should be directed either to look vacantly before him or to regard some far distant object in order that his accommodation may be relaxed to the utmost, and the ophthalmoscopic signs of hypermetropia become apparent. If the spasm is at all severe, the patient is unable to distinguish distant objects without the aid of concave glasses, and it is only after the oft-repeated application of a strong solution of atropine (gr. iv to ℥j of water) that the ciliary muscle becomes paralysed and the hypermetropia apparent. The atropine may have to be repeated two or three times daily for several days, or even longer, before this effect is gained. The paralysis should be maintained for some weeks by the instillation of atropine two or three times a week. Afterwards, the proper convex glasses should be prescribed for reading, sewing, etc., and, if necessary, also for distance.

CHAPTER X.

SPECTACLES, ETC.

THE spectacles which are generally used for the purpose of correcting some optical defect in the eye are either spherical or cylindrical lenses, or a combination of both. The properties of such lenses have been already sufficiently explained, (p. 4), and I shall therefore now only add a few remarks as to the different kinds of spectacles and their construction.

From the perusal of the different anomalies of refraction and accommodation, the reader will have been sufficiently impressed with the importance of the proper and scientific selection of spectacles. I have already (p. 3) insisted upon the necessity of the surgeon himself determining the number of the glass which the patient is to wear, and not entrusting this to the optician, to whom, however, written directions should be sent as to the strength of the required lenses, etc. The surgeon should, therefore, possess a box of trial lenses, such as are made by Paetz and Flohr, of Berlin, and which

are kept in stock by several of the London opticians. These trial cases contain complete sets of concave and convex lenses, prismatic glasses, tinted glasses, and a clip spectacle frame for holding the lenses. These lenses are defined in the Prussian inches, which are almost identical with the English; whereas the French are somewhat greater. As the arrangement of the lenses in these trial cases is, however, made without any principle, so that whilst there are very many and but slight gradations in the weaker glasses, those in the stronger are not sufficiently numerous, the difference in the refraction of the higher numbers is very great. Thus, whilst the difference in the refraction between convex 60 and 50 is only $\frac{1}{300}$, that between $3\frac{1}{4}$ and 3 is $\frac{1}{39}$. To remedy these defects, as well as to simplify the trial cases, and greatly diminish the number of lenses, Zehender has proposed a new combination scale of glasses (vide "Klin. Monatsbl.," 1866). As a member of the International Refraction Committee, appointed by the Ophthalmological Congress in 1867, I may mention here that it is very probable that the mètre measure will be substituted for that of inches in the determination of the strength of lenses, in order that their number may be the same in all countries.

The strength of any given convex lens may be

easily ascertained by finding the distance at which the image of a distant object (a candle, the bars of a window frame, etc.), is distinctly formed on a sheet of white paper or the wall. The distance of this distinct image from the lens gives the focal length of the latter. But if we have a set of trial glasses at hand, a more simple and ready mode is to find the concave lens which completely neutralizes the convex one, and this at once gives us the number of the latter.

The complete neutralization of the convex lens by the concave is known by the fact that if the two are placed in close apposition, we can read as well through them as without any glass before the eye. Another test is, that if we regard a vertical line (*e.g.*, the vertical bar of a window) through them, it remains perfectly immovable when the glasses are moved to and fro before the eye. Whereas the line will distinctly move if the two glasses do not neutralize one another, the more so, the greater the difference between them. If the object moves in the contrary direction to that in which the lenses are moved, it proves that the convex lens is the stronger of the two; whereas, if it moves in the same direction, the concave is the stronger. The strength of concave lenses may be tried in the same way.

Care should be taken that the spectacles fit accurately, that the glasses are on the same level, so that one is not higher than the other ; that they are sufficiently close to the eyes, and that the centre of each glass is exactly opposite the centre of the pupil. The last point should be particularly observed in the selection of glasses which fit on to the nose by means of a spring (pince-nez) for we find that on account of their oval shape these are not generally centred. If they do not fit properly, so that their centre corresponds to the centre of the pupil, they act as prisms, and give rise to diplopia or a correcting squint, and the latter may even become permanent if their use is persisted in. Concave glasses should be quite close to the eye, otherwise they will diminish the size and distinctness of the retinal image. As the rays which impinge upon a concave lens are rendered divergent by it, it follows that the further the glass is removed from the eye, the fewer peripheral rays will enter the latter, in consequence of which the retinal image is diminished in size and intensity.* The

* It has already been stated that concave glasses diminish the retinal image by moving the nodal point further back, and thus diminishing the angle of vision, whereas convex glasses enlarge the retinal image as they move the nodal point forwards, and thus increase the size of the angle of vision. In very high degrees of myopia, I have found Steinheil's solid

reverse obtains in the case of convex glasses, for as they render the rays which impinge upon them more convergent, a greater number of peripheral rays will enter, the further (up to a certain point, of course) the convex glass is removed from it, the retinal image becoming at the same time larger and brighter.

Single eye-glasses should not be permitted as a rule, as they often lead to weakness of the other eye from disuse.

Besides the spherical and cylindrical spectacles we must also consider the following kinds :—

The *periscopic* glasses consist of concavo-convex and convexo-concave lenses (so called positive and negative menisci), and consequently have only a very slight spherical aberration. On this account, when the concave surface is turned towards the eye, there is less irregular refraction at the edge of the glass, so that the regularity of the images is much less impaired. In consequence of this, the observer can look more obliquely through them, as was first shown by Wollaston, who on this account

glass cone very useful for distant objects, as it acts like a Galilean telescope. It consists of a small cone of solid glass, the base of which is convex, and the opposite surface concave, with a smaller radius than the concave. It is about one inch in length, and can be readily carried in the waistcoat pocket. It may be obtained of Messrs. Salom, 137, Regent-street.

termed them periscopic. Their chief disadvantages are that they reflect the light more, and are also more heavy and expensive than spherical lenses.

Spectacle glasses are sometimes required to have a different focus in the upper and lower part (*pantoscopic spectacles*). This is more especially the case if presbyopia co-exists with myopia or hypermetropia. Thus Franklin, who was presbyopic and also slightly myopic, employed glasses, the lower halves of which were convex, to neutralize the presbyopia, and the upper halves concave, to neutralize the myopia. In Paris such glasses are termed *verres à double foyer*, and are constructed by grinding in the upper part of the spectacle-glass, the surface which is turned from the eye, with another radius. Such spectacles must be placed at a proper height before the eyes, so that in looking at near objects the rays only fall upon the eye through the lower part, whereas, those from distant objects must only fall upon the upper part. This form of spectacle is found very useful by miniature painters, lecturers, etc.

Prismatic spectacles are sometimes employed either for the purpose of exercising and thus strengthening certain of the muscles of the eyeball, or to relieve them. The actions of prisms and the uses of prismatic spectacles in the affections of the muscles of the eye, are fully explained in the chapter on muscular asthenopia. The prisms are generally turned with their base inwards (to relieve the internal recti muscles), and may either be used alone or in combination with convex or concave lenses. In the latter case, they are ground in such a manner as to combine the effect of a prism with that of a spherical lens. By turning the base of the prism inwards, the rays will be deflected somewhat to the inner side of the yellow spot, the eye will consequently move slightly outwards, so as to bring the rays again upon the yellow spot; there will consequently be a less convergence of the optic axes, the effect being the same as if the object were placed somewhat further off, but it is seen under the same visual angle, and the divergence of the rays is also the same.

Closely allied to the prismatic glasses, are the decentred lenses of Giraud-Teulon. They are constructed in such a manner, that the eccentric portions of two convex lenses are used instead of the centre, so that they may thus acquire a slightly prismatic action. Thus in convex lenses the centre should lie a little to the inner side of the visual lines, whereas in concave glasses the reverse obtains, and the centre should lie a little to the outer side of the visual lines.

Dr. Scheffler proposes to substitute for the common spherical lenses glasses which are cut out from the periphery of a large lens, and in such a manner as to act as decentred lenses; he calls them "orthoscopic" spectacles. The advantage which he claims for them is, that with them the convergence of the optic axes undergoes an alteration in harmony with the change in the accommodation, which is not the case when the common spherical lenses are used. His work "Die Theorie der Augenfehler und der Brille," in which this subject is fully treated, is being translated into English by Mr. R. B. Carter.

I have already mentioned (p. 113) that eye-protectors are found of much service to guard the eye against very bright light, dust, or cold winds. The best are the medium blue curved eye-protectors. Goggles are only indicated if the patient is exposed to the atmosphere very soon after a severe operation, when the eye is still inflamed and very susceptible to cold, but for all other purposes the curved glasses are to be preferred. Messrs. Salom have lately introduced an excellent modification of the goggle, by adding thin gauze side pieces to the curved blue eye-protectors, which renders them quite as efficient as the goggles, and much lighter, as well as less unsightly and conspicuous.

The sense of dazzling of which many (more especially myopic) patients complain when they are exposed to bright light, is most effectually relieved by blue glasses. I have already stated that it was formerly supposed that the red rays of the solar spectrum were the most trying to the eye, and consequently green glasses (which exclude the red rays) were much in vogue. But it is now a well known fact that it is not the red, but the orange, rays which are irritating to the retina, and as blue excludes the orange rays, this is the proper colour for such spectacles. Moreover, the blue colour, on account of its more eccentric position in the solar spectrum, makes a less impression upon the retina. Smoke-glasses are not so good, as they more or less subdue and diminish the whole volume of light and colour, and thus render the image somewhat indistinct.

It is often very desirable to combine the blue tint with the use of convex or concave spherical lenses; in the weaker glasses this can be very effectually done; but in the higher numbers it is difficult, for the varying thickness of the glass causes a considerable difference in the tint in the centre and at the edges of the lens. In such cases it will be well to adopt Mr. Laurence's suggestion, viz, to join a very thin piece of plain tinted glass

with Canada balsam, to the back of a plane concave lens.

Besides the coloured eye-protectors which are used in order to diminish the bright glare of light, or to keep off the cold wind, dust, etc., there are those which are used by workmen in order to protect the eye during their work against injury from pieces of stone, chips of steel, etc. The best are those made of thick plate glass, with wire or gauze sides, for they are sufficiently strong to resist the force of any, excepting a very large projectile. The chief objections to these are their expense and their weight. To obviate these defects, Dr. Cohn* has recommended the use of spectacles made of mica instead of glass. If the mica is of good quality, it is quite as transparent as glass, but lends a faint grey tint to objects, which does not, however, in the least diminish the acuteness of vision, but rather tempers the light. They are made in the shape of the large curved eye-protectors, and should fit quite close to the eye, leaving only the temporal side somewhat open. They are much lighter and cheaper than the glass spectacles, and do not break on falling down.

* Berliner Klinische Wochenschrift, Feb. 24, 1868.

DIFFERENCES IN THE REFRACTION OF THE TWO EYES.

Differences in the refraction of the two eyes are not of unfrequent occurrence, and generally consist in differences in the degree of the myopia or hypermetropia in the two eyes; or, again, one eye may be emmetropic, the other myopic or hypermetropic; or myopia may exist in one eye, and hypermetropia in the other. Absence of the lens (aphakia) in one eye, gives rise, of course, to a very great difference in the state of refraction of the two eyes. In the majority of cases, the refraction of the two eyes is very nearly alike. Sometimes, however, we find considerable differences in the degree of myopia or hypermetropia. The practical question is, what kind of glasses are we to give to such patients? It might appear proper to furnish each eye with the glass suitable to its own state of refraction, but in practice we find that this does not generally answer, for the patients, as a rule, complain that such spectacles render their vision confused and indistinct, on account of the difference in the size of the two retinal images. It is best, therefore, to furnish both eyes with the glass which suits the least ametropic (hypermetropic or myopic) eye. If it is very desirable that the patient

should enjoy the greatest possible acuteness of vision, we may give two different glasses, so as completely to neutralize the difference in the state of refraction, and the patient must try whether he is able to see distinctly and comfortably with them. Sometimes a little practice will enable him to do so, and then their use may be allowed. If this is not the case, we may partially neutralize the difference, and thus diminish the size of the circles of diffusion. Thus if the myopia of the one eye $= \frac{1}{14}$, and of the other $\frac{1}{6}$, we may prescribe concave 15 for the former, and concave 9 or 10 for the latter. It has also been advised that when the sight of the two eyes (which differ considerably in the degree of their myopia) is equally good, the glass which lies midway between the two degrees of myopia should be given for both eyes. If, for instance, the one eye requires concave 4 and the other concave 8, it would be advisable to prescribe concave 6 for both eyes. But such glasses prove unsuitable, as they suit neither eye, being too strong for the one, and too weak for the other.

If there is a difference in the refraction of the two eyes—the one being myopic, the other hypermetropic—it is also often difficult to suit them with glasses which shall neutralize each anomaly. This is owing to the difference in the size of the

retinal images which will be produced, for the convex lens will enlarge, the concave lens diminish the size of the retinal image, and this may prove a source of considerable confusion. In all cases of difference in the refraction of the two eyes, the patients should try the glasses for some little time, so as, if possible, to become accustomed to them, before we decide definitely as to the kind of glasses which we shall prescribe.