and we then give them for the purpose of reading so that the patient will be enabled to read, sew or work at the convenient distance of fourteen inches.

## CHAPTER IV.

**AMETROPIA.** In an eye in which there is a defect of sight, the rays of light from twenty feet will not focus upon the retina with the muscle of accommodation or accommodative apparatus at rest, and the generic term employed to express defective vision, imperfect or abnormal sight, or errors of refraction, is Ametropia.

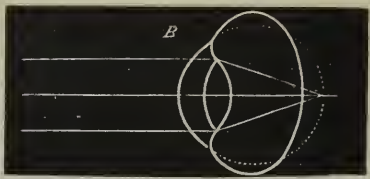
There are three ametropic states or conditions with which we are called upon to deal: these are hypermetropia, myopia and astigmatism.

Ametropia.
1. Hypermetropia,
2. Myopia,
3. Astigmatism.

### HYPERMETROPIA.

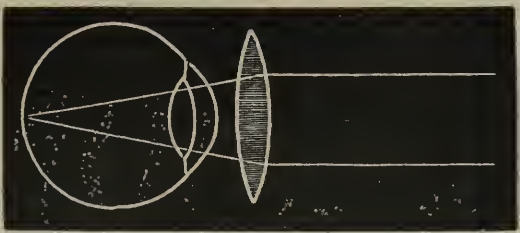
This is by far the commonest cause of the subject of our chapter—it is known as hypermetropia, hyperopia, or far sight. There are also other causes, such as lessened convexity of the refracting surfaces while the other parts of the eye may be normal. Undoubtedly the real cause of far sight is arrested development, or a reversion to the natural type of eye and failure to take on the increased accommodation of civilization; it is largely due to heredity. The refractionist will be told by the person who has hypermetropia or far sight, of the inability to keep up continuous close work. The sewing is blurred and the letters of words run together; general weakness and pain in and about the eyes, headache and heaviness of the eyes and of the lids will be spoken of. The edges of the lids may be inflamed. Vision for distance will be good because the crystalline lens can be made convex enough to bring parallel rays, or rays coming from a distance not less than twenty feet, to a focus upon the retina, but the crystalline lens is unable to do this for rays of greater and greater divergence or for objects nearer. The ciliary muscles soon become exhausted from these efforts to bring divergent rays to a focus on the retina, and the strain spreads to surrounding portions of the eye, and thereby causes other affections, making it very important to correct this error of refraction as soon as possible. In children, far sight may cause strabismus or cross-eye, owing to the great accommodation or convexity of the crystalline lens required in far sight of a medium high degree being productive of greater convergence than is really necessary for the fixation of the object, by the visual axis ;

this is due to the fact that accommodation increases with convergence.



I—SHOWING FORM OF EYEBALL IN FAR SIGHT.

We divide hypermetropia or far sight under three heads according to the condition of accommodation, or power of the crystalline lens to become convex. To illustrate, if a person with hypermetropia or far sight of moderate degree and having good accommodation and strong muscles comes to you to be fitted with glasses, and you have found that it is hypermetropia, you place your distance test type 20 feet from the patient and find the smallest type they can read at that distance, if this is marked XX over it, then vision is $\frac{20}{20}$ or V=1; if you now commence with your weak convexes and they tell you that they can see better without the lenses, the patient has latent or concealed hypermetropia or far sight (if you have found that it is not old sight), which can only be corrected by paralyzing the accommodation with atropine (see Appendix). If another patient is placed at 20 feet from the test chart and reads the line marked XX, and when you place a convex spherical before the eye, vision remains the same $\frac{20}{20}$, then the strongest convex that the patient can still see the 20 foot line with, will be the manifest Hypermetropia or far sight, the vision for distance being normal whether lenses are used or not. But this is not all of the far sight that you have to correct. There is some that is concealed or latent, due to the action of the ciliary muscles. In order to correct all the far sight we must stop the action of this muscle by something that will temporarily paralyze the accommodation. Sulphate of atropine is considered the best for this purpose; in a solution of about 4 grs. of the sulphate of atropia to 1 oz. of water and one drop in the eye 3 times a day for three days. This must never be used after 40 years of age, as it is likely to produce a more dangerous disease than you are trying to cure, that is, glaucoma. After we have paralyzed the accommodation we will find that the patient does not see so much as he did of the distance test card; then the strongest convex lens that will make vision equal $\frac{20}{20}$ will be his full correction or total hypermetropia including the latent or concealed and the manifest. Some people with a high degree of far sight will bring print and work near to them as if near sighted. In these cases you will usually notice very small pupils, and they will tell you that they see badly evenings and require a strong light to see well at any time. Sometimes distant vision fails when they can no longer correct the error by accommodation, and they will be obliged at an early age to use convex lenses.



CUT SHOWING A CONVEX LENS CORRECTING FAR SIGHT BY UNITING PARALLEL RAYS ON THE RETINA WITH THE CRYSTALLINE LENS AT REST.

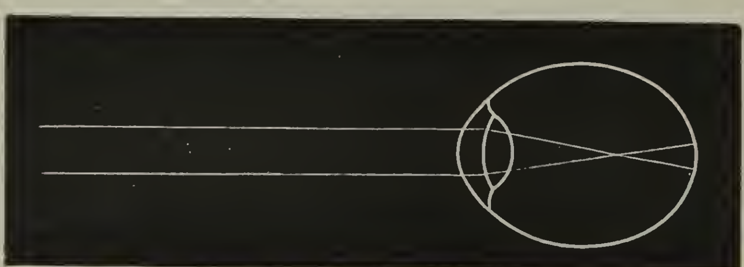
Diphtheria or chronic ill health and over taxation of the sight may cause the same result before the usual time. But it is quite common for these people to suffer from painful sight in work, and not from defective sight. They will tell you that they can work or read for a short time, and then it becomes blurred, also pain in and about the eyes, headache and sometimes sickness at the stomach. Styes and inflamed eyelids will be frequently seen. How large a percentage of people who are afflicted with far sight and become cross-eyed has never been shown, but it is said that about two-thirds of all cross-eyes are caused by far sight or hypermetropia. Efforts at accommodation seem to stimulate the internal muscles; the proper correction and of course removal of the cause will in most cases strengthen the cross-eyes. Strabismus, Amblyopia (see Appendix), Astigmatism, Spasm of Accommodation (see Appendix), will sometimes exist with the hypermetropia. You must remember that this error in refraction is not curable but is correctible; and in high degrees a weaker pair will be required for distance and a stronger pair for near work. In most cases when they find near vision indistinct and tiresome, we may give them the glass which is easy and comfortable to the eyes without using any atropine, and a distance lens is not required.

## THE TEST FOR HYPEROPIA.

The crystalline lens acts as a strong convex spherical lens and when the eye-ball is normal in size it has sufficient accommodative power to bring rays to a focus on the retina; but as you have learned, the eye is too-short in hypermetropia in its axial diameter, consequently the retina is nearer the lens, and of course the focal distance of the crystalline lens must be shorter, or the refractive or bending power greater to still unite the rays and form an image on the retina. This it is not able to do, or if it is, there is a strain on the ciliary muscles, causing the symptoms we have already spoken of. So you see it is necessary to help the lens in bending the rays; and the greater the bending power or strength of this lens, the less remains for the crystalline lens to do. The strongest convex spherical lens that still leaves vision clear for distance should always be prescribed for hypermetropia. And you find it in the following manner ; place your patient 20 feet from the distance test card and find the smallest type he or she can read at that distance, it will usually be the one that should be read at that distance by a normal eye, marked XX or 20. You now commence by covering one eye with the oxidized or ground glass disc from the test case and placing a weak convex before the other ; if he tells you he can see just as well, this proves that it is hypermetropia or far sight. You keep increasing the strength until you find the strongest with which he can still see the 20 foot line clearly. If the eyes give no trouble only when reading, writing or sewing, glasses may only be worn for near vision. If there is headache, inflammation or pain in or about the eyes, advise your patient to wear them constantly. The full correction or the strongest convex lens that still leaves vision clear is the one for both near and distant vision until the age at which presbyopia or old sight begins (about 45) when they will need stronger lenses for their near vision. As the same kind of lenses are required for presbyopia and hypermetropia, stronger glasses are required over the correction for reading.

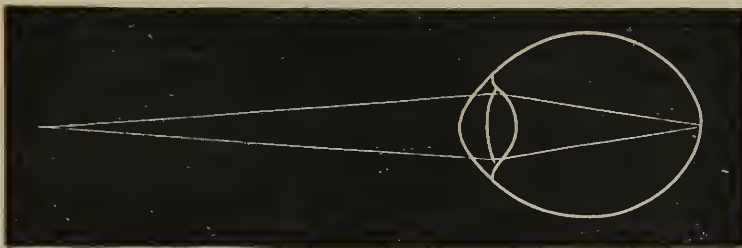
## MYOPIA.

Near sight is defective sight of a nature exactly the opposite of that of over sight, far sight or Hypermetropia. Instead of the eyeball being too short, it is elongated from before backwards, so that parallel rays with the accommodation suspended or at rest, come to a focus before they reach the retina, or in other words, that condition in which, in order that an object should be distinctly seen it must be brought within a certain distance from the eye nearer than the one in the normal eye, so that rays of light proceeding from the object are so divergent that they exactly focus on its retina, and this point is the far point.



NEAR SIGHTED EYE SHOWING RAYS COMING TO A FOCUS BEFORE THEY REACH THE RETINA AND CROSSING.

If the object be removed to a greater distance than this far point the rays coming from it are brought to a focus before they reach the retina, and after they have crossed form a blurred image upon it. The degree of near sight depends on the greater or less distance of the far point from the eye.

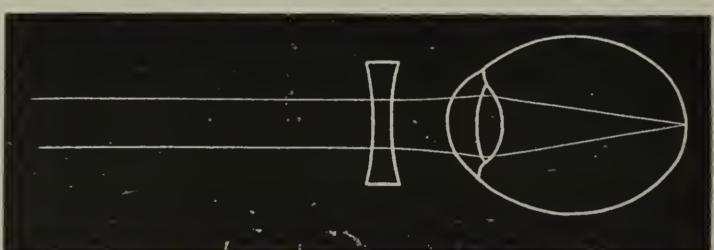


NEAR SIGHTED EYE SHOWING RAYS DIVERGING FROM A NEAR OBJECT SO THAT THEY COME TO A FOCUS ON THE RETINA.

We can make an emmetropic eye temporarily myopic by a convex lens. Place for instance a $+ {}^{1}/_{10}$ lens before the eye and look at the objects around the room and you will get a good idea of the appearance which things present to a near sighted person. The forms of objects, differences of light, and shade and color may be distinguished, but the details are invisible, the clearness depending on the strength of lens you have placed before the eye, or in other words, the degree of near sight you have produced. The stronger the convex the more bending power on rays, and the farther in front of the retina they are brought to a focus the more near sight or poorer vision. If you now hold the near vision chart in front of the eye with the convex still before it, you will find it is difficult to see any of the fine lines unless the card is brought quite close. The farther away the object, the more blurred and indistinct it is. You can correct your temporary myopia by placing before the convex, concave spherical lenses until you have found the one that just neutralizes its action. False myopia is produced by spasm of the accommodation, so that the crystalline lens is rendered convex enough to simulate myopia because a concave sphere appears to correct the apparent error. Rest and tonics are required in instances of this kind, as the patient is usually weak and in ill-health. It is obvious that just as the convex lens placed in front of the eye brings the rays to a focus too soon, so a like condition is established if the lens in the eye itself be too strong, but this is probably rare. This condition sometimes occurs in the development of cataract. A disease known as conical cornea or cone-shaped cornea, where the cornea from some cause or other will become cone shaped is also a cause. It generally arises between the 10th and 25th year. In its beginning and while it is developing, there will be pain and symptoms of weak sight. Distant vision will grow bad, and objects will have to be brought close to the eye, simulating near sight, but lenses will give little or no relief; such cases are for the ophthalmic surgeon, and not an optician.

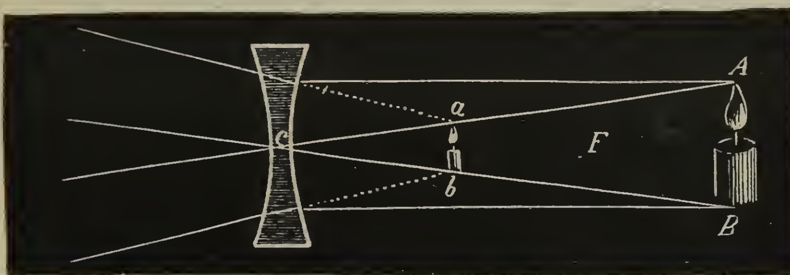
Constant use of the eyes for near work, especially in the young, may be said to be the principal cause. Although near sight is not hereditary, as a matter of fact, it appears that children are not born so, but acquire it as soon as their attention is directed to small objects, and the smaller the work and the more the attention is given to it, the more rapidly does the condition progress. Owing to the increasing firmness of the tissues, myopia becomes stationary about the 20th year. When it has once commenced it is very likely to grow worse if not fully corrected. Imperfect sight in children due to cataract, etc., may cause myopia by making them hold objects close to the eye. The principal symptom is inability to see distant objects plainly. Pain in and about the eyes, especially after using them by electric, gas or strong lamp light, and redness of the edges of the lids, are also noticed. The near sighted eye is generally prominent or bulging and the pupil large and inactive. To find the proper lens—after deciding that it is myopia, you proceed in this manner: Find how much he can read on the test card at a distance of twenty feet. Commence with a weak lens and gradually increase until you find the weakest that will enable him to read the 20 foot line. The patient is apt to choose too strong a lens if it is left to him. In most cases of near sight, vision will be improved while you are testing with each increase of strength until it is normal, while in others but little improvement takes place until the lens which is nearly the full correction has been placed before the eye.

So you see it is not well to assume the absence of near sight if at first concaves do not improve it. Besides enabling the person to see well, you guard him against an increase by directing him never to read in a train or carriage. Read books only that are printed in good clear type, avoid the stooping position and take



A DOUBLE CONCAVE LENS MAKING PARALLEL RAYS SO DIVERGENT THAT THEY ARE BROUGHT TO A FOCUS ON THE RETINA.

care of the general health. In high degrees the lens that is worn for distance will not be used for reading. We must then give a weaker lens for near vision; we find the proper one by subtracting from the number in diopters of the lens giving the best distant vision, the number in diopters of the lens representing the distance at which the patient wishes to read or sew. For instance, if — 8.00 D. give the best vision for distance, and he wishes to read at 16 inches — 8.00 D. — 2.50 D. = — 5.50 D. will be the lens required; or again we may find it in this way by letting him take the near type in his hand and finding the farthest point at which he can read the No. 6 line; this should be read at 40 inches, but he can read it only when it is brought much nearer. If 40 is divided by the distance at which he reads it, or his far point, the quotient will be the number required in diopters; for instance he reads it at 10 inches, then $^{40}/_{10} = -4.00$ D., the number that will make rays coming from 40 inches as divergent as though they came from 10 inches.

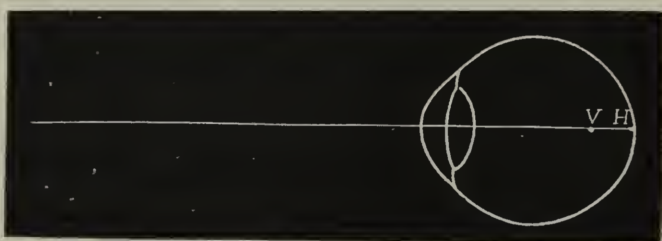



A DOUBLE CONCAVE LENS (*c*) RENDERING RAYS PROCEEDING FROM THE OBJECT (A B) AS DIVERGENT AS THOUGH THEY CAME FROM A POINT NEARER (*a b*).

The higher degrees of myopia sometimes increase steadily from an early age, which must be considered a dangerous state. This form is known as progressive or malignant myopia. Those afflicted in this manner require stronger and stronger concaves, and yet their vision will not be brought to the normal point. There is danger of its breaking up the retina, causing inflammation of the middle coat of the eye. You must give them the weakest concave lens that will give them the best vision, and refer them for further treatment to the oculist.

## ASTIGMATISM.

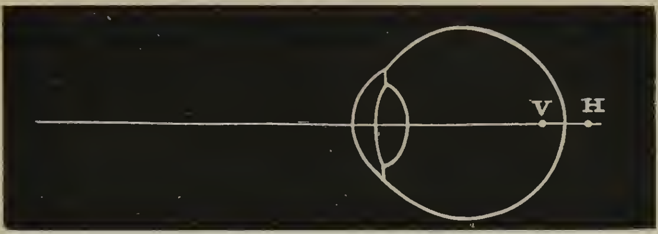
We have seen in our previous talks on the errors of refraction, that hypermetropia or far sight was in the majority of cases due to shortness of the eye-ball, myopia or near-sight to lengthening of the eye-ball. We now have for our consideration an error of refraction known as astigmatism or irregular sight, in which the cornea plays the most important part. Astigmatism is a Greek work meaning that the rays of light coming from the object are not united at a point. This defect was first discovered in 1801 by Thomas Young, who was himself astigmatic. In speaking of which he says his "eye in the state of rest collects to a focus on the retina, those rays which diverge from an object at a distance of ten inches from the cornea, and the rays which diverge horizontally from an object at seven inches distance." We shall see later, that he must have had the defect known as compound myopic astigmatism. The principal cause of astigmatism is the unequal curvature of the cornea, the outer clear portion of the eye which joins with the white. There are other causes, such as an unequal convexity of the crystalline lens, etc., but these are of little interest to the optician, as this form of astigmatism, known as irregular, is not correctible by glasses. We will therefore confine overselves to the detection and correction of the regular variety, the cause of which is a misshapen cornea. As the refracting power of a transparent substance depends on its curvature, you can easily understand that if the curve is greater in one line across the cornea than another, the rays of light will be bent more and therefore come to a focus sooner than those entering other parts. Therefore if those entering the other meridians are just brought to a focus on the retina, those entering the line where there is more curvature in the cornea, will come to a focus before they reach it. We then have a condition of refraction in this line similar to the one in which the eyeball is too long, the other parts being normal and all the rays coming to a focus before they reach the retina known as myopia or near sight, which requires a concave lens to diverge the rays enough to reach the retina.




SIMPLE MYOPIC ASTIGMATISM—SOME RAYS COMING TO A FOCUS V, AND OTHERS ON THE RETINA H.

Therefore in this imperfection known as simple myopic or near-sighted astigmatism, where one line only is defective, we must fit a lens that has the diverging power of the concave spherical lens in one line only, the other parts having no power on the rays. A lens of this kind is known as a concave cylindrical lens. Instead of the cornea being more curved in one line, it may not have so much as the others that are normal ; then rays of light entering this line will come to a focus behind the retina.

This line would therefore be hypermetropic or far-sighted, called simple far-sighted astigmatism, and we must bring the rays entering this line to a focus with the others ; this you know will require a lens that converges rays, and with this power in one line only, called convex cylindrical lenses. If the condition is such that in one line rays come to a focus before they reach the retina and in another line behind it in the same eye, it is called mixed astigmatism, requiring a concave and convex cylindrical or a spherical and cylindrical lens to correct it.




MIXED ASTIGMATISM—SHOWING SOME RAYS COMING TO A FOCUS V BEFORE THEY REACH THE RETINA, OTHERS AT H BEHIND IT.

When both are ground upon a single piece of glass it is called a cross cylindrical, which may be reduced to sphero-cylindrical lenses; take for example the following :

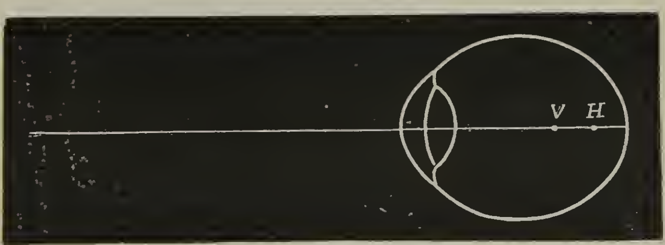
John, M. M.

R. E. V. } L. E. V. } $\frac{20}{100}$ : $\frac{20}{20}$ with + 1 D.c. ax. 90° ○ —2 D.c. ax. 180°.

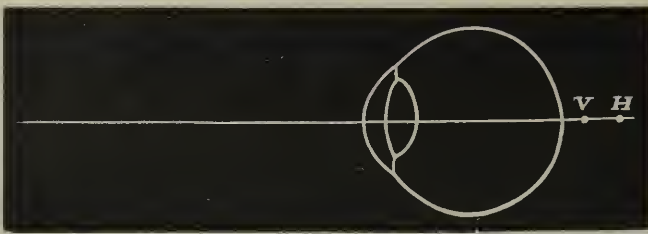
Reduce to sphero-cylinders :

℞ O. D. } O. S. } + 1. D.s. ○ – 3. D.c. ax. 180.° Distance .

Reduce one of the cylinders to a spherical lens, retain the signs of both, add both powers to the second, retaining the axis of second power. The cornea may have one of the curves we have mentioned, and the eye-ball being shorter or longer than normal, combining near sight or far sight with the astigmatism ; it is then known as compound myopic or near-sighted astigmatism and compound hypermetropic or far-sighted astigmatism, respectively.



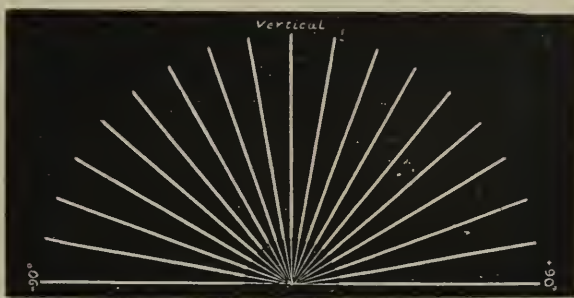

COMPOUND MYOPIC ASTIGMATISM—SHOWING SOME RAYS COMING TO A FOCUS V, AND OTHERS AT H, BOTH BEFORE THEY REACH THE RETINA.




COMPOUND HYPERMETROPIC ASTIGMATISM—SHOWING ALL RAYS COMING TO A FOCUS BACK OF THE RETINA, SOME A LITTLE SOONER THAN OTHERS.

The symptoms of astigmatism are headache and weak sight, dimness of vision for distant objects, watery eyes, inflammation of the eyelids, and inability to get satisfactory results from either concave or convex spherical lenses. If there is no disease of structure, we can at once suspect astigmatism when these symptoms are present.

Irregular astigmatism is either due to some abnormality of the crystalline lens or the cornea. There may not only be a difference in the curvature of the meridians of the cornea, but a difference of curvature in the same meridian, mostly caused by some disease (such as the inflammations or direct injuries) of the cornea. It is also present in conical cornea. In this trouble, vision will be impaired and objects will be seen in a blurred condition. This condition cannot be corrected by lenses, but there is a way by which we can improve it, viz., by the use of the stenopaic slit, pinhole disc, or an opaque disc of some kind which will prevent those rays from entering which would pass through the imperfect part and blur the image. The aperture is placed over that portion of the eye which has regular refraction. This of course shuts off a large portion of light coming from an object, but those few rays which pass through the opening are brought to a perfect focus. You can suspect irregular astigmatism if a person has good vision when the stenopaic slit is over certain lines of the eye, but you are unable to improve the line at right angles with any convex or concave lenses you may use. The best method and the only certain one, however, of detecting irregular astigmatism, is that of the ophthalmoscope. It may also be detected by Javel's ophthalmometer. The method of correcting and detecting astigmatism with the test lenses and test letters, is, however, on the whole, the most practicable and satisfactory. For testing astigmatism, a test case containing concave and convex cylindrical lenses and a trial frame with numbers from zero to 180, beginning with the left side of either eye, and extending around half the circle to the point opposite, is required. It is very important that the trial frame should have as little weight as possible and at the same time have the necessary grooves for holding four lenses and adjustments to regulate the pupilary distance, height of nose, etc. The Spencer Optical Company have succeeded in making a trial frame which combines all these requisite qualities with little weight. Astigmatic cards are also needed. There are various kinds of radiating lines for testing astigmatism, but the most desirable are Javel's fan (figure below) or Green's astigmatic card in the form of a clock face, and Dr. Pray's astigmatic letters (figure below) made by the Spencer Optical Mfg. Co.




JAVEL'S FAN.


PRAY'S ASTIGMATIC LETTERS.

## MODE OF PROCEDURE.

First test for far-sight and near-sight and get the best possible vision with concave or convex sphericals; and if vision is then below the normal, test for astigmatism in this manner; place the lenses with which you get the best vision in the lensholder in the trial frame nearest to the eye. Place your astigmatic card ten or twenty feet away and direct the patient's attention to it, and learn by questioning if any of the lines are more distinct than others. If those running horizontally are clearest, commence by placing a weak convex cylinder at right angles or in the opposite direction to the lines that seem to be darkest, increasing the strength if there is any improvement, until all the lines appear equally clear. If, however, convex cylindricals do not improve, or render vision worse, concave cylindricals are tried in the same manner. The stenopaic slit may also be used in detecting astigmatism or confirming your diagnosis. Another method of finding the proper correcting lens for astigmatism is by increasing the strength of convex or concave spherical lenses until those lines which were seen the most indistinctly on the astigmatic card, are seen clearly and distinctly. Thus, if a person with near-sighted astigmatism sees the vertical lines the darkest, you place a concave spherical lens before the eye, sufficiently strong to enable the eye to see the horizontal lines equally well. The number of the spherical will then be the number of the cylinder required to correct the astigmatism. If compound near-sighted astigmatism is present, then the weakest concave that renders the lines clear will be the number of the spherical required, combined with the cylinder of the same strength as the concave spherical required to enable the eye to see the other lines distinctly. Far-sighted, compound far-sighted, and mixed astigmatism may be estimated by sphericals in the same way. Simple near-sighted or far-sighted astigmatism is corrected by a cylindrical lens alone. Compound far-sight and compound near-sight by a spherical and cylindrical. Mixed astigmatism is corrected by spherical and cylindrical or two cylinders combined. After you have corrected the visual error it will be necessary to write the prescription to send to the optician who grinds your lenses. The spherical lens, if any, is usually written first; for instance, if the astigmatism is either simple, near-sighted or far-sighted, then a cylinder only is required, and you must designate it in this manner, by writing the sign, then the number and axis, convexes are designated by plus (+) and concaves by minus (—). If you have found that a number forty convex cylinder renders all the lines equally clear you designate it on your prescription by + 1.00 D. cylindrical (dioptric system of numbering), + 40 cylindrical (the focal distance), or + $\frac{1}{40}$ cylindrical, then the axis, the number on the trial frame which is pointed to by the marks on the cylindrical; we will say that this is ninety degrees or vertical, then your prescription would be written in this way, + 1.00 D. cyl. axis 90°. If it is compound near-sighted astigmatism which requires a concave spherical and concave cylindrical for a correction, you first designate the kind and number of the spherical and then the kind and number of the cylindrical with its axis, for instance, if a concave spherical number twenty combined with a concave cylindrical number forty were required to give normal vision, your prescription would be written in this manner: —2.00 D. spherical ⊂⊃ — 40 cylindrical axis—whatever it may be.

## CHAPTER V.

### THE OPHTHALMOSCOPE.

The objective methods for making an examination of the eyes with the view of giving a correction are by means of the Ophthalmoscope, Skiascope and Ophthalmometer.

The Ophthalmoscope was invented by Helmholtz in 1851 and was the result of a careful study of the conditions which prevent the pupil from emitting light from the eye. He demonstrated that

By courtesy Jewelers Circular Pub. Co.

OPHTHALMOSCOPY.
THE INDIRECT METHOD.

this was in accord with the well known law of optics that light passing through a lens follows the same lines both when entering and returning. With the pupil not larger than $\frac{1}{8}$ to $\frac{1}{4}$ of an inch an immergent ray is very small and must go straight to a source in a path so narrow that an observer will not be able to catch it without screening off the light with his head. It is by the use of the ophthalmoscope that we can intercept those return rays as they pass outward; the pupil of the eye is an orange color, while any opacities obstructing the rays will appear as black spots in whatever part of the refractive media they may be situated.

Loring's ophthalmoscopes are conceded to be the best now in use; they are made by the Spencers with stationary or tilting mirror and quadrant behind the disc of lenses. See illustration on page 10. The mirror in an ophthalmoscope which is slightly concave on its surface so that it will concentrate the rays of light, has a small perforation in the center to look through, while behind the mirror is a disc containing convex and concave lenses, which can be rotated so as to bring the lenses before the aperture. The Spencer Optical M'f'g Co. have devised a mechanism for their new ophthalmoscope by which all of the lenses can be brought before the aperture without moving the instrument from the eye. The discs (there are two, one for the concave, and the other for the convex) containing the lenses are connected by cog gear, with a device on the handle, so that by simply touching it with a finger any one of the lenses can be brought into position.

The mirrors or reflecting surfaces of the ophthalmoscope are either plane or concave. Artificial gaslight is used. There are two methods of examination, the direct method with the upright image, and the indirect method with the inverted image. We will speak of the direct method first, in order to get a view of the back part or fundus of the eye; provided the eye is normal and its accommodation is inactive, the observer must look as if the object were far away, although he knows that it is only about an inch distant. He can use one eye; the other eye is disregarded. We commence in the following manner by darkening the room and using a single light—a student's lamp or Argand gas burner being preferred. The object we are to look for is the fundus or back part of the eye, and the person examined is requested to look over your shoulder, while the examiner looks in the eye at an angle of about 15 degrees. When examining the left eye the examiner's left is used, and the right eye, the examiner's right; the light is placed behind the patient on the left and right side of the head respectively. The examiner now takes up his ophthalmoscope and looks through the small aperture in the center of the mirror with the reflecting surface toward the patient and the reflection of the mirror thrown into the eye. If now, the eyes of both are normal in refraction, and the accommodation entirely at rest, the details of the interior will be easily seen. The indirect method is as follows: the examiner holds the mirror 12 or 14 inches from the patient and brings within two inches of the eye examined a biconvex or double convex lens of two and one-half inch focus. This lens gathers the light from the mirror, and also collects the light coming from the eye into an inverted image which lies at about two and one-half inches from the lens, between it and the mirror. The examiner sees this image in the air and not in the eye; it covers a smaller surface than seen with the direct method. If upon moving the lens back and forth we find the image of the fundus round and remaining of the same size, the eye is emmetropic or normal; if the lens causes an increase in size when it is advanced, near sight is present, and if it decreases we have hypermetropia. In astigmatism the disc will have an oval appearance. To make a proper test by means of the ophthalmoscope the examiner's eye must be emmetropic or wear the proper correction. The practical procedure in the direct method is as follows: your light is arranged in such a position that it will strike from behind and to the side of the eye you are examining, while there is no reflection from the lamp into the eye. You now place yourself in front of the person to be examined with the mirror adjusted to reflect the light in the pupil. When you have a reflec-


By courtesy Jewelers Circular Pub. Co. SKIASCOPY.

tion through the pupil you advance the instrument to the eye you are examining, at the same time holding it close to your own, bringing it within half an inch of the eye, keeping the fundus in view. With a little patience and change of position the image of the fundus will come into view. The lenses of the instrument are now thrown before the opening in the mirror, until one is found which gives the clearest and sharpest outline to these objects. And this lens if convex shows you that the patient has hypermetropia, and the strongest + lens that leaves the fundus clear is the amount of the hypermetropia; and if a concave lens, myopia or near sight; the weakest concave spherical lens will give the correction. In astigmatism one meridian may be normal, and the vessels seen in that meridian will be the axis for the cylindrical correction. A convex or concave spherical lens may develop the opposite meridian, causing a blur in the first meridian, and we have either hyperopic or myopic astigmatism approximately demonstrated.

In Skiascopy, the shadow test, we have the best and most accurate objective method known for demonstrating errors of refraction.

At the present writing there are a great many methods adopted, indeed nearly every skiascopist has his or her conceit as to what is best, expedient and proper. The writer's method, which is similar in many respects to Thorington's, presents a few unique and attractive features.

By courtesy Jewelers Circular Pub. Co. OPHTHALMOMETRY.

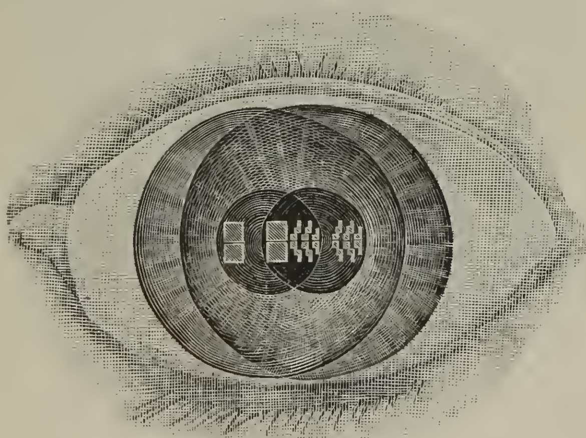
In the first place the light may be placed above or to one side of the patient or as near as six inches from the level of the examiner's eye, and the light in this latter position thrown on the level into the patient's eye located either twenty-six or forty inches away. The distance in either instance will require neutralizing lenses, or the difference can be made by deducting the neutralizing lenses from the calculations altogether after the examination is completed. If the distance selected is twenty-six inches a neutralizing lens of +1.50 D. power will be required and with this lens in position, the shadow is caused by the light passing through the pupil or is cast upon the retina. If a circular or spheric shadow is formed upon the retina and upon tilting the plane mirror (Thorington's) the shadow moves with the movement of the tilting mirror, the error is hyperopia. If the shadow moves against, it is myopia, and the lenses which will block the shadow will give the correction to within at least one-half dioptre. If the forty-inch or meter distance is selected the correction is as close as one-eighth of a dioptre.

In astigmatic eyes the mirror will throw a square sided shadow, showing striæ in the meridian of least error. A shade of asbestos with several apertures through which the light may be permitted to pass is placed over the glass chimneys covering the Argand burner, so that every particle of light may be excluded in making this, the most delicate and accurate objective method for determining errors of refractions.

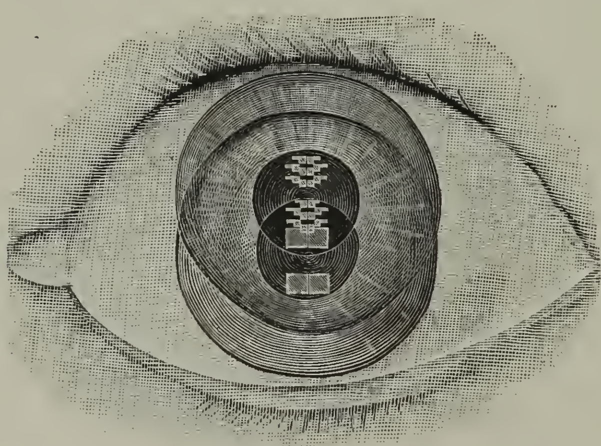
In passing it may be well to state here that Presbyopia, which is not an error of refraction, cannot be measured objectively by any kind of instrument.

The Ophthalmometer, or, properly speaking, the Keratometer, an instrument the purpose of which is to measure the various meridians of the cornea, was brought out in the year 1889 by Javel and Schiotz; since that time several Keratometers have been developed.

The instrument proper consists of a large metal disc with a number of concentric circles and lines radiating from a common center with figures giving the different meridians of a half circle marked upon the face; directly in front of the patient's eyes. When undergoing an examination, this disc stands upon three legs placed upon a firm base made of steel. A chin-rest with lights is attached to this steel base for the purpose of giving a firm support to the head of patient. Through the center of the metal disc, a telescope with its objective, prisms of Wollaston's spar and arc with mires complete the instrument.



In making an examination of the cornea by means of the ophthalmometer the patient's head is securely held by means of supports in the chin-rest. The examiner takes a position behind the metal disc and engages the attention of his right eye at the objective end of the telescope, and after adjusting the objective so that the crossed cobwebs come into view, the metal disc with attachments are directed upon the patient's cornea and moved up to a position where the cornea appears clear and distinct. The first position is secured by moving the mires until the central black lines appear continuous and just touch them ; by revolving the telescope one-quarter around we will be enabled to discern whether the mires overlap or separate in this new position. If the mires overlap, it is a case of either hyperopic astigmatism with the rule, or myopic astigmatism against the rule. If the mires separate in this new position the case is either myopic astigmatism with the rule, or hyperopic astigmatism against the rule. If the mires separate in this second position, move them toward each other so that they just touch, and then rotate back to first position. The number of steps overlapped give approximately the number of of dioptres, and the long steel point indicates the axis of the astigmatism.

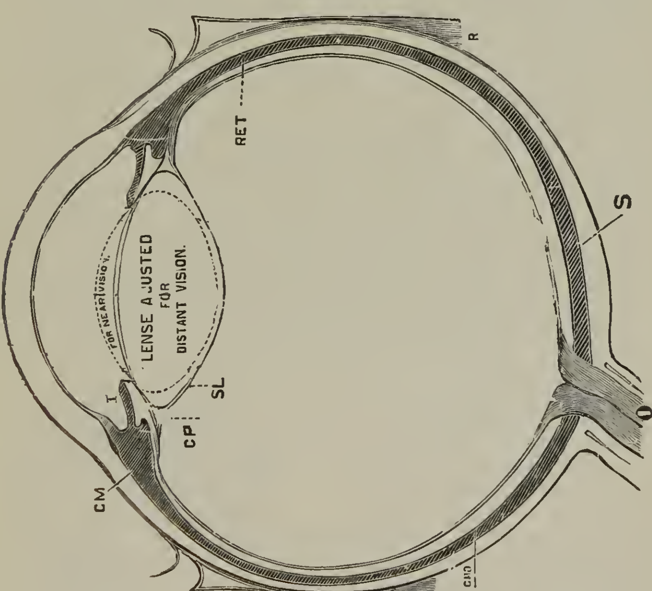


# CHAPTER VI.

## PRESBYOPIA.

Presbyopia or old sight is neither an error of refraction nor a disease. It is simply a state or condition of the eyes in which form progressive hardness of the crystalline, the near point recedes.

As age advances the crystalline lens diminishes in refracting power or loses its former elasticity whereby the near point is moved beyond a point eight inches away. This change in the lens begins at an early age, but is not troublesome till the near point is no longer within a comfortable range of about 14 inches. In a young person with emmetropic eyes distant or near objects can be seen clearly, but not at the same time. When a distant object is seen, the near one will be indistinct or vice versa.




CUT SHOWING THE CRYSTALLINE LENS ADJUSTED FOR THE NEAR POINT AND DISTANT VISION.

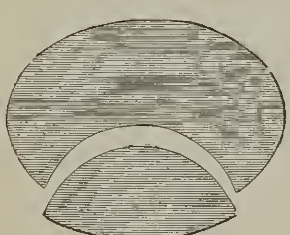
This power of the eye of adjusting itself for near or distant objects is known as the power of accommodation. This depends upon the action of the ciliary muscles, which render the crystalline lens more convex—the nearer the object the greater bending power necessary to bring the rays to a focus on the retina. In the normal eye this muscle relaxes and the crystalline lens is left quite flat or weak when looking at objects 20 feet or more away. If an object is brought near the eye, these muscles are brought into play by the will, and the nearer the object a greater exertion will be made by this ciliary muscle to give the lens sufficient bending power to unite the rays on the retina. At a certain point near the eye at which all the exertion of which the ciliary muscle is capable is used, the crystalline lens is made as convex as can be and rays from any nearer point cannot be united on the retina; the nearest point to the eye from which rays can be focused on the retina is know as the punctum proximum or near point (n. p.). To find the near point you ascertain the smallest line that the eye can see on the reading chart at 14 inches, then gradually bring it toward the patient until he cannot see it any closer; the distance then from the eye to the card will be the near point. This near point should be from 5 to 8 inches from the eye, if there is no abnormality. In presbyopia and in hypermetropia it is farther away and in myopia nearer to the eye; in children where the crystalline lens is so very soft and the ciliary muscle is able to make it very convex, objects can be seen very close to the eye, but as age advances and the lens loses its elasticity, the near point recedes until between 40 and 45 years the recession of the near point is beyond an easy reading distance. The patient will, in coming to you for glasses, speak of dimness of vision for reading and sewing, especially troublesome by artificial light, pain about the eyes and a necessity of holding the book or sewing at an uncomfortable distance. If it is simply presbyopia or old sight you will find vision for distance is good, but you must apply a lens in the form of a spectacle or eyeglass that will help bend the rays and bring the near point to a comfortable distance of fourteen inches. It is always best to consult the patient's feelings and learn which gives the most satisfactory result by the test lenses and test type, but as a matter of interest and supplementry information, we have taken from Donders a table showing the near point in inches, and the probable lenses that they will require to bring the near point to nine inches:

| Age. | Near point in inches. | Lens required. |
|---|---|---|
| 45 | 13 | 1. D. |
| 50 | 20 | 2. D. |
| 55 | 30 | 3. D. |
| 60 | 80 | 4. D. |

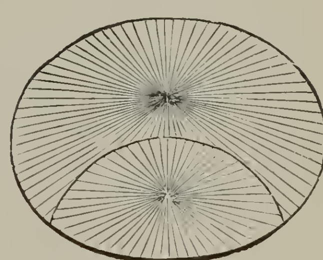
In fitting the lenses for presbyopia we should always test their distant vision to find if any far sight, near sight or astigmatism exists; if far sight is present the strongest glass that the patient can see as well at a distance as without any glass must be added to the old sighted for reading and near work; if near sight exists the lens that will bring the distant vision to its normal point must be subtracted from the convex glass for near vision; for instance, by referring to Donders' table you will find that at 45 there is+1. D.'s for presbyopia. Now if there is any far sight present this lens must be added to the+1. D. for old sight, that is in examining the patient for distance; if you find that with a +2. D.'s the patient has as good vision or better than without any glass this will be the amount of the far sight present, and the glass that should be worn for near vision in this case will be hypermetropia +2. D.'s add presbyopia+1. D.'s =+3. D.'s. A near sighted person requiring a —1. D.'s will not need a lens to read with at 45. If a near sighted person requires a —4.50 D.'s lens he will not require lenses for presbyopia. Those requiring —2. D.'s for near sight will not need lenses until after 50 years of age. The eye appears to be hypermetropic, or as age advances, this is called acquired hypermetropia, this commences about the 55th year when an eye will need a convex glass of a +.25 D.'s to bring vision to its normal point for distance. At 65+.75 D.'s or+48 and at 80+2.50 D.'s. A far sighted person requiring+2.50 D. for a correction will at 80 years of age require+5.00 D.'s for distance, and a myope requiring a —4 D. would require nothing for reading at 60. The method most generally used is that of finding the weakest convex lens that will enable the person to see distinctly and clearly the first line on Spencer's Reading Card at 12 or 14 inches. This line must be the clearest at this distance, although it may be read nearer or farther from the eye. If it is necessary to hold it too near the eye to get clear vision in presbyopia with a convex lens, the lens is too strong; if too far away it is too weak.

After you have decided on the proper lens it is very important to have them fitted properly. You must see that the lenses are properly centred, otherwise they will act as weak prisms.

If the patient requires frequent change for stronger lenses a disease called "glaucoma" may be suspected and care must be taken that lenses are not given if any symptoms of it appear. This disease commences mostly after middle age, and usually where hypermetropia is present. Frequent changes for stronger lenses, sudden attacks of obscurity of sight, colored rings around a flame and painful sensations about the eyes are some of the symptoms.



PERFECTION BIFOCAL.



CEMENTED BIFOCAL.

Where it is necessary for a person to wear lenses for near and distance, it is sometimes more convenient to place the lenses in a single frame called bifocals or Franklin glasses. They are made in three forms, called split when they are composed of two half lenses, single when both are ground on one lens and "perfection" when the upper and lower parts are ground in a circular form and cemented together, the distance lens above and the one for near below. There are lenses cut horizontally or lower on their upper part called "clericals" for those who have good vision for distance but wish to read and look off without removing them. Lenses for distance should be placed vertically before the eye (care taken in every case that the eyelashes do not touch the glasses), and for reading the frames should be rendered pantoscopic.

## CHAPTER VII.

**ASTHENOPIA,** Or weak sight, as the term implies, refers to a strain placed upon the muscles controlling the movements of the eyes in which we have, as a result, pain and blurring, especially while reading, and in consequence of which there is a headache which locates itself in the temporal region and at the base of the brain.

The pain to which allusion is made is due to the strain placed upon the weakened muscle in its effort to maintain equilibrium, and the failure to do this allows the eyeball to rotate upon its axis, and the blurring of the image results.

The nice adjustment of the muscles controlling the movements of the eye, other things being equal, depends upon the vision. If the eyes are in Emmetropia they will also be in Orthophoria. Exceptional instances are found in the reflex variety alone, and this one exception proves the rule.

Again it will be found that Asthenopia is the forerunner of a more pronounced state, and that if the error is allowed to go uncorrected, vision in one of the eyes, from want of use, will become more or less Amblyopic, so that Asthenopia should be considered as the primary or initial stage of squint and strabismus, the more advanced type of the same.

For our convenience in the study of Asthenopia, we subdivide the subject under three headings :

Asthenopia { 1. Hyperopic, 2. Myopic, 3. Neuresthenic, } Strabismus.

1. Orthophoria—Normal as to muscular balance.

2. Heterophoria Abnormal tendencies {
Esophoria tending in,
Exophoria " out,
Hyperphoria one eye tends above its mate.
Hyperesophoria tending in and down,
Hyperexophoria tending out and up.

2 (a) Heterotropia, generic term for same form of squint. {
Esotropia—Convergent squint,
Exotropia—Divergent squint,
Hypertropia,
Hyperesotropia,
Hyperexotropia.

1. *Hyperopic Asthenopia* suggests to the mind that hypermetropia is the cause of the Asthenopic symptoms, that in Axial

By courtesy Jewelers Circular Pub. Co. PHOROMETRY

Hyperopia the strain is placed upon the external rectus caused by over-stimulation of the sphincter iris in the act of accommodation, together with excess of convergence from extra activity of the internal rectus acted upon through the third pair of nerves, the motor-oculi, the result being that in hypermetropia there will be a proportional amount of esophoria. In simple hyperopic astigmatism the tending of one eye is to turn downward while its mate will tend to turn upward in a direction toward one another, the obliques being involved. In compound hyperopic astigmatism, the external rectus, together with the obliques, there will be a proportionate hyperesophoria. If the hyperopia exceeds the hyperopic astigmatism the tendency will be more in esophoria than hyperphoria and vice versa if the hyperopic astigmatism is in excess. In hypero-myopic astigmatism the external rectus, together with the superior and inferior recti, are relaxed.

2. *Myopic Asthenopia* is due to some form of myopia. In axial myopia the internal rectus is not sufficient to maintain equilibrium, because the third pair of nerves are not stimulated, as the dilator iris through the influence of the sympathetic nerves renders the crystalline lens as flat as possible, and thus the tendency is outward with a resultant insufficiency of the internal rectus, and consequent exophoria.

In simple myopic astigmatism there is an insufficiency of the superior and inferior recti. In compound myopic astigmatism the internal, the superior and inferior recti are relaxed in hyperexophoria. In myo-hyperopic astigmatism the internal rectus and the obliques are not sufficient to maintain equilibrium.

3. *Neuresthenic Asthenopia* depends upon the nervous system for a cause, as the weakness placed upon the muscles controlling the movements of the eyes are secondary and symptomatic of some disease outside of the eye. Dyspepsia, diseases of the genito-urinary tract, are all causes bringing about asthenopic symptoms, and in no instance, pure and simple, can an error of refraction be found in this variety, although in the other varieties the reflexes may also be associated with them.

From the foregoing remarks it will be seen that errors of refraction play a large factor in bringing about asthenopia, and even the more advanced type, strabismus. If a solution of atropine will straighten the eye, the correction alone is all that should be prescribed. After the correction is given and prisms are conjoined with the correction, the question naturally arises: what is being done for the permanent restoration of the weakened muscles if they are allowed to remain relaxed, and even forced to remain in that state? It seems that a permanent injury will result rather than a restoration, and we defeat the very purpose of our object.

Orthoptic exercises should be exercised in order to produce a tonic effect of the weakened muscles, and as the normal tendency, like diseases, is toward recovery, the additional gymnastic exercises faciliate this recovery, whereas prisms or decentration of lenses will retard.

In summarizing: first correct the existing error of ocular refraction ; secondly, experiment with prisms, and finally, if the pain, blurring and headache continue and there still remains any heterophoria, or if the advanced stage is pronounced, and there is some form of heterotropia, an operation of tenotomy is in order, with a view of not only acquiring a cosmetic benefit, but that the eyes may be restored to equilibrium.

The ophthalmoscope should be employed in making the initial examination of the eyes, as by this means diseases as well as errors of refraction are detected, and the optist receives his first hint as to the condition with which he is called upon to deal, and from this step until the examination is completed, the patient is under the control of the one making the examination.

Perhaps the thought may not be a new one to the optist, but in making an examination of the eye the physician does so not with the view of prescribing glasses, as with the optist, but with the view of finding out whether there is a disease or an error of refraction, or both, and it will readily be seen that opthalmoscopy plays an important part in making out a diagnosis of the condition of the eyes.

The ophthalmoscope, then, gives the first hint as to the state in which the examiner finds the eye, and his deportment relative to his patient is one of authority through the entire examination after the first steps have been taken. The questions put to the patient after this first step have a positive rather than a negative character, for instead of asking how many letters the patient can read, the examiner will direct the patient to read such and such letters, framing his remarks when making the subjective test in some way as, "Read the letters, beginning with the largest, and so on down," telling the patient which look blurred and which look distinct, etc., etc.

The above statement naturally follows after the objective method by means of the ophthalmoscope and skiascope have been made and the subjective methods of proving the examination thus made by means of the trial lenses, in order to give to the patient lenses which seem the most natural and pleasant for him to wear; in many instances the lenses prescribed by means of the objective test will be identical with those borne out by the subjective test.

If astigmatism presents itself to the optist in his examination, an examination by means of Javal's ophthalmometer, with the view chiefly of determining the meridian in which to place the axis of the cylinder, rather than for any other purpose, except it may be for the moral effect which a thorough and painstaking examination nearly always has upon the patient.

The fifth step in making an examination of the eye is with the phorometer, whether there is an error of refraction or not. If the patient approximates the normal standard relative to vision and still complains of pain in the eyes, blurring while reading and headaches located in the temporal region and the base of the brain, the muscles controlling the movements of the eyes alone may be suffering secondarily, due to a leak made upon the nervous system, in which the eyes suffer through sympathy, and we have then what is known as reflex asthenopia, a neuresthenia in which the eyes take a part, and the examination with the phorometer will be made with the view of knowing how great the muscles controlling the movements of the eyes are out of parallelism. This can be determined approximately after several such examinations have been made.

Finally, in trying the accommodation, a record of all the steps of the examination of the eyes may be made, at which time the name, age, place of residence and date of the examination of the patient can be filed away for future purposes.

To recapitulate, the steps necessary for making a thorough, systematic and scientific examination of the eyes:

1. Ophthalmoscopy and skiascopy.

2. The subjective method, by means of the trial set of lenses. This is done with a view of having the patient see for himself, and to note modifications we may be called upon to make.

3. The ophthalmometer is employed at this point chiefly in order to determine the meridian in which to place the axis of the cylinder, if astigmatism is present; also to help verify the kind and, approximately, the amount of astigmatism.

4. Phorometry is in order at this particular part of the examination, so that the examiner may know to what extent the error of refraction is a cause for the asthenopic symptoms; and if there is no error and the phorometer reveals heterophoria of some kind, the proper disposal of the patient is to send him or her to the family physician for advice and treatment.

5. The accommodation should be tried, with a view of prescribing lenses for reading.

6. A record should be made for future as well as for present purposes. The following formula may serve as an example:

Name------------------------------------- Age----------

Residence--------------------------------- Date------------------

R. E. V.
L. E. V.
Ophthalmoscope.
Skiascope.
Ophthalmometer.
Phorometer.

Prescription:

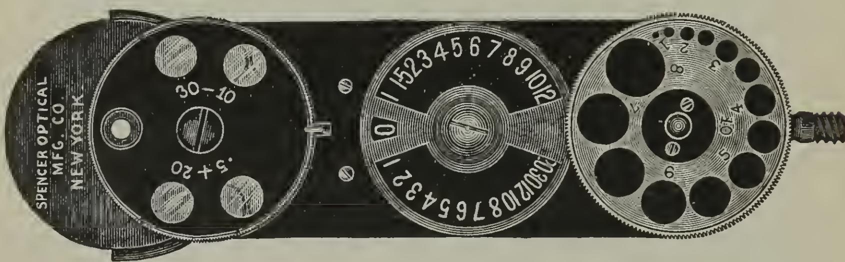
| | | |
|---|---|---|
| ℞ O. D -------------------- | } Distance or constant use. | |
| O. S -------------------- | | |
| ℞ O. D -------------------- | } Reading, etc. | |
| O. S -------------------- | | |

## DR. PARENT'S OPHTHALMOSCOPE WITH CYLINDRICAL LENSES.

THE LATEST IMPROVEMENT WITH THREE DISCS.

One contains 10 plus lenses, one 10 minus lenses, one with 7 cylinders that can be rotated to determine axis of astigmatism, graduations on disc to denote axis, with 2 mirrors and large lens for examination, in neat, durable case, complete ........................................ $15 00

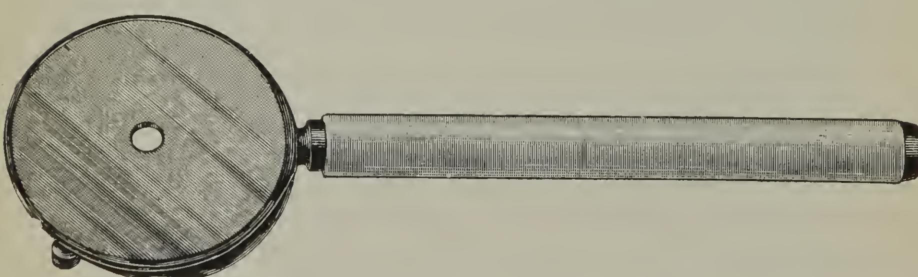
## MORTON'S IMPROVED OPHTHALMOSCOPE.





Positive pleasure to use Morton's Ophthalmoscope, which consists essentially of 29 lenses, running in an endless groove, and can be propelled by a driving-wheel. Four other lenses, set in a separate disc, and so placed that they can be turned in front of the sight hole or removed without rotating the whole series of lenses. The driving wheel rotates a disc, which always indicates the number of the lens presented at the sight-hole.

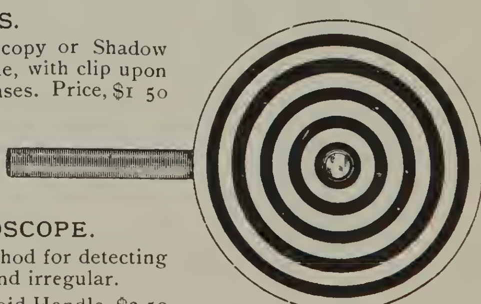
Price reduced to ........................................ $17.50



## RETINASCOPES.

638 Plane Mirror, for Retinascopy or Shadow Test, ivory-celluloid handle, with clip upon the back for holding test lenses. Price, $1 50

639 Concave Mirror, for Retinascopy. Otherwise same as above.
Price .......... $1 50



## PLACIDO'S KERATOSCOPE.

A rapid, reliable and handy method for detecting astigmatism, both regular and irregular.

Price, complete, with Ivory-Celluloid Handle, $2 50

## CHAPTER VIII.

### HINTS AND ILLUSTRATIVE CASES.

We have referred to the spectacles required under the respective errors of refraction, but will now repeat briefly what has been said and give a few illustrations.

In far sight, as long as the vision is normal for distance, glasses need not be worn only for reading, and these should be the strongest convexes with which the patient will see as in normal eye; or in other words, those which correct the manifest hypermetropia.

If distant vision is improved by convexes then such may be worn.

In far sight, we give the full correction.

In near sight of medium degree the best results are often obtained when the full correction is worn constantly, for near and distance. In low degrees or mild near sight, when the lens is not stronger than—18 that renders distant vision normal, no lens is necessary for reading. The full correction for distance in high degrees may be satisfactory, but uncomfortable for reading, owing to insufficient accommodation. They will tell you that the objects are made smaller. You must prescribe two pairs, the stronger one for distance and a weaker one for reading.

In astigmatism it is always best to give the full correction in people over 28 years of age, and sufficiently good results will be obtained at any age if care and judgment are exercised.

Cylindricals correcting astigmatism should be worn constantly. If there is old sight, of course the convex spherical will be added to the cylinder for the near point, and in near sight the proper concave. If of high degree two pairs of lenses may be required in near sight, one for reading and the other stronger for distance. The cylinder, however, is the same both for the near and the distance points.

Convex lenses add to the quantity of light entering the eye, while concave glasses diminish, which accounts to some extent for the want of acuteness in near sighted eyes.

Lenses are made of crown, flint and rock crystal (also called pebble). Those made from pebble are harder, and are therefore less liable to become scratched than glass. These are apt to bend rays unequally if not cut exactly right, and it is very hard to get pebbles free from streaks or striæ. Therefore (considering also the expense), crown glass is nearly equal to the best pebbles. The best pebbles are those which are "axis cut," or those that have the optical axis of the lens in a line with the axis of crystallization of the pieces of quartz from which they are taken. The "axis cut" are said to refract light better, forming clearer images, thus giving better vision. Stenopaic spectacles are sometimes useful in irregular astigmatism, myopia, etc.; they consist of an opaque screen with a small central aperture which may be of any shape according to the requirements, so that all the peripheral rays are cut off, only such as are in the optic axis are allowed to pass. They can be combined with a concave or convex lens.

Prisms may be worn either alone, base in, out, up, or down, or in combination with convex or concave sphericals or cylindricals. Some near sighted people who read well without glasses suffer from asthenopia, which can be relieved by prisms $1^\circ$ or $2^\circ$ bases inwards.

Pantoscopic glasses (also called bifocals—the upper and lower half having different foci) are useful where a person requires lenses for distant and near vision of different strength; for instance, a person may be near sighted for distance and old sighted, or old sighted and acquired hypermetropic. Smoke, blue, or green tinted glasses are sometimes necessary for diminishing light in cases of irritation or inflammation of the retina, dread of light from myopia, etc. Smoke-colored glasses should be worn to diminish the quantity of light. In inflammation where we wish to relieve the retina without injuring the distinctness of vision, light blue glasses are best. For reflected light from snow, etc., blue is preferable.

In high degrees of myopia a light tint blue combined with the correcting lens is beneficial. Tinted glasses are, however, sometimes injurious to weak eyes. Goggles are sometimes worn to shield the eye from dust, etc. These are of various forms; some having wire on all sides and a plain white, blue or smoke tinted glass to look through, while others consist simply of a large hollowed glass like a section of a globe, called dissecting or driving spectacles, etc.; it is, however, unnecessary for us to speak of these to any extent. From this brief talk upon spectacles, we will pass to the consideration of some illustrative cases and methods of examination; the shape of the head and face and the appearance of the eyes it is well to notice first, and listen to the complaints of the patient, after which we test the acuteness of the vision of each eye separately. By testing the acuteness of vision, we mean finding how much can be seen on the distance card at twenty feet, and also on the near card, finding the nearest point (p. p.), and the farthest point (p. r.), at which the finest line can be read. A prominent and bulging eye is often indicative of near sight, and asymmetrical features are often associated with astigmatism. In order to illustrate the methods of examination we will give a few cases that have been fitted satisfactorily. A girl, aged fourteen, had some trouble in reading at night; she saw well when she began, but after an half hour or so had a dull, throbbing pain behind the eyeballs. The eyes felt tired, letters were blurred, but she saw well at a distance. I noticed while she was talking with me that the eyes were small and sunken, from which I inferred that no near sight was present. I, however, directed her to the distance card, twenty feet away, and asked her to call off the smallest line she could see. This is the line that should be read at that distance ; she therefore had no near sight, nor could she have much astigmatism, if any, and she was too young to be old sighted; her trouble must be either due to far sight or some disease. But I proceeded with my test and placed a weak convex, number sixty, before one eye, while the vision was obscured in the other by the ground disc. I again directed her to the distance card, and learned by questioning if vision was more indistinct than the naked eye. She told me that she did not see any difference, and that she saw just as well with as without the glass. I now had proof that this was a case of far sight, and the strongest convex glass with which just as much of the distance card could be seen as without any glass, would correct the manifest hypermetropia. I therefore tried stronger and stronger convexes until I found the one which just permitted clear, distant vision. In this case it was number thirty, and I advised its use.

The next case was a young man, aged 18, whose symptoms were the same as the first. The vision was normal for distance ; there could, therefore, be no stigmatism, near sight nor old sight. Weak convexes blurred the vision, and there was, therefore, no manifest far sight ; but you remember we spoke of latent or concealed far sight due to the action of the ciliary muscles. The only way to correct and estimate this is to paralyze the accommodation by atropine or some other substance used for this purpose (see mydriatics, appendix). I then ordered a solution of four grains of the sulphate of atropia to an ounce of water, one drop to be put in each eye three times a day for three days before coming to be fitted for lenses.

After this had been done I found, on testing the eyes for distance, that the thirty-foot line only could be seen at twenty feet, both eyes the same. Vision was, therefore, $\frac{20}{30}$, or $\frac{2}{3}$ of the normal. I commenced with a weak convex and found it improved it, and with a number forty-eight convex the vision was brought to $\frac{20}{20}$, or normal ; forty-eight was therefore prescribed for reading and far vision. In this case it is not entirely necessary to prescribe lenses. Donders does not advise the use of lenses where the far sight is less than one diopter, attention to the general health being all that is necessary. In some cases, however, the eyes will not be relieved without lenses ; a weak lens, about + 72 for reading and the near print, will mostly give good results in cases of far sight or less than one diopter. Case No. 3 was a young man whose occupation was that of a stenographer. He was suffering from inflamed eyelids, and complained that his eyes became very tired at night so that he could not read any length of time without a blur before the eyes ; he is apparently healthy, and nothing special was noticed except that the eyes were small. I directed him to the distance card, twenty feet away, and found that he read the line that should be read at that distance with both eyes and with each eye separately. I placed in front of the right eye a + 40 lens, the left being covered with the ground glass disc, with which he informed me he saw just as well if not more distinctly than without it. A + 36 was next tried with the same result, but with a + 30 vision was not as good. The same result was obtained with the left eye, + 36 was the strongest convex glass with which the 20 foot line could be read, therefore the one that corrected the manifest hypermetropia and which proved satisfactory for reading and the near print; this lens will not correct the total far sight which includes the latent and manifest. This could only be found by paralyzing the accommodation in the manner we have spoken of before. Then we found the convex sphere which enabled him to read the twenty-foot line. This lens, less one diopter, was the proper one. A full correction in young people is not borne well. The use of atropine is, therefore, in most cases unnecessary, the glass correcting the manifest, viz., the strongest convex lens with which the twenty foot line can be read at twenty feet gives good results. Case No. 4 is a child, aged 10, who has convergent strabismus. In the chapter on far sight we have told you that sometimes crosseyes are produced by it, and knowing that this is the only error of refraction that can cause convergent strabismus, I test the eyes for far sight and find that a + 36 just corrects the manifest hypermetropia, but in order to relieve the excessive accommodation by convex lenses, the child must be placed under atropine, and the total far sight (latent and manifest) estimated. One diopter less than the full correction must be worn constantly. I found that after a drop in each eye of a three-grain solution of atropine had been given for three days before she came for examination, that a + 4.00 D.'s lens enabled her to read $\frac{20}{20}$. This was, therefore, the measure of the total far sight. The lens which I prescribed was, therefore, + 4.00 D.'s — 1.00 D.'s = + 3.00 D.'s. These she was advised to wear constantly, and also that she abstain from near work. Particular pains were taken to have the optical center in its correct position. After a few months the eye was entirely straightened. In cases of this kind, as in all errors of refraction, astigmatism must be looked for and corrected. Prisms should never be prescribed in such young people and for crosseyes. If the correction of the errors of refraction and stimulation of the muscles do not serve to straighten the eyes, an operation is advisable. Convergent crosseyes are almost always caused by far sight. It is said that about 80 per cent. is due to this cause. Vision for distance is not always $\frac{20}{20}$ in far sight, sometimes it is as low as $\frac{20}{200}$, or even lower. It is sometimes necessary to prescribe two pairs of glasses, a stronger one for reading and a weaker one for distance. Astigmatism is often found in far-sighted eyes, especially in the higher degrees. It is well, therefore, to look for astigmatism if vision cannot be brought to $\frac{20}{20}$ with sphericals. We have now given about all the cases necessary to illustrate the various forms of far sight. Probably you will find that no two patients recite precisely the same symptoms, but the mode of testing and correcting is the same in every case; for instance, one of my patients, aged about 25, said he was troubled with blurring of vision, accompanied by pain in and around the eyes. He also said that he had a flow of tears whenever he attempted to keep up continuous close work. Also had pain in the top of his head ; first noticed it a few months ago after doing some very fine work. I tested his distance vision first, as I do in every case, and found that it was $\frac{20}{20}$. The symptoms would lead any refractionist to suspect astigmatism, especially if of longer duration, but the fact that he had normal vision for distance does away with this. I try convexes in the same manner as before, and find that he needs a + 1.00 D.'s to correct his manifest hypermetropia. Another man, aged 43, has worn lenses for far sight since he was 26 years old. They were comfortable at first, and until a few months ago were perfectly satisfactory. He complained of headache, and in reading at night the eyes felt strange. I found he could only read the 30-foot line at 20 feet. Vision for distance was, therefore, $\frac{20}{30}$. A + 36, however, brought vision to $\frac{20}{20}$, but this did not enable him to read the finest line on the near vision card at 14 inches. So we tried a still stronger convex lens which enabled him to do so. I found that + 15 was required to enable him to accomplish this. Two pairs of glasses were therefore prescribed, + 30 for distance and + 15 for near vision.

My next case was a young man, aged 23. I noticed that he had a prominent nose and bulging eyes. He told me he had no trouble in reading the finest print when it was brought sufficiently close, but vision for distance was blurred, and he was unabled to recognize people as well as he ought. I found that his vision for distance was $\frac{20}{40}$, or just one-half what it should have been. He was able to read everything on the Jaeger card when brought near enough. We again directed him to the distance chart, and placed a weak convex in front of the eyes, which rendered vision more indistinct than with the naked eye. We next tried a weak concave and found that this improved it. I increased the strength until I found the weakest one, which brought vision to $\frac{20}{20}$. This was prescribed for distant vision. His accommodation was strong and active, so that he was enabled to read with the same lenses.

In higher degrees of myopia, where a much stronger concave is required for distance, they will complain of being unable to read with the same lenses, as the print appears much smaller. Then two pair of lenses are necessary. The strong ones for distant vision and weak ones for reading and near work. We can find the necessary lens by subtracting from the lens which gives the best distant vision that lens whose focus represents the distance at which he wishes to read or work; for instance, if — 5.00 D.'s is the lens required for distance, and he wishes to read at 16 inches, we must subtract — 2.50 D.'s, which represents 16 inches from — 5.00 D.'s, which gives us 2 50 D.'s, or — 16, the lens required for reading. There is a method of estimating near sight or finding the lens required to correct it by dividing 40 by the distance in inches from the eye to the farthest point at which the finest line on the Jaeger card can be read. The quotient will be the number in

D. For instance, if the farthest point is 10 inches, 40 ÷ — 10 = — 4.00 D., or — 10, the number of lens required.

Our next case was a lady who told me she had always been near-sighted, and had worn glasses for distant vision only. She held her book about 7 inches from the eyes, and said she had never succeeded in getting a lens to suit her for reading. She said her eyes were getting worse, as they pained her after reading half an hour. I found that her distant vision for both eyes was $\frac{20}{100}$, but with a — 10 I brought it to $\frac{20}{40}$, but was not able to improve it any more with stronger sphericals. I therefore suspected the presence of astigmatism, and placed the lenses, with which I obtained the best vision in the groove of the trial frame nearest the eye, and after placing the ground glass disc in front of the left eye, directed the attention to Spencer's astigmatic letters, which were 15 feet from the patient. I found by questioning if there was any difference in the distinctness or density. She told me that all the letters, except the N., were of a lighter color and indistinct. The letter N., as you will notice, is formed of lines running vertically or at an axis of 90°. I knew that astigmatism was present, and must find a cylindrical lens that would render all the lines equally clear. The axis of the cylinder is always at right angles to the lines that are seen the plainest. In this case, therefore, the axis of the cylinder will be somewhat near 180°, or horizontal. I found in this case that a — 20 cylindrical at an axis of 180° rendered all the lines equally clear, and brought the vision to $\frac{20}{20}$, or normal. The same for both eyes. The lenses prescribed were :

R/ O. D. — $\frac{1}{10}$ ⁀‿ — $\frac{1}{20}$ cyl., ax. 180°,
O. S. — $\frac{1}{10}$ ⁀‿ — $\frac{1}{20}$ cyl., ax. 180°

for constant use.

This was a case of compound myopic astigmatism.

The next case was a gentleman, aged 55, who complained of not being able to read as comfortably as formerly, though his distant vision, he said, was good. I tested his distant vision and found it $\frac{20}{30}$, and it was brought to $\frac{20}{20}$ by a + 1.00 D.'s lens. Any stronger lens blurs the vision + 1.00 D.'s ; this, therefore, was the measure of his manifest hypermetropia. We know from his age that he must be also old sighted, requiring at least + 3.00 D.'s to relieve it. The lens, therefore, that he requires for near vision would be + 1.00 D.'s + 3.00 D.'s = + 4.00 D.'s or + 10. We therefore gave him a + 10 lens for reading, and all work within a distance of 14 inches from the eyes.

The next case was a young girl aged 14, who had been ill with scarlet fever and diphtheria. She said that since her sickness she had been able to see distant objects as well as before, but that she was unable to read or do any near work. I noticed that the pupils were very large. I tested her vision for distance and found that it was $\frac{20}{20}$, or normal for both eyes. While she was still looking at the distance card I placed a weak convex before the eye, + .55 D.'s, but it did not blur vision and she saw just as well with as without. I next tried a + .75 D.'s, but this blurred vision, which proved to me that her trouble was not due to far sight. I now have good reason for thinking that it was paralysis of the accommodation caused by sickness, which, if there is no error of refraction previous to the sickness, leaves the vision good for any distance at 20 feet or beyond. But as the ciliary muscles are temporarily paralyzed, the crystalline lens cannot be made convex enough to bring the rays from near objects to a focus on the retina. You can easily understand then that a lens is only needed to assist in near vision. In this case I gave the weakest convex, which enabled her to read the finest lines on the near vision card, and changed for weaker ones as the eyes regained their former strength. Attention to the general health and tonics were also advised. In a few months, lenses were no longer needed.

The next case was a young man, aged 22. He was a stout and healthy looking young man, but complained that the vision of his right eye had been gradually growing worse. He first noticed it six months ago. I found that vision for distance in the left eye was $\frac{20}{20}$, and in the right, $\frac{20}{40}$. The left eye was, therefore, normal for distant vision, but the right eye had about $\frac{1}{2}$ of the normal acuteness. Neither convex or concave sphericals improved it. I therefore suspected astigmatism, and covered the good eye with the ground-glass disc, and directed him to look with the other at the astigmatic letters. I then asked him to notice if there was any difference in the color or density, and he told me that the letter S., which is made up of horizontal lines, was a great deal darker than any of the others, which were blurred and indistinct. There is, therefore, no doubt but that he had astigmatism in the vertical line. I therefore placed a convex cylinder before this eye at an axis of 90°, but it did not improve the vision, and he told me it was worse. I next tried a concave cylindrical at the same axis with better results. There was an improvement, but still the horizontal lines were a great deal the darkest. This led me to think that the cylinder was not strong enough. I accordingly increased the strength and find that with a $-\frac{1}{18}$ cylinder all the lines appeared equally clear. I then directed him to the distance card and found that vision in this eye was also $\frac{20}{20}$ or normal, equal to the left eye.

The lenses we prescribed for this case were:

O. D.—$^1/_{18}$ cyl. ax. 90°.
O. S., Plano.

The right eye, therefore, was astigmatic, and the left emmetropic, which condition is known as anisometropia.

The next case was a man, aged about 48, who said he had always had good vision, but lately found some difficulty in reading, especially in the evening. He thought he saw at a distance just as well as he ever could. I tested his distant vision and it was $\frac{20}{20}$, and weak convexes blur it, therefore there was no hypermetropia. I had good reason for believing it to be old sight or presbyopia. I next tried the accommodation and found that the near point was removed, and he told me that he had noticed that he saw much better when his paper was held a little farther from him. The lenses prescribed therefore, were the weakest convexes that would enable him to see everything on the card clear and distinctly at the normal distance, or 12 or 14 inches. In this case +24 was required to do this. I therefore advised the use of this number for reading and near work.

The next case was a man, aged 53, who complained that his eyes became tired when he read. He had tried several pairs of lenses, but none seemed to suit him. Distant vision was far below normal, $\frac{20}{80}$. Convex spherical lenses did not improve it, but with a concave 2.00 D.'s, vision was $\frac{20}{20}$. He had, therefore, — 2.00 D.'s of myopia. But he needed lenses also for reading and near work ; an emmetrope of 55 requires a convex glass of + 3.00 D.'s for the presbyopia. This man was, however, a myope of — 2.00 D.'s, so we have to deduct this from the number in diopters of the lens required for the presbyopia. In this case, if he had been an emmetrope or had no myopia or hypermetropia, the lenses required would have been about + 2.75 D.'s. The lens required and which I prescribed was + 2.75 D.'s — 2.00 D.'s = + .75 D. for reading and — 2.00 D.'s for distance.

The next case was a boy, about 14 years of age, complaining of having to hold his book very near him in order to see the print, and also of trouble in seeing figures on the blackboard in school. Distant vision, I found, was $\frac{20}{70}$ for both eyes, but a concave glass improved it, and one sufficiently strong brought it to $\frac{20}{20}$. I therefore prescribed the weakest concave which would bring the vision to $\frac{20}{20}$. If this was not comfortable for reading, I gave a weaker one.

The next case was a young lady ; complained a great deal of headache and poor vision for both near and distant objects. Distant vision was $\frac{20}{40}$ for both eyes ; concave or convex sphericals did not improve it. Of the radiating lines, the horizontal ones could be seen clearly with the right eye, while the others were blurred and indistinct. With the left eye, those at an axis of about 60° were seen more distinctly than others. The existence of astigmatism was therefore proven, and I had to find the cylindrical lens that would render all the lines equally clear. Vision was obscured in the left eye, and I placed a convex cylinder + 60 before the right with its axis at right angles to the lines that were seen to be the darkest with this eye, which would be 90°, or vertical. This, she told me, did not improve. I tried a concave —.67 D.'s in the same manner and at the same axis with marked improvement, and with a —1.00 D.'s cylinder at an axis of 90° all the lines appeared equally clear. I next tried the left eye in the same manner, except that the astigmatism was in a different axis. In this eye the lines at an axis of 60° were seen the clearest, therefore, the axis of the cylinder would be placed at 120°. Convex cylinders were tried, but no improvement. A —1.00 cylinder, axis 120°, made all the lines equally clear.

The lenses given her for constant use were :

O. D. — 1.00 cyl. ax. 90°.
O. S. — 1.00 cyl. ax. 120°.

In this case of simple myopic astigmatism the headaches disappeared.

The next case was a boy who had been cross-eyed for some time. Could not tell just the time it commenced, but noticed it first six months ago. The eyes I noticed were small. The symptoms lead me to suspect that it was caused by some error of refraction. We told you in the chapter on Hypermetropia that this was a fruitful source of convergent strabismus (or inturning cross-eyes); nearly $\frac{8}{10}$ of all cases are caused by it. If the lens correcting the total hypermetropia (manifest and latent or concealed) within + 1.00 D.'s be worn, the cause is removed, and the eyes straighten usually in a few months. I found distant vision was $\frac{20}{40}$ in both eyes and with a + 1.00 D.'s vision was the same for distance; but as I could estimate the total far sight without paralyzing the accommodation, I ordered a drop of a 4 grain solution of atropine in each eye, three times a day, for three days, when we found that + 4.00 D. was required to bring the vision to $\frac{20}{20}$ + 3.00 D. It was therefore prescribed for constant wear. In six months the eyes were reported straightened.

The next case was a man, I should judge about 55 years of age; has worn glasses for some time, but they have never been suitable. He had pain in and about the eyes. Distant vision was O. D. $\frac{20}{100}$, O. S. $\frac{20}{200}$. I covered the left eye and proceeded in this manner to correct the error of refraction. A + 60 was first tried with a noticeable improvement, and I kept trying stronger ones until I found the one giving the best vision. With a + 2.00 D.'s his vision was very much improved, but stronger ones blurred it. The vision was, however, far from normal. I next directed the attention to the radiating lines, and learned that the vertical ones were the darkest, placing the + 2.00 D.'s, which gave the best vision of any of the sphericals in the groove, in the trial frame next to the eye. I placed over it a weak convex cylindrical at an axis of 180°. This improved it; and a + 48 cylindrical, axis 180°, rendered all the lines equally clear and brought the vision to $\frac{20}{20}$.

The lens required for this eye then is O. D. + 2.00 D. ⌒ + .75 D. cyl. ax. 180. The right eye was then covered and the left tested in the same manner. I found that the spherical required was + 3.00 D., and cylindrical + 1.00 D. at an axis of 165°. The lenses prescribed for distance was, therefore:

O. D. + 2.00 D. ⌒ + .75 D. cyl. ax. 180°.
O. S. + 3.00 D. ⌒ + 1.00 D. cyl. ax. 165°.

He also wanted lenses for reading and near work. A + 3.00 D. placed before the lenses required for distance enabled him to read the smallest lines with ease. The lenses required for near work and reading were, therefore:

O. D. + 5.00 D. ⌒ + .75 D. cyl. ax. 180°.
O. S. + 6.00 D. ⌒ + 1.00 D. cyl. ax. 165°.

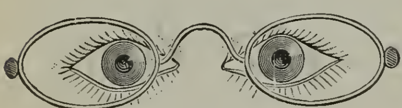
In a number of cases it will be impossible to give normal vision, but it should always be corrected as far as possible, no matter how poor the vision may be. A lady informed me some time ago that she had no vision in one eye, but that the other was all right. She complained of a great deal of discomfort about the eyes. Some oculist had prescribed a plane glass for the poor eye. I tested the distant vision and found it $\frac{20}{200}$; with the pinhole disc, however, it was brought to $\frac{20}{100}$, which proved that it could be improved to an equal extent, if not more. I found that a convex improved it and advised its use, although the improvement was little. I have since been told that the headaches have disappeared.

## FITTING SPECTACLES AND EYE-GLASSES.

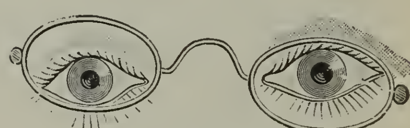
Your success as an refractionist depends almost as much on the manner in which you fit the frames as upon the correction of the visual defect. For the information of those whose experience has been limited we append the following hints and suggestions: Always adjust the frame so that the optical center of the lenses are in the center of the pupils, and just far enough away from the eyes to prevent the eyelashes from touching the glass. This is the sum and substance of successful fitting.

The farther from the eye a convex lens is placed the stronger it is, and a concave has the effect of a weaker lens when removed from the eye. Therefore, an ill-fitting spectacle or an eyeglass frame that throws the lenses farther away from the eye than the trial frame with which we tested may give a different result.

If your frame is too wide or not wide enough, lenses will have the effect of a weak prism.

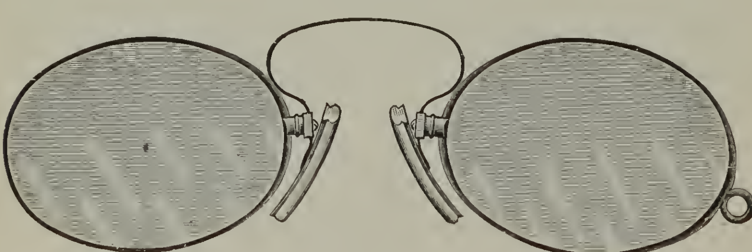


CUT SHOWING FRAME TOO WIDE.



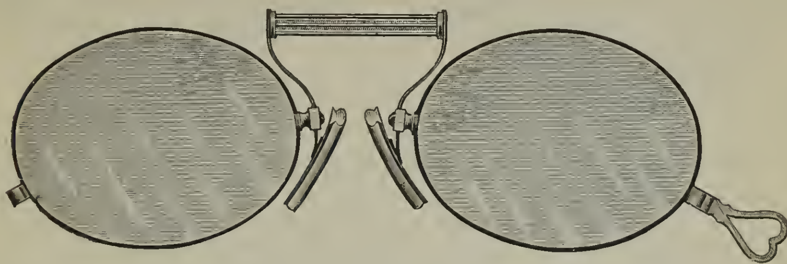
AN ILL-FITTING FRAME.

Cylindrical lenses for the correction of astigmatism should invariably (if stronger than .75 D.) be worn in a Riding-bow spectacle, so that they may be kept in the desired position and the axis always the same. This is impossible in the usual forms of eyeglasses, as it takes considerable practice and adjustment to always get them in the same position before the eyes. If one lens



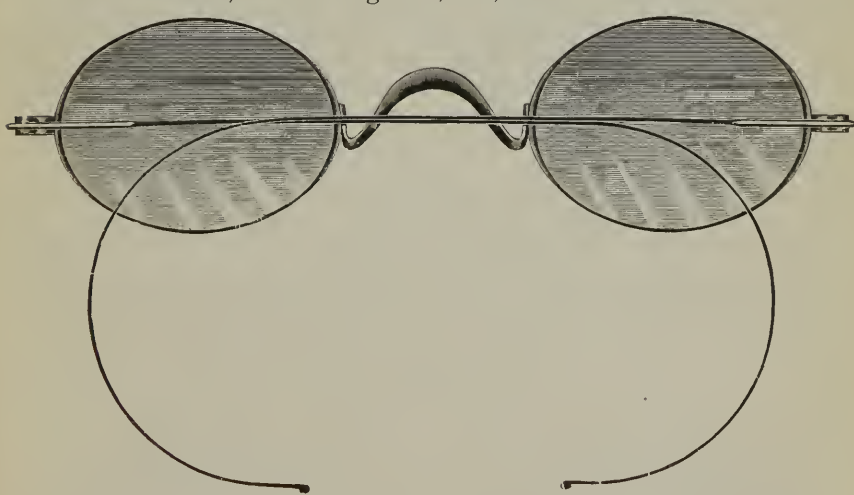
FORM OF EYEGLASS THAT MAY BE USED FOR CYLINDRICAL LENSES.

is a little lower down than the other on the nose, the axis of the cylinder is changed. There is, however, one form of eyeglass which can be worn with these lenses with a great deal of satisfaction, and this one has a spiral spring on a horizontal bar to take the place of the ordinary eyeglass spring.



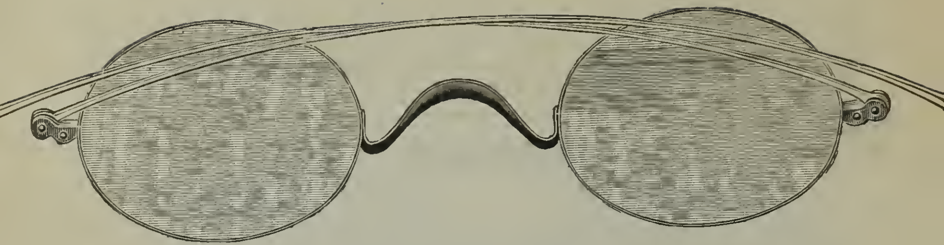
CUT OF EYEGLASS THAT MAY BE USED FOR CYLINDRICAL LENSES.

Fit your patients correctly and quickly, as they will question your knowledge of the business if too many kinds of frames are tried before you find a suitable one. The first thing to decide in fitting spectacles is the kind of a frame your patient wishes. Is it gold, steel, silver, nickel or aluminum alloy (a material resembling gold in its wearing qualities ; does not tarnish or rust, and is about half the weight of steel), or other materials used for frames? What form? Riding-bow, fitting over and behind the ears sometimes called hook-bow, half Riding-bow, etc., etc.?



CUT OF RIDING-BOW SPECTACLE.

He may wish straight-bow or turn-pin temples, where about one-third of the straight-bow temple is separated and united with the other part with a pivot so that it can be turned down behind the ears.



CUT OF STRAIGHT BOW.

Or slides (J. D.), the last two mentioned are old style and seldom used, although occasionally there is a call for them in gold or silver. You must next decide what size of eye is best suited. This will depend to some extent on the pupilary distance and the wishes of the patient. If the pupilary distance is not more than two and five-eighth inches, the standard large eye, also called 1-eye, may be used. In children, 3, 4, or 5 eye is generally used. And 00 and 0 are now worn by people with an unusual pupilary distance, or in smoked or colored glass to protect the eyes, although a large lens is a benefit to any one wearing glasses for distant vision.

In the accompanying illustration (see page 76) we give the actual sizes and shapes of lenses.

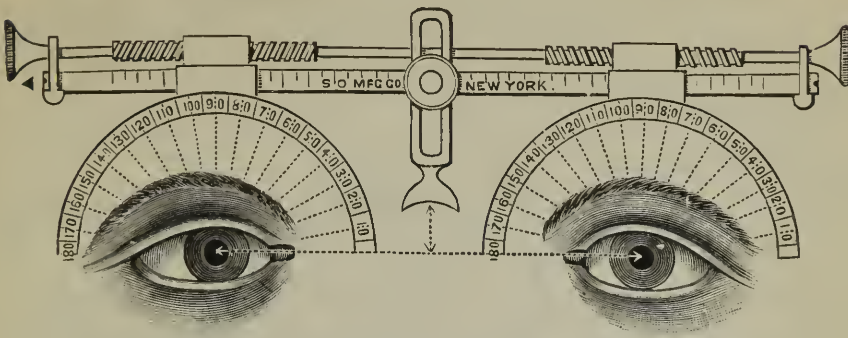
The lenses with a portion of the upper part ground away (F., C., D., etc.), called clerical lenses, are useful in cases when distant vision is normal and a lens is required for near vision, and it is inconvenient to remove the spectacle or eyeglass every time one wishes to look at the distance.

You must also decide what form of nose-piece is best. You have already selected your frame and size of eye; you must next select a nose-piece that will rest easily and comfortably upon the crest, just wide enough, and high enough to bring the center of the lens in the center of the pupil and prevent it from coming in contact with the eye-lashes. There are various forms of nose-pieces, of which the C. nose is the most common, and when not specified it is generally understood that C. nose is meant. In the cuts are shown the various heights and widths of C. noses (see page 77). The width of the nose piece and the length of one eye of the size of lenses you select will equal the distance between the centers of the pupil.

For a flat nose it will be necessary to have a nose-piece of the form known as SS. or snake nose (see page 78). Another person may have a very prominent nose and sunken eyes. In this case you will select a nose-piece like the one in cut known as CC. (see page 77). You have now selected your frame, kind of nose required and size of eye. You must now decide the pupilary distance and height of nose.

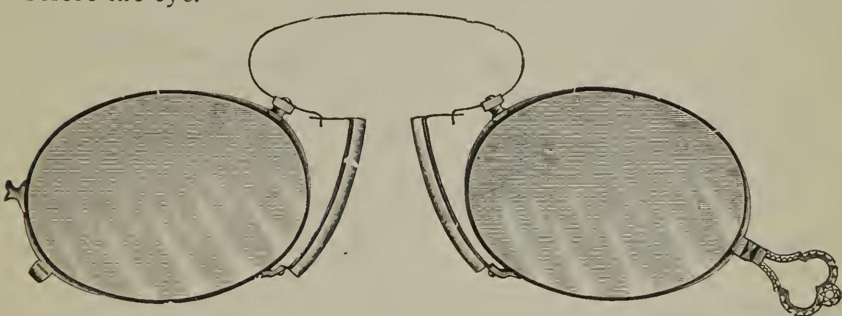
By pupilary distance is meant the distance from the center of one pupil to the center of the other. (Abbreviated P. D.)

The height of nose is the distance from the center of the horizontal line, passing through the center of the pupils. In the cut is shown a nose-piece measuring one half inch above this line ; the height of nose-piece will then be said to be one half inch.



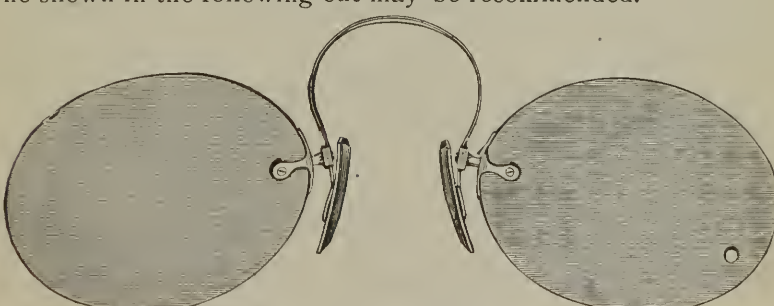

CUT SHOWING LINE THROUGH CENTER OF PUPIL FROM WHICH THE HEIGHT OF NOSE-PIECES ARE MEASURED.

If an eyeglass is preferred (as it generally is), they must be selected for your patient with a great deal of care, taking pains that they fit neatly and comfortably and in the proper position before the eye.



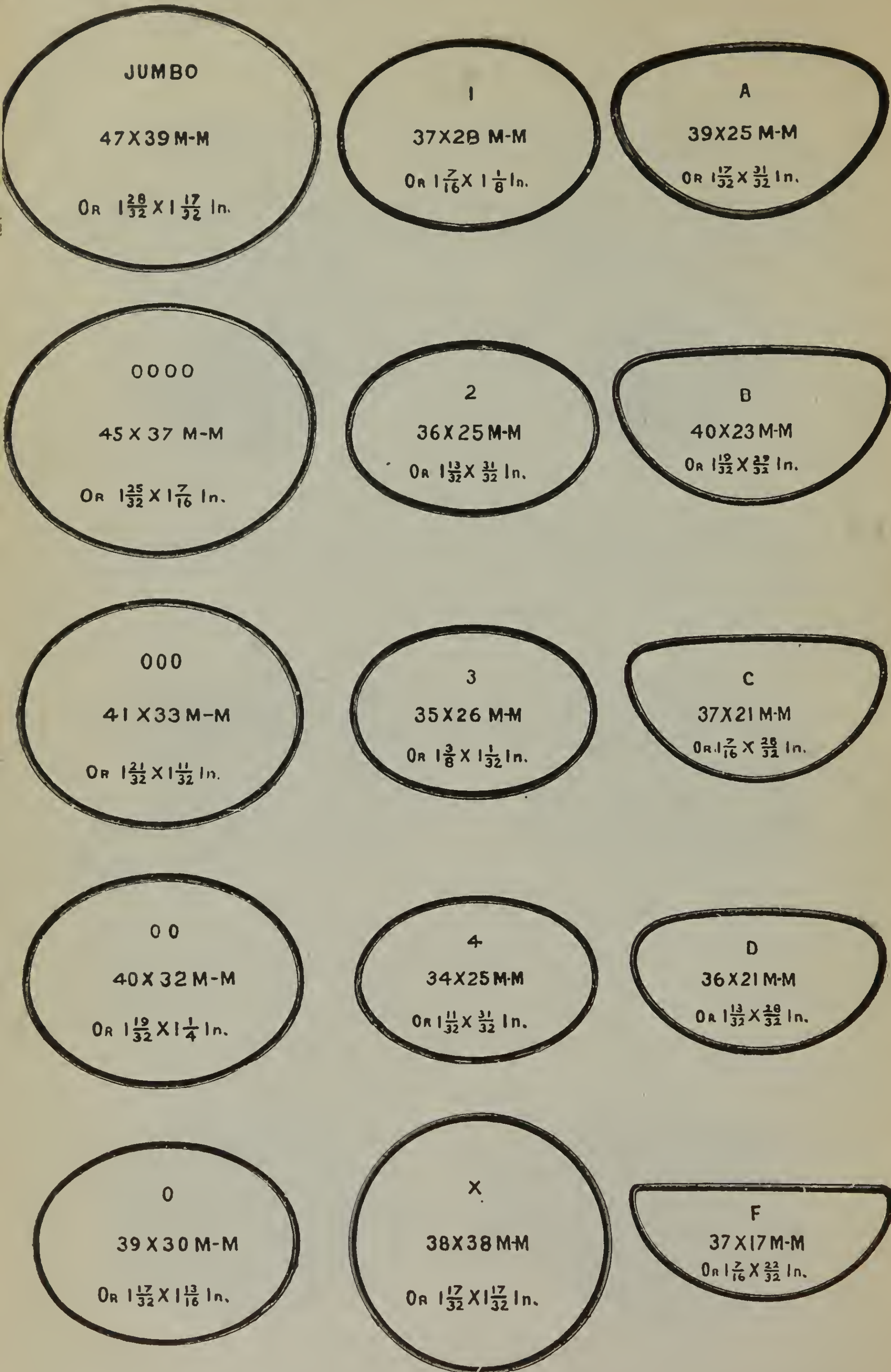
CUT SHOWING THE EYEGLASS WITH ADJUSTABLE NOSE-PIECE IN ITS PROPER POSITION.

There are various forms also of eyeglasses, but space will not allow us to dwell upon them. There is one form, however, which it will be well to mention, as some do not care to wear spectacles, and eyeglasses cannot be tolerated on account of the pressure on the nose necessary to keep them in place ; then a frame like the one shown in the following cut may be recommended.



CUT OF EYEGLASS THAT MAY BE RECOMMENDED IF SPECTACLES ARE NOT DESIRED AND THE USUAL FORM OF EYEGLASSES CANNOT BE WORN.

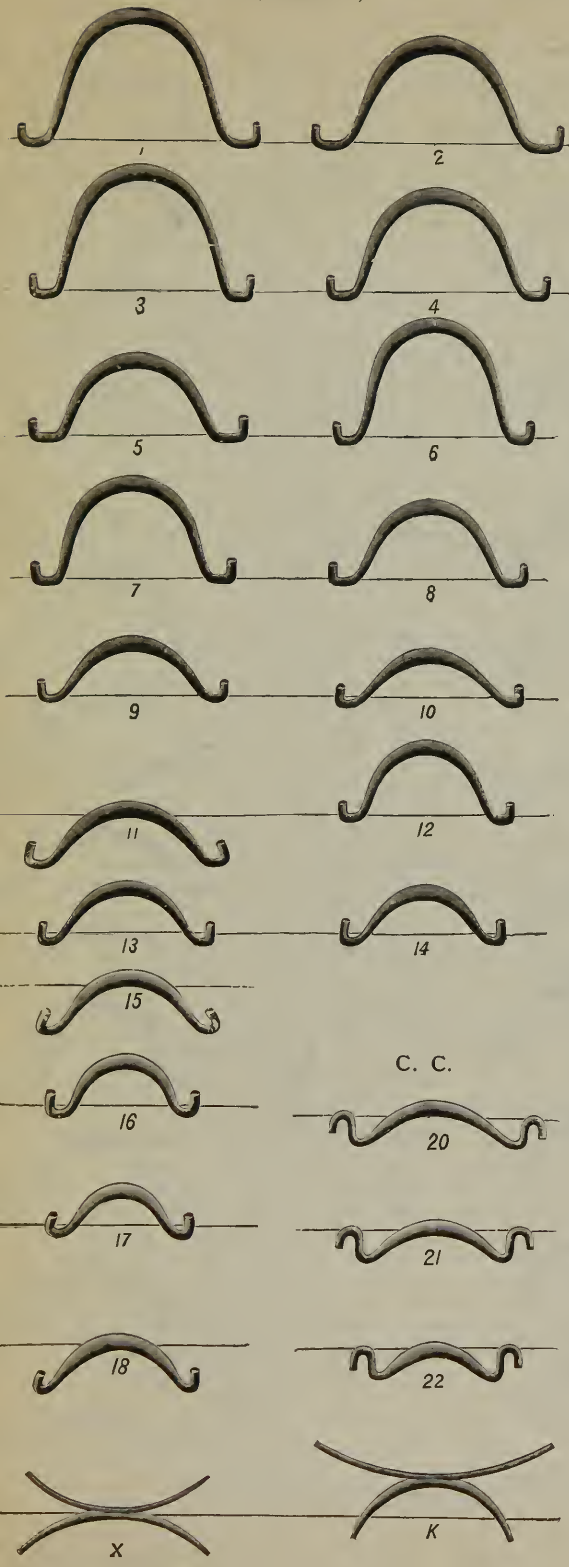
The following diagrams are approximately the sizes of interchangeable Lenses. Numbers 0, 1, 2, 3 are the standard which we carry in stock. All others must be ground to order, require a little more time to grind, and must be charged extra accordingly.




To get the pupillary centers with any given nose-piece and eye, add the length of nose-piece to length of one eye.
Eyes of any shape or size, and any other length or styles of nose-pieces made to order.
It is always necessary when ordering the C nose-piece to mention the assortment, unless you wish them all alike.

# NOSE PIECES OF DIFFERENT DIMENSIONS.

C. (Common.)




## Length and Height of Nose Pieces.

### C.

| No. | Length | | Height | | m. m. |
|---|---|---|---|---|---|
| 1 | $1\frac{1}{4}$ | in. | x $\frac{5}{8}$ | or | 32 x 16 m. m. |
| 2 | $1\frac{1}{4}$ | " | x $\frac{1}{2}$ | " | 32 x 13 " |
| 3 | $1\frac{1}{8}$ | " | x $\frac{5}{8}$ | " | 29 x 16 " |
| 4 | $1\frac{1}{8}$ | " | x $\frac{1}{2}$ | " | 29 x 13 " |
| 5 | $1\frac{1}{8}$ | " | x $\frac{3}{8}$ | " | 29 x 10 " |
| 6 | 1 | " | x $\frac{5}{8}$ | " | 25 x 16 " |
| 7 | 1 | " | x $\frac{1}{2}$ | " | 25 x 13 " |
| 8 | 1 | " | x $\frac{3}{8}$ | " | 25 x 10 " |
| 9 | 1 | " | x $\frac{1}{4}$ | " | 25 x 6 " |
| 10 | 1 | " | x $\frac{3}{16}$ | " | 25 x 5 " |
| 11 | 1 | " | x 0 | " | 25 x 0 " |
| 12 | $\frac{7}{8}$ | " | x $\frac{1}{2}$ | " | 22 x 13 " |
| 13 | $\frac{7}{8}$ | " | x $\frac{1}{4}$ | " | 22 x 6 " |
| 14 | $\frac{7}{8}$ | " | x $\frac{3}{16}$ | " | 22 x 5 " |
| 15 | $\frac{7}{8}$ | " | x 0 | " | 22 x 0 " |
| 16 | $\frac{3}{4}$ | " | x $\frac{3}{16}$ | " | 19 x 5 " |
| 17 | $\frac{3}{4}$ | " | x $\frac{5}{32}$ | " | 19 x 4 " |
| 18 | $\frac{3}{4}$ | " | x 0 | " | 19 x 0 " |

### C. C.

| No. | Length | | Height | | m. m. |
|---|---|---|---|---|---|
| 20 | $1\frac{1}{8}$ | in. | x 0 | or | 29 x 0 m. m. |
| 21 | 1 | " | x 0 | " | 25 x 0 " |
| 22 | $\frac{7}{8}$ | " | x 0 | " | 22 x 0 " |

### S.

| No. | Length | | Height | | m. m. |
|---|---|---|---|---|---|
| 30 | 1 | in. | x $\frac{3}{8}$ | or | 25 x 10 m. m. |
| 31 | 1 | " | x $\frac{5}{16}$ | " | 25 x 8 " |
| 32 | 1 | " | x $\frac{1}{4}$ | " | 25 x 6 " |
| 33 | 1 | " | x $\frac{1}{8}$ | " | 25 x 3 " |
| 34 | $\frac{7}{8}$ | " | x $\frac{3}{8}$ | " | 22 x 10 " |
| 35 | $\frac{7}{8}$ | " | x $\frac{5}{16}$ | " | 22 x 8 " |
| 36 | $\frac{7}{8}$ | " | x $\frac{1}{4}$ | " | 22 x 6 " |
| 37 | $\frac{7}{8}$ | " | x $\frac{1}{8}$ | " | 22 x 3 " |

### HOOP.

| No. | Length | | Height | | m. m. |
|---|---|---|---|---|---|
| 25 | $\frac{7}{8}$ | in. | x $\frac{3}{8}$ | or | 22 x 10 m. m. |
| 26 | $\frac{3}{4}$ | " | x $\frac{3}{8}$ | " | 19 x 10 " |
| 27 | $\frac{5}{8}$ | " | x $\frac{1}{4}$ | " | 16 x 6 " |
| 28 | $\frac{1}{2}$ | " | x $\frac{3}{16}$ | " | 13 x 5 " |

### S. S.

| No. | Length | | Height | | m. m. | | Outset |
|---|---|---|---|---|---|---|---|
| 40 | $1\frac{1}{4}$ | in. | x $\frac{3}{8}$ | or | 32 x 10 m. m. | outset | 5 m. m. |
| 41 | $1\frac{1}{8}$ | " | x $\frac{1}{4}$ | " | 29 x 6 " | " | 4 " |
| 42 | 1 | " | x $\frac{3}{8}$ | " | 25 x 10 " | " | 2 " |
| 43 | 1 | " | x $\frac{1}{4}$ | " | 25 x 6 " | " | 4 " |
| 44 | $\frac{7}{8}$ | " | x $\frac{1}{4}$ | " | 22 x 6 " | " | 4 " |
| 45 | $\frac{7}{8}$ | " | x $\frac{3}{16}$ | " | 22 x 5 " | " | 3 " |
| 46 | $\frac{7}{8}$ | " | x $\frac{3}{16}$ | " | 22 x 5 " | " | 4 " |
| 48 | 1 | " | x $\frac{1}{8}$ | " | 25 x 3 " | " | 2 " |
| 49 | 1 | " | x $\frac{3}{16}$ | " | 25 x 5 " | " | 4 " |
| 47 | $\frac{13}{16}$ | in. | x $\frac{1}{8}$ | or | 21 x 3 " | | |
| 50 | $\frac{13}{16}$ | " | x $\frac{1}{8}$ | " | 21 x 3 " | | |
| 51 | 1 | " | x $\frac{1}{16}$ | " | 25 x $1\frac{1}{2}$ " | | |
| 52 | $\frac{7}{8}$ | " | x $\frac{1}{16}$ | " | 22 x $1\frac{1}{2}$ " | | |
| 53 | $\frac{3}{4}$ | " | x $\frac{1}{16}$ | " | 19 x $1\frac{1}{2}$ " | | |

### S. S. S.

| No. | Length | | Height | | m. m. |
|---|---|---|---|---|---|
| 55 | $1\frac{1}{32}$ | in. | x $\frac{3}{16}$ | or | 26 x 5 m. m. |
| 56 | $\frac{15}{16}$ | " | x $\frac{3}{16}$ | " | 24 x 5 " |
| 57 | $\frac{7}{8}$ | " | x $\frac{3}{16}$ | " | 22 x 5 " |
| 58 | $\frac{3}{4}$ | " | x $\frac{1}{5}$ | " | 19 x 3 " |

### BAND.

| No. | Length | | Height | | m. m. |
|---|---|---|---|---|---|
| 60 | $\frac{7}{8}$ | in. | x $\frac{3}{8}$ | or | 22 x 10 m. m. |
| 61 | $\frac{3}{4}$ | " | x $\frac{1}{4}$ | " | 19 x 6 " |
| 62 | $\frac{11}{16}$ | " | x $\frac{1}{4}$ | " | 17 x 6 " |
| 63 | $\frac{9}{16}$ | " | x $\frac{3}{16}$ | " | 15 x 5 " |

### X. and K.

X.............................. Give length.

K.................Give length and height.

25 m. m. to the inch.

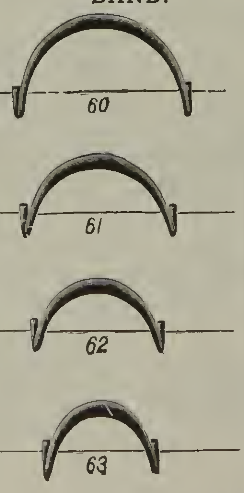
Height of Nose is calculated from pupillary line to under side of nose-piece.

# NOSE PIECES OF DIFFERENT DIMENSIONS.

(S. S. Saddle.)

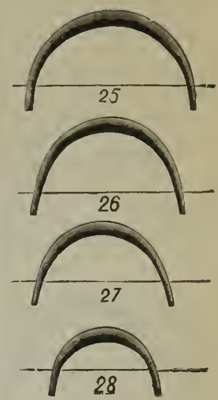

S. S. S.


BAND.

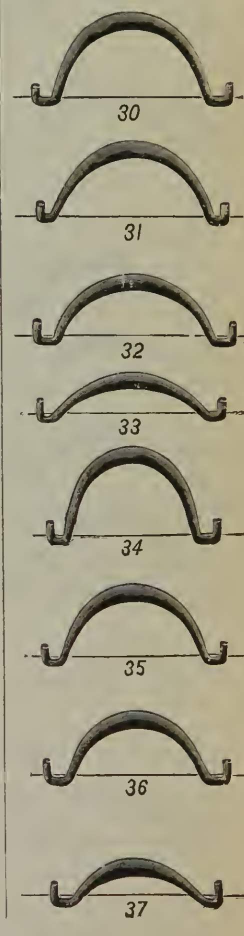





HOOP.




S. (Snake.)




NOSE PIECES CONTINUED FROM PRECEDING PAGE

## APPENDIX.

ABERRATION—a wandering.

There are three kinds—chromatic, distantial, and spherical.
Distantial aberration is caused by a wandering of rays proceeding from a distant object causing indistinct vision. Chromatic and spherical aberration are of special importance to the optician, as no optical instrument can be used with any degree of satisfaction while spherical or chromatic aberration is uncorrected.

When light passes through a prism it is resolved into a series of colored rays, and as all concave lenses may be said to be composed of a number of prisms with their bases out and convexes with their bases in, when light passes through these lenses the same effect is produced—not to so great a degree, but enough to interfere with the perfection of microscopes and telescopes, causing the image to be tinted at its edges with various colors. This is not observable in spectacle lenses, but it does exist and in some cases it proves so irritating to the eye of the wearer in the stronger numbers that some tint is necessary to prevent this. It is a well-known fact that a colored prism will not resolve rays of light into their spectrum.

Chromatic aberration is obviated in optical instruments, such as telescopes, microscopes, opera, field and marine glasses, by combining a concave and a convex lens of flint and crown glass by Canada balsam.

Spherical aberration is caused by the rays entering or passing nearest the center of a lens, being brought to a focus at a greater distance from the glass than those which pass nearer the edge, causing the object to be seen more distinctly in the center but not so well defined at its edges. It is obvious, therefore, that no object can be seen with perfect distinctness in every part through a convex lens at the same moment because of its spherical aberration, as it is termed. This applies to the concave as well as to the convex. Spherical aberration may also be obviated by combinations of lenses, but in spectacle lenses this would be impracticable. By means of the periscopic concave and the meniscus or periscopic convex, spherical aberration may be completely removed. This is why periscopic lenses are considered better for the eye than plano or double lenses.

Accommodation—the power of adjusting the eye to distinguish objects at different distances.

Accommodation—spasm of. Apparent myopia or near sight, sometimes called accommodative near sight, because true near-sight may be entirely absent and the eyeball even too short or normal, generally caused by an overstraining of the ciliary muscle so that the condition of the spasm exists for near and distant vision.

Symptoms—pain and discomfiture about the eyes will be complained of, distant vision is affected and cannot be improved by convex glasses and will be nearly normal when a concave lens is placed before the eye. But it will not be satisfactory; the patient will probably see well with them for a short time and then not as well and even worse than before. It is impossible to get any satisfactory results without the use of atropine to paralyze the accommodation. One drop of a solution of atropine (four grains of atropine to an ounce of water) in the eye three times a day for three days, when lenses can be fitted. The lens then correcting the far sight or near sight will do away with the spasm.

Achromatic—without color.

Achromatic lenses. (See aberration.) Lenses composed of concave and convex cemented with Canada balsam.

Achromatopsia—color-blindness; inability to distinguish color. The most common kind is inability to distinguish red from green while other colors are perceptible.

The cause of color-blindness has been a subject of discussion since it was discovered by Dalton (it is sometimes called Daltonism), but as yet no definite cause has been found. The proportion of color-blind people is about three to five per cent. Some have no perception of a certain color while others are totally color-blind. Some confound dark red with light green, and they are green blind. As far as refraction is concerned, vision may be good for distant and near objects and yet color-blindness may be present. Color-blindness may be detected by Holmgren's colored worsteds which are of all colors tied in skeins; about forty of these are thrown upon a white cloth before the person to be examined; he is then asked to pick out certain colors, purple, blue, etc. But another way is to hand him a skein and tell him to match it from the samples which are before him. There are other tests, such as Donders' which consists of colored glass viewed by transmitted light, etc , but the method just given is the more common.

Albinism—present in Albinos; due to the absence of the pigment to absorb light that does not help to form the image on the retina. If extreme, strong light becomes unendurable by those affected; it is inherited and usually associated with far sight or some other error of refraction. The proper correcting lens should be given with some tint; smoke is preferable.

Amaurosis—a Greek word meaning to render obscure. Blindness, principally from organic changes in the brain, optic nerve or retina.

Amblyopia or dull vision; partial loss of vision; that condition of poor vision for which no cause can be assigned by the most careful examination. Sometimes in high degrees of far sight it is impossible to bring the vision to the normal point with any glass, and yet all parts of the eye will apparently be in a perfectly healthy condition.

Amblyopia—exanopsia; loss of eye sight caused by the eye not being used.

Ametrometer—an instrument for measuring the refraction of the eye, among which may be named Spencer's ophthalmoscopic test lens, Thomson's ametrometer, Tweedy's optometer, De Zeng's Refractometer, etc., etc.

Ametropia—that condition in which the refraction of the eye is such that parallel rays of light are not brought to a focus on the retina. Therefore, if far sight, near sight or astigmatism be present the eye is said to be ametropic.

Anerythropsia—color-bindness in which the patient is unable to distinguish the color red.

Anisometropia—that condition where you have a difference in the refraction of each eye. One may be near-sighted and the other far-sighted ; you will, therefóre, see the importance of testing each eye separately.

Aphakia—absence of the crystalline lens from absorption or removal. The strength of the crystalline lens is equal to a convex lens of about eleven diopters, so that after it is removed, a spectacle lens of about this power should be fitted to compensate for its absence. If near sight was present before the cataract was removed, then the lens required will be weaker than if far sight was present. The glasses are fitted by test lenses and test letters the same as in an error of refraction. The glass for distance will be found to be about six diopters weaker than those for reading ; two pair of spectacles should therefore be prescribed.

Apparent myopia. (See accommodation, spasm of.)

Aqueous humour—the watery fluid between the cornea and the crystalline lens.

Arcus senilis—a white ring forming on outer edge of cornea in aged people due to a fatty change.

Asthenopia—a fatigue of the muscles of the eyeball, or the visual powers caused by uncorrected far sight, near sight, overstrain of the eyes, etc.; headache is the most important symptom, made worse by reading, writing or sewing ; heaviness of the lids, imflammation, etc., will be noticed. The proper lens should be prescribed if there is an error of refraction present ; if not, then the general health should be thought of and rest for the eyes. A weak solution of atropine is often used ; about a one-hundredth of a grain to the ounce of water ; one drop in each eye, alternate nights.

Artificial eyes—the artificial eye is made of glass, to be fitted in the socket after the eye has been removed (or shrunken); may be inserted about a month after the eye has been removed if there is no inflammation. At first it should not be worn over an hour or two a day. In ordering an artificial eye the distance from the point where the upper and lower lid meet at the nose to where they meet on the outer side must be given. Give color and diameter of the iris ; it is always best to inclose a colored drawing if ordered. When the patient calls in person, of course this is unnecessary. Also state whether for right or left eye, and whether eyeball has been removed or is shrunken. To insert the artificial eye, it should first be dipped in water and then the outer end pushed vertically under the upper lid. The lower lid is then drawn downward, and the person directed to look up, when the eye can be very easily rotated into place.

Astigmatism—from the Greek word astigma; not a point (see astigmatism).

Axial hypermetropia—far sight in which we have a positive shortness of the diameter of the eye from before backwards ; when far sight is due to insufficient power of the crystalline lens and the eyeball is normal in diameter, it is called refractive hypermetropia, or far sight.

Axial myopia—near sight due to elongation of the eyeball ; near sight is also caused by an increase of the bending power of the crystalline lens and the cornea. This form is called refractive myopia.

Axis, optic—an imaginary line from the center of the cornea passing through the nodal point to the center of the optic-disc.

Axis, visual—a line from the object we are looking at to the yellow spot, or macula lutea.

Bathymorphia—name sometimes given to an elongated eyeball and near sight.

Bifocal—a lens having two foci ; the upper for distant and the lower for near vision. They are made in both concaves and convexes. There are four kinds, the split bifocals, sometimes called the " Franklin glass." Bifocals ground on a single lens and the " Cemented," which are two lenses cemented together with Canada balsam and " Perfection." They are usually made by grinding away a circular portion of the lower part of the lens for distant vision and inserting a lens for near vision. The " Perfection " bifocals are considered the best. It usually takes from two to three weeks to get accustomed to bifocals, after which they are worn with a great deal of comfort and satisfaction.

Binocular—pertaining to two eyes. The binocular telescope, two telescopes combined, similar to the opera glass.

Blindness, color. (See achromatopsia.)

Blindness—from intense light; partial or complete loss of sight from exposure of the eyes to the sun or electric light.

Blind spot—the place where the optic nerve enters the eye there is no sense of sight. First discovered by Maryiotte (sometimes called the blind spot of Maryiotte). If you will take a sheet of paper with a penny and make a cross about six inches from the coin, close the left eye and look at the cross steadily, you will on moving the coin to and from the cross, find there will be a point at which it disappears, although you can see it again when it is moved nearer or further from the mark at which you are looking.

Brachymetropia—myopia or near sight.

Bulbus oculi—the Latin for eyeball.

Caligation—cloudiness on the front part of the crystalline lens.

Canal of Pettit—the fissure surrounding the crystalline lens.

Canthus—corner of the eye.

Cataract—opacity of the crystalline lens, mostly caused by insufficient nutrition of the eye, disease, injury or old age. The symptoms are poor vision, which glasses fail to relieve, and spots before the eye. A white spot will always be seen through the pupil. If they have become "ripe" enough they can be removed by an operation, after which glasses can be fitted for the near and the far point. (See Aphakia.)

Choroid—the middle coat of the eye between the sclerotic coat or white of the eye and retina (see anatomy).

Chromatic—pertaining to color (see aberration).

Chromopsia—vision in which the image formed on the retina is colored.

Ciliary muscle—the muscle of accommodation which adjusts the crystalline lens for near and distant vision (see anatomy, chapter first).

Collyrium—eye water.

Color-blindness—(see achromatopsia); an inability to see certain colors.

Compound lenses—lenses having the properties of spherical and cylindrical lenses; sometimes called sphero-cylinders; prisms may be combined with a cylinder or spherical, alone or together with a spherical and cylindrical. Thus a prescription may read:

R/ (take)

O. D. (oculus dextra or right eye) (cx) + or — (cc), 1/40 or 1.00 D. (1 diopt.) sph. (spherical) ⊃ (combined with) — or + .75 D. (48) cylindrical axis anywhere from 0 to 180 degrees, which would be a compound lens when it is ground on a single piece of glass, or it might be combined with a prism of any degree with base out or in, up or down. Nearly $\frac{8}{10}$ of all the errors of refraction can be corrected by simply concave or convex spherical lenses. But others require compound lenses which are combinations of spherical, prismatic and cylindrical lenses. In most cases two but sometimes three are ground on one lens.

Combinations of spheres and cylinders are, however, the most used. The spherical is ground on one side and the cylindrical on the other. If a prescription reads + 4.00 D. sph. ⊃ + 1.00 D. cyl., it is filled by grinding the convex 4.00 D. on one side of a piece of glass and the 1.00 cylinder on the other. Every lens ground to order should be tested to see that it is correct before delivering it to your patient, as the execution of your order by the grinder cannot always be relied upon. The best mode of testing is by neutralization. (It is taken for granted that every optician who calls himself such, has an oculist's trial case.) To test the convex-sphero-prism combination take from the trial case a prism, and place the thick part or base over the thinest part or apex of the lens you are neutralizing, and look through, and at the same time over it at a line 4 or 5 feet from you, the same as you would in finding the optical center of a lens. The line will now be seen in the center of the lens, where before it was on the border. We then place over these two a — spherical, when if the lens is accurate and as ordered, will have the appearance of plane glass when looked through and moved backward and forward. To test the sphere and cylindrical combination, we place a — 1.00 D. cylindrical, so that the axis is the same as the prescription, and then over these a — 4.00 D. spherical, and if correct we must have a plane glass. This is very easy when we know the strength and the axis, but suppose a customer hands you a pair of lenses to duplicate? He may have lost his prescription and forgotten the combination. The first step is to find if one side of the lens is thicker than the other. Is an object elevated and lowered by turning the lens in the fingers from right to left? Is the optical line in center of the lens or is it decentered? If so, there is a prism present. To find the number of which we commence, by placing a weak prism with its thick part over the thin part of the lens, and increase the strength until we find one that brings the optical line in the center. Keeping the two lenses together we must find whether there is a cc. or cx. spherical in the combination by looking through it at some object or a line and move it to and fro before the eyes. If the object moves with the lens there is a cc. present, if against or in the opposite direction a cx. If a line is viewed through the lens, and upon rotating it between the fingers the line seems to be broken and carried with the lens, we have a cylindrical present. You can find the strength and axis by neutralization as already mentioned.

Concavo-convex lenses—periscopic concave.

Convexo-concave — periscopic convex, sometimes called a meniscus.

Conical-cornea—a cone-shaped cornea, caused by the pressure of the contents of the eye upon the cornea. Often the cause of irregular astigmatism ; may simulate near sight, but glasses give little or no relief ; an operation is necessary.

Conjunctivitis—inflammation of the conjunctiva or the thin membrane lining the front part of the eyeball and the inner side of the lids.

Cornea—(see anatomy, chapter first.)

Crystalline lens—(see anatomy, chapter first.)

Cylindrical lens—a lens that is a section of a cylinder having power to bend rays in one line only across it which is at right angles to its axis. They are plane on one side and convex or concave on the other. In all complete cases or trial lenses there are 20 pairs of each convex and concave cylindrical lenses with the axis marked by a line at the edge. (See chapter II on lenses.)

Dioptric media—the cornea aqueous humor, crystalline lens and vitreous humor (see anatomy, chapter first.)

Dioptric system—A system of numbering lenses (see chapter II, on lenses.)

Diplopia—double vision ; two kinds of double vision ; homonymous when the two objects seen are not reversed and crossed when the right object is seen by the left eye and vice versa. Prisms and operations or treatment to strengthen the recti muscles are needed (see chapter on test case) ; an error of refraction should always be suspected, such as far-sight or near-sight, which if corrected, often relieves the trouble.

Emmetropic eye—an eye is said to be emmetropic or normal when in a state of rest its refractive power is such that it can see distinctly at a distance of twenty feet or more, so that parallel rays are brought to a focus on the retina.

Far-point or punctum remotum—the farthest distance at which a certain object can be seen.

Facultative hypermetropia—about the same as manifest hypermetropia ; so that the eye is able to see well at a distance either with or without glasses.

Field of vision—the space in which objects can be perceived.

Franklin glasses—(see bifocals.)

Glasses for far-sight ; the strongest lenses with which the person has just as good vision as without any for distance, should be worn constantly for a short time and for reading and close work.

Glasses for myopia—the weakest concave which will enable a person to see the twenty-foot line at twenty feet on the distance card. If this is not below sixteen, lenses will not be required for reading. Or if below that a weaker lens than that used for distance will be needed. The distance in inches, from the eye to the farthest point, at which the finest line on near vision chart can be read, will be the number in inches of the concave lens required for distance.

Hypermetropia or far-sight—(see chapter IV.)

Inch system—(see chapter second.)

Iris—(see anatomy, chapter one.)

Keratoscope—Placido's disc ; sometimes called the astigmatic detecter.

Latent hypermetropia—(see hypermetropia )

Macula lutea—yellow spot; (see anatomy, chapter first.)

Manifest hypermetropia—(see hypermetropia, chapter VI.)

Maryiotte's blind spot—the point where the optic nerve joins the retina ; (see blind spot.)

Megalopsia—a condition of the eye in which things seem too large.

Metamorphopsia—that condition of the eye when objects appear distorted, caused by some change in the retina.

Micropsia—that condition of the eye when objects seem to be smaller.

Mydriatics—substances used to paralyze the muscles of accommodation : the one in general use is sulphate of atropia, the active principle of belladonna. A solution of four grains of the sulphate of atropia to one ounce of water is the usual strength ; a drop is put in each eye three times a day for three days, before examination. The effect does not wear off until about a week after stopping its use. The hydrobromate of homatropine combined with cocaine is sometimes used or the homatropine alone, in a solution of three grains to six drams of water for ophthalmoscopy.

Muscles—(see anatomy, chapter one.)

## OPTICAL PRINCIPLES.

There is some doubt over the actual nature of light, notwithstanding the numerous works that have been written upon it. There are so many theories that we hardly know which one to accept, but the one known as the Emission theory, propounded by Newton, has attracted much attention. This sets forth, that light consists of a substance of extremely small particles of matter, and these particles are thrown off from luminous bodies (or those that produce light, such as the sun, etc.) with great rapidity and that it is the contact of these minute particles with the retina of the eye, which produces the sensation of vision. There is another theory, however, which has been almost universally adopted in the last few years, known as the "Undulatory theory," which assumes that there is everywhere an exceedingly thin and elastic substance, which is called ether, which surrounds all matter and fills every space; the material composing luminous bodies is supposed to vibrate rapidly, which generates wave-like motions in the ether.

The sensation of vision according to this theory, is caused by the shocks of these waves upon the retina. According to this theory, light is, like sound, the results of wave-motions, and the ray of light is a line coming from the center of these waves; and every object we can see owes its visability to these wave-motions coming in contact with the retina.

The velocity of light has been found to be one hundred and eighty-six thousand miles a second, according to which it would take light over three years to reach us from the nearest fixed star; if all the stars were blotted out of existence, it would be a quarter of a century before we should miss some of them. The light which enters our eyes as we look at some stars, started on its journey years ago. The bodies which emit or generate light (as the sun, lamp, flames, etc.) are called luminous, and those which reflect rays (such as the moon, looking-glass, etc.) are illuminated bodies; a single ray of light cannot be obtained, a number together form a beam or pencil of light, which can be easily shown; for instance, if a room is darkened and the air contains particles of dust or tobacco smoke, and light is let in through an opening in the shutter, it will be seen to pass in a straight line, showing that a beam or pencil of light always passes in a straight line, while traversing the same medium. Rays of light emitted from the luminous and the illuminated, pass off divergent, but rays of light coming from an object not less than twenty feet distance from the observer are for all practical purposes considered as parallel rays and those from objects nearer are divergent A ray of light moving through the same medium, such as air, would continue in a straight line forever, but if it comes in contact with another substance it may be either absorbed or bent in its course. If the substance is such that it cannot pass through, it is reflected or thrown back. If it passes through a transparent substance denser than the medium through which it came, it will be refracted or bent, as from air into water or glass.

The length and vibration of the light-waves determines color.

The perception of color is due to the different rates of frequency of the wave-motions.

Common sun-light contains a mixture of all wave lengths and frequencies.

A transparent medium is a substance that permits the passage of light.

Light moves faster in a rare media than in a dense one, and in the same track, so long as it moves in the same media, but when it passes from one media to another of different density, it is changed or bent in its direction, called refraction.

Optometers—instruments for estimating errors in refraction.

Perimeter—an instrument for testing the field of vision.

Placido's disc or keratoscope.

Presbyopia or old-sight.

Prisms—wedge-shaped pieces of glass for relieving double vision and muscular weakness. They are also used for exercising the muscles of the eye, for which purpose a number are placed in frames and called prismatic piles (manufactured by the Spencer Optical Co.).

Punctum proximum—near-point; the nearest point at which an object can be seen.

Retina. (See anatomy, chapter one.)

Sclerotic coat or white of the eye—(see chapter one).

Second-sight—when the reading power has returned after the age of sixty-five or seventy it is called second-sight. While this is the cause of rejoicing on the part of the patient, the symptoms are by no means favorable, as in most cases it is due to a slight swelling of the crystalline lens in commencing cataract before there is any opacity.

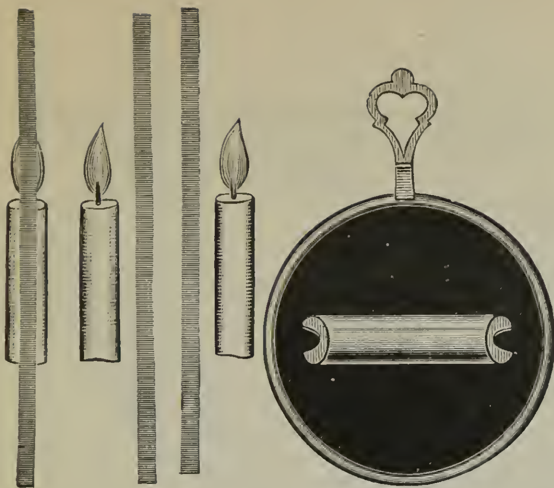
Shadow test—(retinoscopy).

Squint—a convergence or divergence of the eyes ;, also called cross eyes. It is either inherited, caused by far sight, or paralysis of the muscles ; the majority of the convergent cross eye is caused by uncorrected far sight, the eyes often straightening after the proper lens has been worn for a few months (see hypermetropia, chapter VI.). Divergent cross eyes are often associated with near-sight ; when the muscles have become fixed an operation is neccessary to straighten the eye.

Total hypermetropia or far sight—the latent and manifest combined (see hypermetropia, chapter VI.).

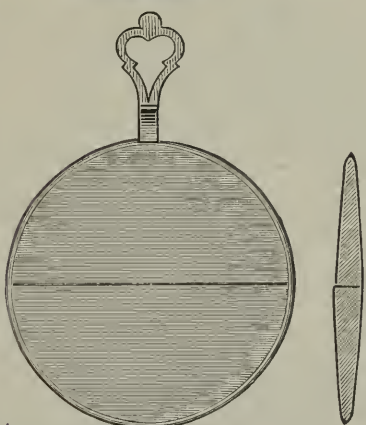
Vitreous humor. (See chapter I.)

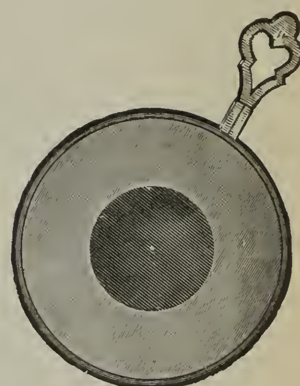
Yellow spot—(macula lutea).



# MADDOX ROD AND DOUBLE PRISM FOR HETEROPHORIA.

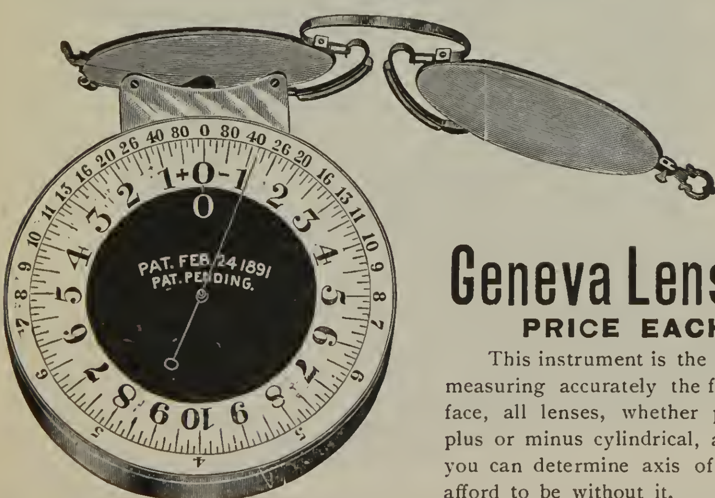
Maddox Rod. A Test for Muscular Insufficiency, consisting of a Glass Rod set in an opening of a Metal Disc, 75 cents each.





Double prism. For detecting Muscular Insufficiency, with two prisms set in rim with bases together, $1.25 ea.

Chromatic Detector. To detect Ammetropia, based on Chromatic Aberration, mounted in Aluminum Alloy Rims, 75 cents each.

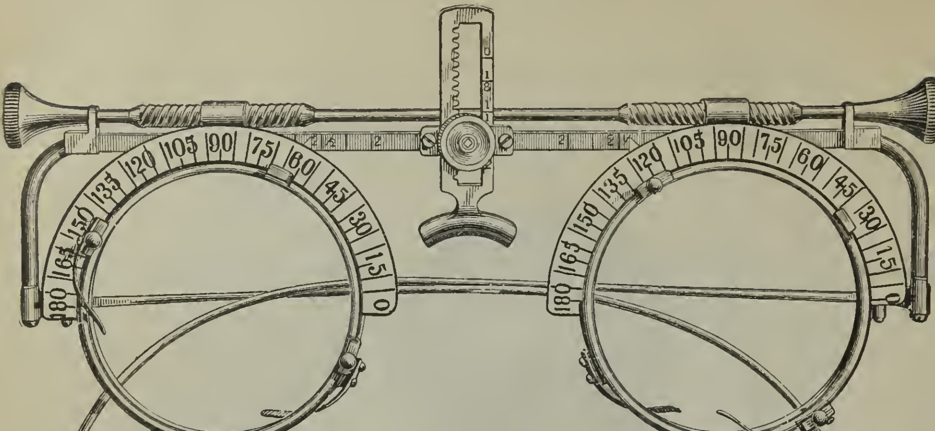



# Geneva Lens Measure

**PRICE EACH, $10.00.**

This instrument is the most practical made for measuring accurately the focus by curvature of surface, all lenses, whether plus or minus spherical, plus or minus cylindrical, and by a quadrant scale you can determine axis of cylinder. You cannot afford to be without it.

# SPENCER IMPROVED TRIAL FRAMES.




No. 940.

No. 940. This frame has a right and left-hand threaded screw, which carries the cells for holding lenses together or apart by this screw, equally, uniformly and rapidly, and holds them in any position desired. The milled thumb-pieces enable one to easily turn the screw and vary the pupiliary distance between the centers of the eyes. The nose bridge lined with cork in center of bar, with rack and pinion, slides up and down to give the height of crest of nose above line drawn from the center of one lens to the center of the other. This slide is graduated in fractions of an inch.

The frame is provided with two graduated arcs for holding three sets of lenses, and springs for keeping them in place; the outer ones revolve in grooves.

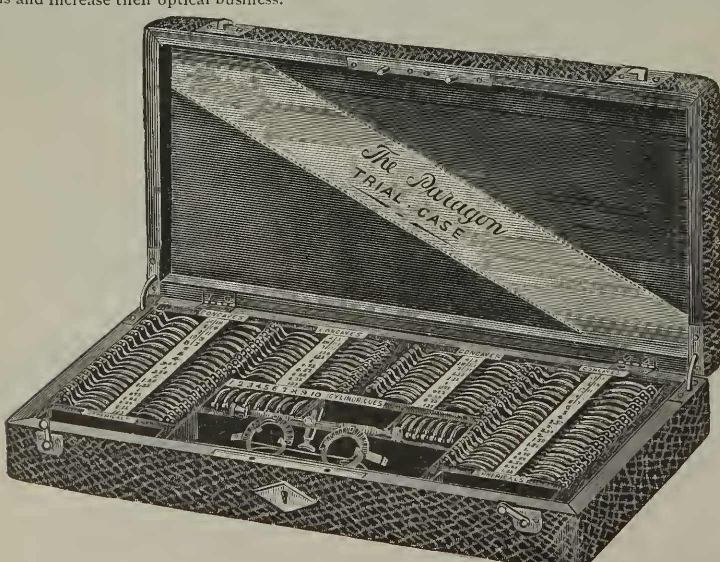
Being constructed from the lightest known metal—aluminum alloy, steel and celluloid—the entire Frame complete only weighs 20 pennyweights. The graduated arcs are made from ivory-celluloid. It is considered by all oculists who have examined it as the most complete, easy to operate, most perfect and durable Frame yet constructed. Graduations are made on the square bar to read pupiliary distance.

| | | |
|---|---|---|
| | Highly finished, nickel plated. Price, including prescription blanks.................. | $10 00 |
| No. 941. | Highly finished, nickel plated. Adjustable Extension Temples...................... | 12 00 |

# THE "PARAGON" TRIAL CASE.

Accurate Lenses. 1¼ Inch Diameter. Nickel Silver Rims. Convex Polished. Concave Gold-Plated.

This Case is specially adapted to the wants of small dealers, and will enable them to make examinations and increase their optical business.




Morocco-Covered, Velvet-Lined, Celluloid Numbering. Price, $32.50.

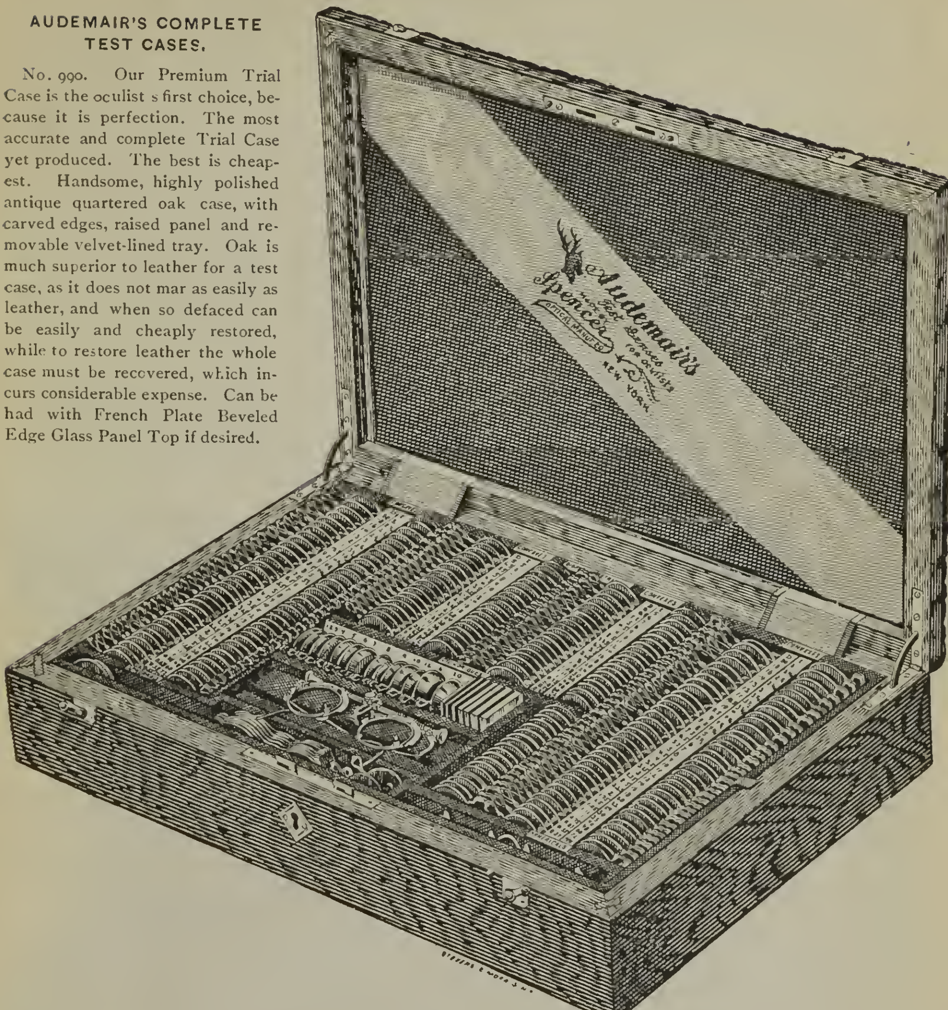
25 Spherical Powers, plus and minus, 0.125 to 20.00. 14 Cylindrical Powers, plus and minus, 0.125 to 4.00. 8 Prisms, 7 Lenses and Discs.

# AUDEMAIR.

## THE BEST AND CHEAPEST TRIAL CASE MADE.

### AUDEMAIR'S COMPLETE TEST CASES.

No. 990. Our Premium Trial Case is the oculist s first choice, because it is perfection. The most accurate and complete Trial Case yet produced. The best is cheapest. Handsome, highly polished antique quartered oak case, with carved edges, raised panel and removable velvet-lined tray. Oak is much superior to leather for a test case, as it does not mar as easily as leather, and when so defaced can be easily and cheaply restored, while to restore leather the whole case must be recovered, which incurs considerable expense. Can be had with French Plate Beveled Edge Glass Panel Top if desired.




### THIS CASE CONTAINS:

| | | | |
|---|---|---|---|
| 38 Pair Spherical Convex | Centered Lenses | 0.125 to 20. | Diop. |
| 38 " " Concave | | 0.125 to 20. | " |
| 22 " Cylindrical Convex | | 0.125 to 8. | " |
| 22 " " Concave | | 0 125 to 8. | " |

20 Prisms from 1° to 20°, Part Mounted, Part Square.
18 Special Discs, comprising Metal Plain, Single and Double Pinhole, Stenopaic, Plano Colored, Half and Full Ground Glass Opaque.
1 Chromatic Detector for Diagnosing Ametropia by Flame Test
1 Full Set Celluloid Handy Tryers, containing Two Spherical Plus and Minus, Two Cylinders, Plus and Minus Pinhole and Opaque Discs.
1 Bar Muscle Test for Asthenopia.
1 Keratascope.
1 Retinascope for Shadow Test and Internal Explorations.
1 Perfected Aluminum Alloy Trial Frame No. 940, also 946. with Complete Set Test Cards, Types, ℞ Book and several Cuts for advertising.

**PRICE COMPLETE, - - - $100.00.**

All Removable Trays are Padded on the Bottom, they may be placed on top of the case without defacing it.

## THE HANDSOMEST SET OF TRIAL LENSES IN THE WORLD.

## AUDEMAIR TRIAL CASES. ALUMINUM ALLOY RIMS.

No. 952. Complete in velvet-lined, highly polished antique oak case, ornamented edges, with double clasp, lock and key. There is a space beneath the removable velvet-lined tray for test types, charts, opthalmoscope, book and sundry extras, as desired.

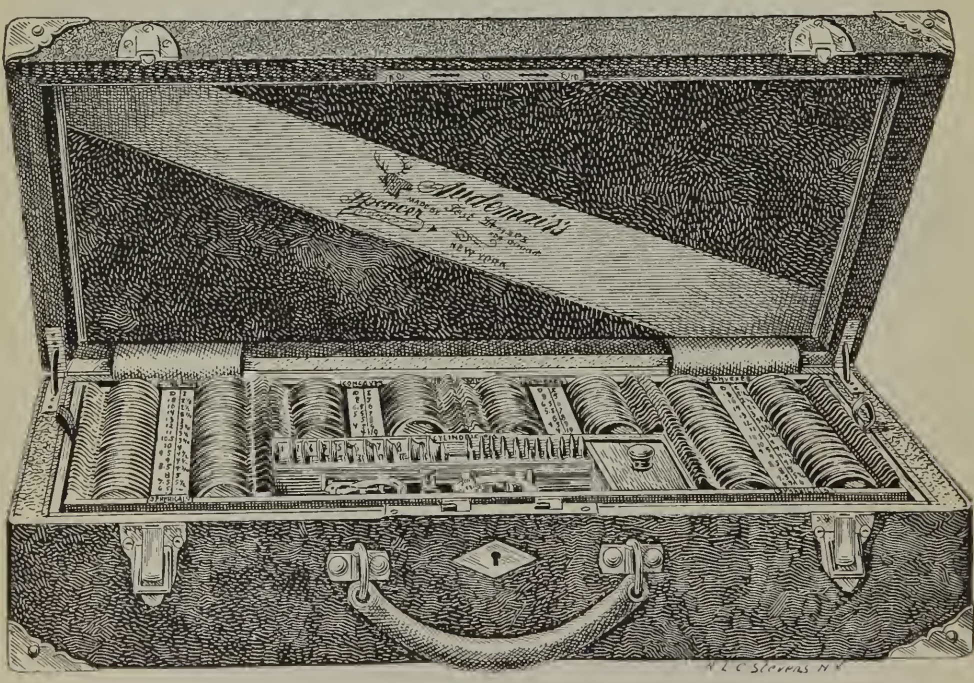
### THIS CASE CONTAINS:

38 pairs each spherical Convex and Concave Centered Lenses 0.125 to 20. Diopters.
22 pairs each Cylindrical Convex and Concave Centered Lenses 0.125 to 20. Diopters.
10 Prisms from 1° to 10°, Mounted.
5 Colored Lenses, all Mounted.
1 White Glass Disc.
1 Half Ground Disc.
3 Metal Discs, Opaque, Stenopaic, Slit and Pin Hole.
1 Opaque Glass Disc.
1 Perfected Aluminum Alloy Trial Frame, No. 940, also 946, with complete set of Test Cards and Types. ℞ Book and several Cuts for Advertising. Price, Complete--$80.00

No. 961 same as 952 without rims. Price Complete------------------------------$60.00

## AUDEMAIR TRIAL CASES.—Morocco Leather Covered.

WITH HANDLE AND METAL CORNERS.



| | | | |
|---|---|---|---|
| 1990L Contains same as No. 990. | Leather Covered Case with Velvet Lined Removable Tray and space below with divisions for one gross lenses and eight dozen frames. | Price, $100.00 |
| 1952L " " No. 952. | | " 82.00 |
| 1852L " " No. 952 with Nickel Rims. | | " 75.00 |
| 2990L Contains same as No. 990. | Leather Covered Case, Two Velvet Lined Removable Trays and divisions for one gross lenses and eighteen dozen frames. | Price, $110.00 |
| 2952L " " No. 952. | | " 90.00 |
| 2852L " " No. 952 with Nickel Rims. | | " 82.00 |

## AUDEMAIR'S COMPLETE SETS OF TRIAL LENSES.

ALUMINUM ALLOY OR CELLULOID RIMS.

Do not fail to inspect these superior Trial Cases before purchasing. We manufacture other and cheaper grades of Trial Cases, but the duly qualified optician demands perfection, and this is not attainable in a cheap case. The secret of the success of the Audemair Cases is *true merit.* All lenses and special discs in Nos. 990 and 952 cases are mounted in aluminum alloy rims, white for all convexes, and heavy gold plate on the same metal for all concaves.

Our aluminum alloy is unsurpassed for trial lens rims as it comprises lightness, extreme flexibility, strength and beauty. Either case made up in amber and shell celluloid rims, if so desired, at same price.

## AUDEMAIR TRIAL CASES.—Morocco Leather Covered.

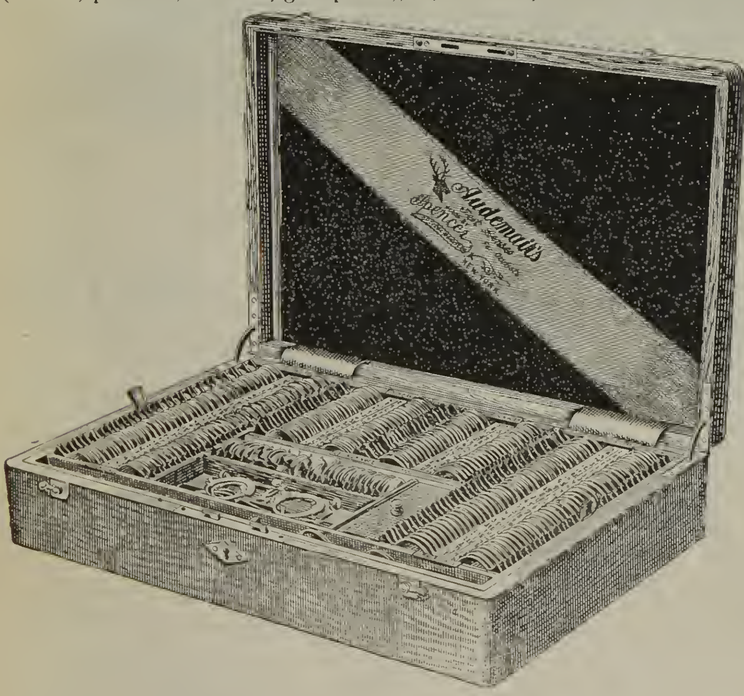
990L Contains same as No. 990..............Price, $100.00
952L " " No. 952.............. " 80.00
852L " " No. 952 Nickel Rims. " 75.00
1990L " " No. 990 with removable velvet-lined tray and divisions below for stock and lenses.................... " 100.00

1952L Contains same as No. 952, with removable velvet-lined tray and divisions below for stock and lenses.......................................... $82.00
1852L Contains same as No. 952, Nickel Rims, with removable velvet-lined tray and divisions below for stock and lenses........................... 75.00

All Removable Trays are Padded on the Bottom that they may be placed on top of the case when in use without defacing it.

## AUDEMAIR TRIAL CASES. SOLID NICKEL SILVER RIMS.

No. 952½. Complete, plain, highly polished antique oak case, tray oak finish, double clasp, lock and key. There is a space beneath the tray for test types, charts, ophthalmoscope, book and sundries, as desired. The convex and concave lenses are mounted respectively in solid nickel (convex, polished; concave, gold plated), or, if desired, *shell* and *amber celluloid rims.*




This Case Contains:
35 pairs each Spherical Convex and Concave Centered Lenses 0.25 to 20. Diopters.
20 pairs each Cylindrical Convex and Concave Centered Lenses 0.25 to 20. Diopters.
10 Prisms from 1° to 10°, all Mounted.
5 Colored Lenses, all Mounted.
1 White Glass Disc.
1 Half Ground Disc.
3 Metal Discs, Opaque, Stenopaic Slit and Pin Hole.
1 Opaque Glass Disc.
1 Perfected Aluminum Alloy Trial Frame No. 940, also 946, with complete set of Test Cards and Types, ℞ Book and several cuts for advertising. Price, Complete ...$60.00

No. 953½. Same as 952½, with solid Nickel Trial Frame similar to 940........................................$55.00

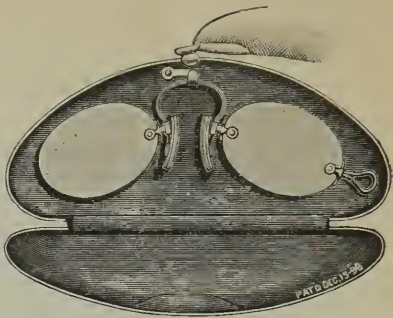
All removable trays are padded on the bottom that they may be placed on top of the case when in use without defacing it.

# SPECTACLE AND EYE-GLASS CASES.

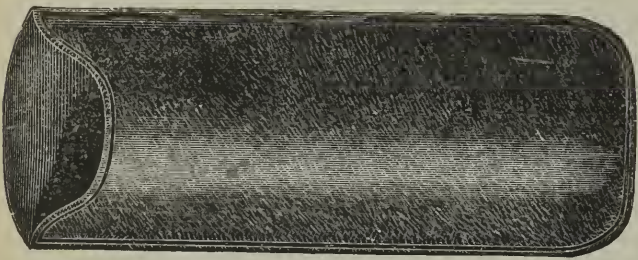
**New Patent "Feather Weight" Steel Leather Covered Case.**

Light, Durable, and made especially for Offset Guards.

Fine Leather Cover over Steel Frame, $18.00 gross.
The Strongest, Neatest Case made for Offset Guards. Will hold any glass with handle or without, and any height of Nose Guards.

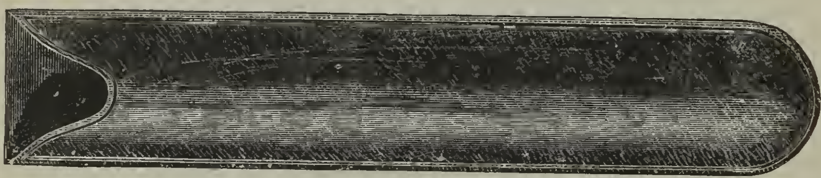


No. 321. OPEN.

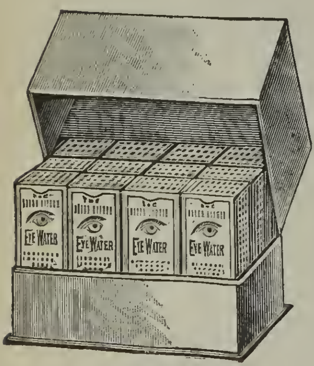


No. 288.

The Lightest, Strongest and Best Cases Made, Tempered Steel, Covered with Fine Grained Leather, both for Riding Bow and Straight Temple Specs, only $12.00 per Gross.



No. 290




THE GREAT

# GERMAN EYE WATER

**(From the Original Prescription by Dr. AGNEW.)**

Is the best known remedy for weak or inflamed Eyes, Granular or Scaly Eyelids, or any Inflammation caused by Overwork or Injury to the Eyes. Each bottle is put up in a box with a medicine dropper. Price **$2.00** per Doz., **$21.00** per Gross. Customers ordering 6 dozen or more can have the bottles labeled with their business card if desired, without extra charge.

## TEXT BOOKS.

| | |
|---|---|
| Tiffany, Anomalies of Refraction | $3.00 |
| Gould's Medical Dictionary, Dark Seal | 3.25 |
| Gould's " " Morocco, Thumb Index. | 4.25 |
| Hartridge on Refraction | 1.50 |
| Valk on Refraction | 2.40 |
| Hartridge, The Ophthalmoscope (just out) | 1.50 |
| Hansell and Bell, Diseases of the Eye | 1.75 |
| Opticians' Manual | 2.00 |
| Nettleship, Diseases of the Eye (Medical) | $2.50 |
| Bohnes' Hand-Book for Opticians, New and Enlarged Edition | 2.50 |
| Visual Defects and their Correction, by Dr. Stout (free to purchasers of our goods) | 1.00 |
| Hirschfeld, Anatomy and Physiology of the Eye and its Appendages, six handsome colored plates (worth $5.00). Fifty-four illustrations | 1.50 |

All the late Standard Medical Works furnished at publisher's lowest rates.

# GENERAL INFORMATION.
# SPENCER OPTICAL INSTITUTE.

Classes are formed the **first Tuesday** of each month, and **continue for two weeks.**

The lectures are arranged **in topics** and the system is so simple that they can be **readily understood** by any one who is not familiar with the science of Ocular Refraction. The **course is complete** with this school, and we can safely state that the method **is superior** to any other adopted by similar institutions.

Throughout the course **practical demonstrations** and quizzes are held, so that the students **become thoroughly proficient** in their work, as they learn to recognize the **error of Refraction** in each patient presented for treatment.

The **Audemair trial case** of test lenses is used in this school, as it is **the only test set** containing everything which a refractionist should have. The use of the **Audemair case** is taught early in the course, so that **sufficient practice** may be had in order to acquire that **degree of confidence** so necessary for success.

The **lectures are illustrated** by charts, papier maché and wax models.

The **tuition** for the course is $25. The $25 is **required on deposit.** The course is **free under certain conditions which may be** had on application.

**Classes are limited** to 15 members, and students are requested to fill out an **application blank** in order that a place may be secured.

A handsomely **engrossed diploma** will be furnished the qualified candidate.

**Board and lodging** can be obtained at very reasonable rates near the institution.

Address **all communications** to the

SPENCER OPTICAL MANUFACTURING COMPANY,
MANUFACTURING AND IMPORTING OPTICIANS,
15 Maiden Lane, New York, U. S. A.

---

# HINTS ON PRACTICAL OPTICS, AND DIRECTIONS FOR ORDERING PRESCRIPTION WORK.

**The media or material the opticians use in ocular refraction are known as lenses. They are made of the finest quality of glass, selected for hardness, transparency, brilliancy, and freedom from scratches and imperfections. In the adaption of correcting lenses it is an important part to have proper fitting lenses so adjusted that the full benefit is obtained.**

In order that we may be enabled to fill your prescriptions correctly, please observe the following rules :

1. Write your prescription distinctly on a separate piece of paper from your letter. Prescription books can be had for the mere asking in duplicating form, and are more convenient. You will find all description in detail printed on them, and by using this method you will be less liable to make mistakes or omissions, and if properly filled out, your record will also be complete for future reference. If errors should be made in filling a prescription, you can refer to your duplicate, and know at once whether you made it or the manufacturer.

2. Always state size of eye wanted. No. 1 is the standard size. Persons with broad and large faces require 0 and 00 size.

3. The optician should use good judgment and careful attention to the size of eye, the fit of the nose piece, and pupil distance. These points will enable him to give his patients becoming and comfortable glasses.

4. For fitting frames you will find it a good plan to have a set of trial frames No. 1 eye interchangeable, riding bow preferred, of the various heights and widths of noses, properly tagged and arranged so as try on by actual test. When the proper one is selected it will be necessary only to mention the number on tag, and state what material it is desired in. The number is a key to the pupil distance, height of nose, and other dimensions.

Eyeglasses are preferred by young people. These are made with various improvements that can be adjusted to suit all anatomical peculiarities.

5. In writing your prescription, be sure to give the required refraction for each eye. The following abbreviations are used: O. D., Ocular Dextra, or right eye, or R. E.; O. S., Ocular Sinistra, or left eye, or L. E.

6. It is well to adopt some system and adhere to it, either the dioptric or the inch ; the dioptric preferred. If you write your prescription in the dioptric system, be sure and use the decimal point in the right place, as misplacement or omission will cause error. Do not fail to put your plus (+) or minus (—) sign before every focal power. This is an error that many make. When you use the combination of spherical, cylinder and prism, let the sphere precede the cylinder, and the prism follow. Do not fail to mention axis of cylinder. This is very important. Prisms are numbered in degrees, and be sure to mention whether they should set base in or out, up or down.

7. If you wish tinted lenses, kindly state tint, whether ruby or pink, sapphire or blue, neutral or smoked. There are seven shades in these tints, from No. 1, the lightest, to No. 5, very dark. Kindly mention shade desired in ordering.

8. The pupilary distance is the distance between the center of lenses. To measure the pupil distance it is necessary to measure the length of one eye and nosepiece. The combined length is equal to the distance between the center of both lenses. Frequently prescription orders are sent with impossible proportions, such as 2 inch pupilary centers with No. 1 eye lenses. The length of No. 1 eye is 1½ inch scant. This would leave ½ inch for a nosepiece, while a ¾-inch spread is a very small nose indeed, so ½ inch would be useless when made. All presumed errors in measurements we take the liberty of using our judgment in correcting the same. If we were to comply with the exact dimensions, we would often make a frame that would be of no use and not wanted when made.

9. Bi-focal spectacles have been made for many years. The demand is continually increasing. The general form being simply to split the ordinary lens, the upper portion being adapted to the distant vision, to overcome the hypermetropia, and the lower portion having added to it sufficient refraction to overcome the presbyopic change of the eye, which is usually 2.50 dioptrics, to give vision for reading. These are called the Split Bi-focal; the distant vision is limited somewhat in the field compared with the Perfection or Cemented styles. The Cemented or Perfection give larger field and are more becoming and used almost exclusively by leading opticians.

10. The solid-ground bi-focal. This is the most defective of all forms, for the reason that the upper or distant portion of the lens necessarily is prismatic in its effect. There is no possible way of grinding these free from that error, and while, to the unskilled observer, they look better than other forms, the defect in them renders them very much inferior. Further, the vision is circumscribed, as the line of separation between the two powers must necessarily curve upward as it proceeds out from the center. We have very many inquiries for these, and orders for them, with the request that they shall be made with the curve the other way, and the calling attention to this paragraph will, we trust, be sufficient explanation to show our customers that it is impossible to comply with their request.