the patient made an effort of respiration; in an hour and forty minutes the respiration was five per minute, though stertorous. In nine hours consciousness returned, and recovery followed.

If the case be at all prolonged, distention of the bladder and possibility of reabsorption are to be prevented by the use of the catheter. If this be done in a case in which there is the faintest possibility of litigation, the urine so removed should be carefully preserved.

Little can be said in favor of the different drugs that have been used as so-called physiological antidotes. Atropin, which is so frequently administered as an antidote to opium poisoning, unquestionably dilates the pupils, but has little, if any, effect upon the respiration. Cases are recorded in which, although atropin has been given until the pupils were widely dilated, the respiration has ceased, and the patient has subsequently recovered by means of artificial respiration (see paper of Dr. Cheatham, quoted above).

Tinctura belladonnæ, strong infusion of coffee by the stomach or subcutaneously, extract of coffee, caffein, brandy, digitalin, chloral hydrate, veratrum viride, and jaborandi have been used as antidotes. The last named, or pilocarpin, may be of value to increase the elimination, and thus lessen the duration of the poisoning.

Post-Mortem Appearances.—The autopsy reveals no lesions which are characteristic of opium poisoning, except, possibly, the odor of the drug. Obviously, if morphin have been the substance taken, or if other more powerfully odorous substances be present, this will not be observed. The surface of the body is livid. Rigor mortis is said to be of shorter duration than usual, although an autopsy is reported by Tardieu at which rigor mortis was well marked sixty-two hours after death. Putrefaction is said to be more rapid than usual. The blood is fluid and dark. The vessels of the brain and meninges are gorged with blood, and the cut surfaces of the brain substance present numerous dark red spots. The veins of the scalp are also filled with blood. Serous effusions are frequently met with between the membranes, more rarely in the ventricles. The lungs are usually congested. The stomach and other viscera are normal, so far as the action of the poison is concerned. The bladder is generally full of urine.

The congestion of the cerebral vessels and of the lungs are the most noteworthy appearances. Yet, as they may be absent in opium poisoning, and may be present when death has resulted from other causes, they are only of value as confirmatory evidence of the cause of death.

Analysis.—To detect the presence of morphin in the viscera after death, or in articles of food, it is necessary to separate that alkaloid in a condition of as near purity as possible. In cases of opium poisoning it is further necessary to search for meconic acid, and, if possible, for other of the opium alkaloids.

If the facts of the case do not point very distinctly to opium or morphin as the poisonous agent, the process of Dragendorff should be followed for the separation of the alkaloids (Dragendorff, "Ermittl. v. Giften," 4 Aufl., 1895, 149–153).

If the indications of opium or morphin poisoning be sufficiently direct, the following simplified method for the separation of morphin and of meconic acid may be followed. The substances, if solid, are finely hashed and extracted several times with water containing one per cent. of hydrochloric acid at the ordinary temperature (if the materials be alkaline, the proportion of acid is to be increased to such an extent that the liquid, when in contact with it, retains its acid reaction). The aqueous extracts are filtered and shaken with amyl alcohol three or four times, and oftener if necessary, until the amylic alcohol is no longer colored, and the alcoholic layers separated. If the substances under examination be liquid, they are to be rendered acid with hydrochloric acid, filtered, and the filtrate treated with amyl alcohol. The amylic solution now contains meconic acid, if present in the objects examined; and the watery solution, the alkaloids as chlorids. To separate meconic acid, the amylalcohol solution is shaken with successive portions of water, which are separated, until the water is no longer colored. The alcohol is evaporated over the water-bath; the residue extracted with hot water; the solution filtered hot; the water evaporated over the water-bath; the residue extracted with alcohol; the solution filtered, and the alcohol evaporated. The tests for meconic acid are finally applied to a portion of the last residue. During this treatment a small portion of the meconic acid is converted into comenic acid, which does not, however, interfere with the tests.

To separate morphin from the aqueous liquid above mentioned, the hydrochloric acid is neutralized completely with ammonia, and the liquid rendered distinctly acid with acetic acid, and evaporated over the water-bath to the consistency of a syrup. The residue is extracted with four or five volumes of ninety-per-cent. alcohol and filtered. The filtrate is freed from alcohol by distillation. The residue, diluted with a small quantity of water, if thick, is heated to 50° to 60° C., an equal volume of amyl alcohol* is added and then sufficient ammonium-hydroxid solution to render the solution distinctly alkaline. The mixture is next strongly shaken at intervals for half an hour, the amylic alcohol separated, and the extraction of the aqueous liquid with amylic alcohol repeated three times. The united amylic solutions are evaporated to dryness; the residue is extracted several times with warm (not hot) water slightly acidulated with sulfuric acid, and the solution filtered. Upon the acid filtrate is floated a mixture of ten parts absolute ether and one part (ninety-five-per-cent.) alcohol; ammonium-hydroxid solution is added to alkaline reaction, and the whole strongly agitated. The ether-alcohol layer is separated; the extraction of the, now alkaline, aqueous liquid is similarly repeated several times, and the ether-alcohol evaporated in a number of small watch glasses. To portions of the residue so obtained, either dry or dissolved in a few drops of water, as the nature of the test may require, and now sufficiently freed from coloring and other foreign substances, the tests for morphin are to be applied.

Tests.—I. *Morphin.* 1. With the general reagents for the alkaloids, the morphium salts give reactions as follows, the fractions indicating the maximum of dilution in which the alkaloid is capable of reacting: With *phosphomolybdic acid*, yellowish, amorphous precipitate, $\frac{1}{5000}$; with *iodin in potassium-iodid solution*, red-brown, amorphous precipitate, $\frac{1}{5000}$; with *potassium and bismuth iodid*, amorphous precipitate, subsequently changing to silky needles, $\frac{1}{5000}$; with *auric chlorid*, lemon-yellow precipitate, becoming darker; with *phosphotungstic acid*, flocculent precipitate, $\frac{1}{1000}$; with *potassium iodhydrargyrate*, yellowish, amorphous precipitate, $\frac{1}{1000}$; with *platinic chlorid*, slowly, yellow, crystalline precipitate, $\frac{1}{100}$; with *picric acid*, bright yellow, amorphous precipitate, $\frac{1}{100}$; and with *tannic acid*, a faint cloudiness, becoming somewhat thicker on standing. For the above tests the solutions of the alkaloidal residue are to be made with very dilute sulfuric acid, and the reagents should be as nearly neutral as their natures will permit.

2. Morphin dissolves in concentrated nitric acid with an orange-red color, which gradually changes to yellow. Addition of stannous chlorid solution does not change the color of the yellow solution to violet, as it does with the similar color obtained with brucin. Limit, 0.01 mgm.

3. Morphin dissolves in concentrated sulfuric acid, forming a colorless solution. If this solution be heated over the water-bath for an hour, and allowed to cool, or, preferably, if it be allowed to stand in a desiccator twenty-four hours, and then treated with a trace of nitric acid or a minute granule of saltpetre, a beautiful violet color is produced, which soon changes to purple-red, and then gradually fades. Limit, 0.001 mgm. (A. Husemann).

A further portion of the sulfuric-acid solution, if

* It is absolutely essential that the amylic alcohol used should be purified, *shortly before use*, by repeated redistillation, until a portion, on evaporation, yields no residue capable of reducing iodic acid.

treated, after warming and subsequent cooling as above, with a small fragment of potassium dichromate, assumes a mahogany-brown color (J. Otto).

4. A fragment of solid morphin moistened with a solution of ferric chlorid, as neutral as possible (best obtained by dissolving the chlorid obtained by the dry method in water), assumes a brilliant blue color.

For the success of this test it is essential that the morphin salt be as free from impurities as possible, that little or no free acid be present, and that but a small quantity of the reagent be used. The color gradually changes to green and brown (Robiquet). Limit, 0.1 mgm.

5. A fragment of morphin moistened with Fröhde's reagent (a freshly prepared and colorless solution of 5 mgm. sodium or ammonium molybdate in 1 c.c. sulfuric acid) colors the reagent violet in a short time. The color changes to blue, and then to dirty green, and, finally, to faint reddish. Addition of water discharges the color instantly. Limit, 0.005 mgm.

6. Dissolve a small quantity of iodic acid in a few drops of water, in a small test tube, and agitate with a few drops of chloroform; the latter must remain colorless. Add the solution to be tested, and again agitate. The chloroform, which settles to the bottom, has a violet color, in the presence of morphin, while the aqueous layer is yellowish. Now float upon the surface of the liquid dilute ammonium hydroxid, with as little mixing of the liquids as possible: a brown band is formed at the junction of the ammoniacal and aqueous liquids (Serullas, Duflos, Lefort). Limits: For the violet color of the chloroform, $\frac{1}{7000}$; for the dark band with ammonium hydrate, $\frac{1}{10000}$.

This reaction is also produced by reducing agents other than morphin.

7. Dissolve the solid in warm, concentrated hydrochloric acid containing a little concentrated sulfuric acid, and heat in an air oven at 110° to 120° C. In the presence of morphin a purple color is produced, still visible in the presence of the accompanying carbonized matter. After evaporation of the hydrochloric acid, a further quantity of the dilute acid is added, and the mixture neutralized with sodium bicarbonate in slight excess; a cherry red color is produced, which changes to a dirty-greenish hue as the point of neutrality is reached. On addition of a few drops of a dilute alcoholic solution of iodin, the color changes to green, and the pigmentary substance now dissolves in ether with a purple color (Pellagri).

The reaction is due to the formation of apomorphin, and is consequently also observed with codein.

Many other tests for morphin are in use; the above are, however, sufficient. No one of them is in itself characteristic.

II. *Narcotin.* The reactions of the alkaloids of opium other than morphin are at present of but little toxicological interest, as they are substances which are not commonly met with, and hence are unlikely to cause poisoning. For the purpose, however, of distinguishing between morphin and opium poisoning by analysis (a distinction which may be of medico-legal importance), the reactions of narcotin and of meconic acid (see below) are taken advantage of. Narcotin is chosen from among the other opium alkaloids for this purpose, partly because it is more abundant in opium, and partly because of the sharpness of its reaction with sulfuric acid.

If the Dragendorff method have been followed, narcotin should be searched for in the residue of evaporation of benzene from the alkaline solution.

1. Of the general reagents for the alkaloids, phosphomolybdic acid, potassium iodhydrargyrate, iodin in potassium iodid, and picric acid give precipitates in solutions of $\frac{1}{100}$ to $\frac{1}{500}$.

2. Moistened with concentrated sulfuric acid at the ordinary temperature, narcotin produces an intensely yellow solution, which, on gradual heating, changes to orange, then, beginning at the borders, blue-violet, and, when the heat has been raised to the point of volatilizing of the acid, dark red. The colors are presented more slowly, but more purely, by dissolving the residue in dilute sulfuric acid and evaporating quite slowly (Couerbe, Husemann). Limits: $\frac{1}{2000}$, very evident; $\frac{1}{10000}$, faint carmine only.

3. Dissolve in concentrated sulfuric acid, let stand an hour, and add a trace of nitric acid; a red color, which for some time increases in intensity.

III. *Meconic Acid.* 1. Crystallizes in white, glistening prisms, either single and large, or small and arranged in bundles, which at 100° C. lose their water of crystallization and become opaque. If heat have been applied to the solution in the presence of acids, the shorter, prismatic crystals of comenic acid will be also observed.

2. Meconic acid, or a meconate in solution, gives white or yellowish precipitates with lead acetate, silver nitrate, mercurous nitrate, and mercuric nitrate.

3. The characteristic reaction of meconic acid is the formation of an intense red color when the acid or one of its salts is moistened with a solution of ferric chlorid (Sertürner). The color does not disappear either on warming or on the addition of hydrochloric acid, or of auric chlorid, or of mercuric chlorid.

Comenic acid gives the same reaction. It can only be present as a product of decomposition of meconic acid. Acetic and thiocyanic acids and their salts also give a red color with ferric chlorid. The former may be present as a normal food constituent, and the latter is present in the saliva in quantity sufficient to give the reaction without any preliminary purification. The red color, however, produced by acetic acid is discharged by heat or by the addition of hydrochloric acid, and that due to the thiocyanate disappears instantly on addition of auric chlorid or of mercuric chlorid solution.

Failure of Detection.—As morphin is oxidized to oxydimorphin in the body, more or less completely according to the magnitude of the dose, it is usually eliminated in cases of poisoning as a mixture of oxydimorphin and morphin, both of which respond to the reactions given above. This elimination is principally by the alimentary canal and only in traces by the urine, whatever may have been the channel of introduction. Therefore the stomach and intestinal contents, or the product of stomach lavage, are the situations in which the poison will most probably be detected, and we may expect to find it in the urine only when very large doses have been taken. It has also been detected in the liver and kidneys in several instances, but very rarely in the brain. The detection of morphin is by no means certain, and carefully conducted analysis may fail to show its presence in the cadaver after undoubted poisoning by it, even when the stomach has not been washed out and vomiting has not occurred.

Although morphin is more subject to decomposition than strychnin, it still withstands the influence of putrefaction quite well. In a case cited by Woodman and Tidy it was detected four months after death; and Stas gives an account of a case in which he detected morphin in all the organs of a body after thirteen months of burial.

In cases of long burial, caution is required that ptomaïns be not mistaken for morphin, as occurred in an Italian case, in which Selmi showed that what a careless analyst had taken for morphin was in reality a ptomaïn (Selmi, "Sulle Ptomaïne," 1878). Such a mistake is impossible, if the tests described above are carefully applied (see Witthaus and Becker, "Med. Jur.," iv., 760–769).

Rudolph A. Witthaus.

OPTIC NERVE. See *Eye.*

OPTOMETRY—from ὀπτ-, root of ὄψομαι, fut. of ὁράω, to see, and μέτρον, measure—signified, in its older use, the measurement of the range of vision (*die Gesichtsweite*). With the attainment of broader and more accurate knowledge of the physiology and pathology of vision, quantitative methods have been applied to the investigation of other visual functions, and we now recognize, as parts of one general subject, the measurement

(1) of the acuteness of the visual perception of form (eidoptometry),[1] (2) of the perception of light (photoptometry),[1] (3) of the perception of colors (chromatoptometry),[1] (4) of the extent and limitations of the visual field (perioptometry),[1] (5) of the accommodative and refractive states of the eye (dioptometry),[1] and (6) of the position and movements of the eyeballs (ophthalmostatometry and ophthalmotropometry).[1]

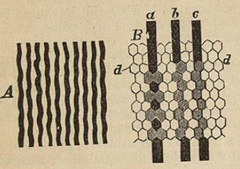


FIG. 3691.

Eidoptometry—from εἶδος, form—deals with the measurement of the acuteness of the visual perception of form—*visus*, V.; German, *Sehschärfe*, S. Assuming an adequate illumination and a sharply defined retinal image, the physiological limit of the acuteness of vision is determined by the fineness of the mosaic formed by the cones of the retina at the fovea centralis. Let *d d* (Fig. 3691, *B*, from Helmholtz) represent the mosaic of retinal cones at the macula, and *a*, *b* and *c* the images of three vertical bars of a grating for which the eye is accurately accommodated. When the grating is removed to such a distance from the eye that the image of each bar does not much exceed the diameter of one of the retinal cones the several images appear more or less distorted or beaded, according as they happen to fall upon one or another, or perhaps upon two, of the cones lying nearest to their tracks. With the bars and interspaces of the grating each of a width of 0.4167 mm., the appearance shown at *A* begins to be manifest when the grating is removed to a distance of 1.1 to 1.2 metres (Helmholtz). This corresponds to a width of about 0.005 mm. in the retinal image for each bar of the grating, and to a visual angle of about 1.2′; it also indicates a very close approximation of the width of the image to the diameter of the retinal cones at the macula (0.0045 to 0.0054 mm.). Observations on the smallest angular distance at which two fixed stars of lesser magnitude (Hooke) or the bars of a grating (Helmholtz) can be positively distinguished by the naked eye, point also to an angle of about 1′ as the normal limit of distinct retinal perception.

The first serious attempt to apply a system of exact measurement to the clinical determination of the acuteness of vision was made by E. Jaeger. Jaeger's *Strichscale*[2] consists of a series of lines diminishing in length and in width from No. 1, with a width of 0.4597 Vienna inch, to No. 80, with a width of 0.0037 inch; the measure of the acuteness of visual perception is the narrowest line which can be positively distinguished at the distance at which the observation is made. Thus a normally acute eye sees No. 5 at 100 feet; No. 30 at 20 feet; No. 80 at 1 foot, etc. Unfortunately, the ratio of gradation adopted by Jaeger is such that the numbers do not indicate the relation of individual measurements to the normal. Moreover, the determination turns entirely on the unchecked statement of the person examined, that he sees the lines down to a certain place in the scale. The results of numerous and characteristically careful measurements made by Jaeger with this scale point to a visual angle of about 1′ as the limit of distinct recognition of the individual lines by a normal eye.

Snellen[3] was the first to work out a system of measurement adequate to the needs of the ophthalmic practitioner. Assuming a visual angle of 1′ as the average limit of distinct vision in the normal eye, Snellen constructed, upon this basis, a number of capital letters of sizes corresponding to seventeen different distances, ranging from 200 Paris feet (No. CC.) to 1 foot (No. I.). Each square letter, viewed from its appropriate distance, subtends a visual angle of 5′, and each letter is made up of lines subtending each an angle of 1′. The ultimate elements from which the several square letters are constructed are small squares, each subtending an angle of 1′; and twenty-five of these smaller squares are equal in area to the larger square in which the letter is inscribed. Only such letters are used as can be drawn approximately within the compass of a square, and even of these scarcely any two are of absolutely equal legibility; still, the difference is not so great as to impair the practical usefulness of the method, and the recognition of only a part of the letters in any line affords the means of making a finer discrimination than if only the more easily recognizable letters of the alphabet were used. Furthermore, certain of the letters often appear under characteristically modified forms when viewed by an astigmatic eye; D sometimes looking like B, O like the numeral 8 or like S, H like N, V like W, etc. The test of perfect recognition of form is the correct naming of all the letters at the distance corresponding to the number. Representing the greatest distance at which all the letters in any given line are recognized by *d*, and the greatest distance at which the same letters are seen by a normally acute eye by D, the measure of the acuteness of vision in any particular case is expressed in the fractional form $\frac{d}{D}$. The adoption of this simple and very convenient system was immediate and general; it remains the only method suited to the daily requirements of the practitioner.

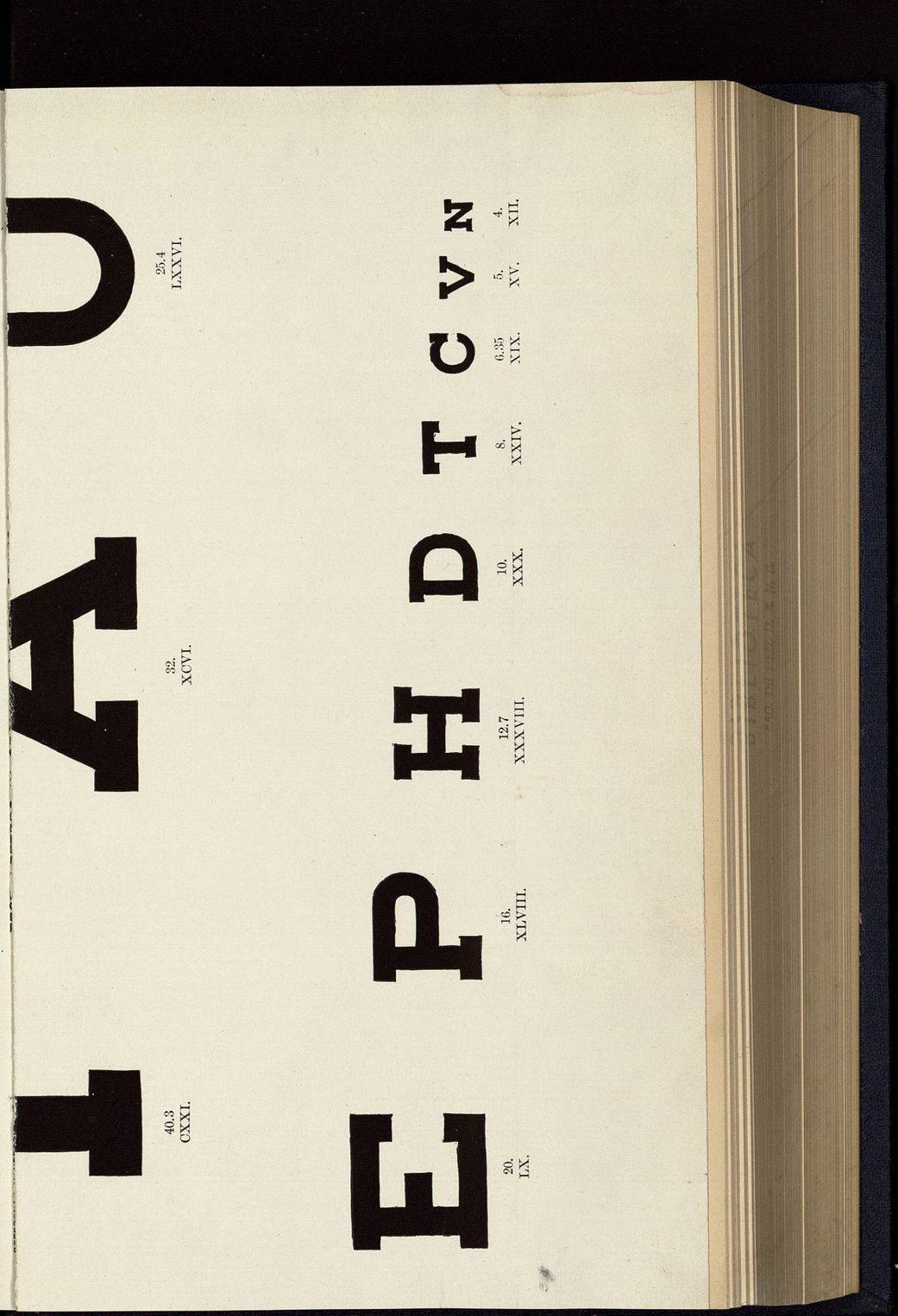
The system of Snellen admits of but little further development; simple geometrical figures[3] and representations of familiar objects of characteristic outlines[4] are of use in examining children or illiterate persons. The substitution of a scale based on distances taken in metres instead of in Paris feet was made by Snellen in 1875.[5] The simpler form of letters known to printers and sign painters by the inappropriate name of "Gothic"[6] has been tried instead of the "block-letter" used by Snellen, and a regular ratio of gradation in geometrical progression[7] has been employed in the place of his somewhat arbitrarily selected series of numbers* (see Plate XLVIII.); a notation expressed in tenths of the normal, and therefore capable of being expressed in decimal form,[8] has also been somewhat extensively used.

For testing the perception of form at short distances, printed texts are in general use; such texts were first published by Jaeger[9] in a great number of different languages and in various kinds of type. Jaeger's smallest type (No. 1, ="gem" or "brilliant"), read fluently at a distance of one foot, is a pretty severe test of normally acute vision conjoined with good power of accommodation for the reading distance. Jaeger's numbers have no definite significance, beyond the fact that the higher numbers indicate the larger sizes of letters; still it is more convenient to employ even an arbitrary standard than to use the somewhat uncertain nomenclature of the type-founders.

Photoptometry—from φῶς, light—is comparatively little employed in the ordinary routine of ophthalmic practice, yet it is not without positive value in the diagnosis of impaired function of the retina. Two principal types of photoptometers have been used, each of which has its special applications.

A rapidly rotating disc, upon which a smaller or larger sector (Masson),[10] or a row of short lines arranged along a radius (Donders),[11] is depicted in black upon a white ground, or in white upon a black ground, presents the appearance of a shaded surface, or of a number of concentric shaded rings diminishing in intensity toward the periphery of the disc. Whenever the width of the black line is less than $\frac{1}{117}$ of the circumference of an imaginary

* The card of test-letters shown in Plate XLVIII. is constructed on the basis of a constant ratio of gradation, $\sqrt[3]{2} = 1.26$; the Arabic and Roman numerals denote, respectively, the distances in metres and in feet at which the letters should be distinguished by a normal eye. For convenience, the foot has been taken as equal to one-third metre, which is a little more than the Paris foot. In the arrangement here reproduced only a single letter is given for each number of the scale. The construction of the individual letters is slightly altered from that adopted by Snellen, with a view to somewhat more uniform legibility of the different letters.



TEST-LETTERS IN GEOMETRICAL PROGRESSION

Based on the common ratio: $\sqrt[3]{2.} = 1.25992$

J. GREEN *inv.* — 1867, 1872, 1876, 1887, 1903

F H

64.
CXCII.

50.8
CLII.

T A U

40.3
CXXI.

32.
XCVI.

25.4
LXXVI.

E P H D T C V N

20.
LX.

16.
XLVIII.

12.7
XXXVIII.

10.
XXX.

8.
XXIV.

6.35
XIX.

5.
XV.

4.
XII.

circle drawn through it, the shaded ring is ordinarily so faint as to be no longer perceived by a normal eye in average daylight within doors (Helmholtz).[12] The acuteness of light perception, in any particular case, is indicated by the number of the concentric rings seen when the disc is rapidly rotated.

The photoptometer (*Lichtsinnmesser*) of Förster[13] is a closed box one foot long, eight inches wide, and six inches high; at one end are two openings for the eyes, and a window, about two inches square, covered with translucent white paper. Behind this paper diaphragm is a small lantern, enclosing a candle of standard illuminating power. The quantity of light which enters the box is determined by the area of the paper diaphragm, and this is regulated by means of two notched plates of metal sliding over each other so as always to leave a square opening whose area may be read off from a graduated scale. At the opposite end of the box is placed the test object, a card showing alternate black and white stripes of from 1 to 2 cm. in width. The measure of the acuteness of the perception of light (L) is the quotient of h, the smallest area of the window required for the recognition of the stripes by a normal eye, divided by H, the smallest area which suffices for the recognition of the same stripes by the eye under examination. According to Förster's observations, made with an instrument of the construction just described, $h = 2$ sq.mm., giving the value, $L = \frac{2}{H} = \frac{1}{\frac{1}{2}H}$.

Chromatoptometry—from χρῶμα, color—as applied to the diagnosis of defective color perception, has been discussed under the title *Color Perception*, Vol. III., pp. 208–217. Approximate measurements of the acuteness of color perception may be made with Snellen's test letters, printed in vivid colors on a black ground; or similar white letters on a black ground may be strongly illuminated by colored light.

The principle of simultaneous contrast may be utilized as a qualitative test of color perception. Thus the shadow cast by any small opaque object upon a white ground appears of a color complementary to that of the light. The test may be made in the dark room appropriated to ophthalmoscopical examinations, by placing a sheet of colored glass in front of the lamp and directing the attention of the patient to the color of the shadow cast by a pencil, or by a small opaque card, upon a white screen.

Perioptometry—from περί, around—is properly the measurement of the limits of the visual field in its several dimensions; it includes also the detection and measurement of defects in the field of vision (scotomata), wherever they may be situated. The simplest, and for many purposes the best, method of testing the central portions of the field, up to a distance of about 45° from the point of fixation, is by means of a blackboard or a large sheet either of dark or of white paper, upon which a central point of fixation is marked by a small cross, +. The patient is placed at a measured distance from the board (usually one foot), and is directed to look with one eye (the other being covered) at the central cross. A bit of chalk or crayon, fixed to the end of a short wand of the same color as the board or paper, is then moved from the periphery toward the centre of the field, until it reaches a point at which it is seen by the patient. The observation is repeated for other ocular meridians in succession, until the boundaries of the field have been determined at a number of points sufficient to admit of drawing a continuous outline through them.[14]

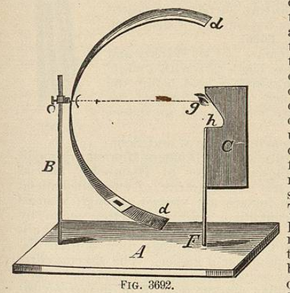


FIG. 3692.

For mapping the periphery of the field, when of nearly normal extent, a plane surface is insufficient, and

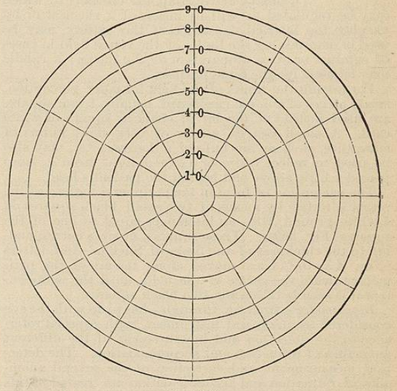


FIG. 3693.

for all distances greater than 45° from the point of fixation the distortion of the peripheral portions of the chart becomes excessive. For the projection of the entire field, with all its parts in due proportion, we require a hemispherical background instead of a plane surface; to this end we make use of the *perimeter*,[15] which is merely one-half of a broad blackened hoop, upon the inside of which the angular distance of any point of the fundus, lying in the meridian corresponding to the direction of the hoop, may be noted (Fig. 3692). By turning the hoop about a central pivot as an axis, it is brought into the necessary position for the observation of the extent of the field in different meridians; each point, as determined, is transferred to a blank chart printed, in concentric circles (Fig. 3693).

For the direct mapping of the visual field in its entire extent the perimeter of Scherk[16] has been devised; it consists of a hollow hemisphere, of one foot radius, blackened on the inside. The eye to be examined is placed at the centre of the sphere, and the limits of the field are marked with chalk in the same manner as when the blackboard is used. For greater convenience the hemisphere is made in separable halves, and the mapping is done for one-half of the field at a time.

Most of the perimeters, as found in the shops, have an arrangement of cords and pulleys, by means of which the test object is moved along the arc; this is a complication of at least doubtful advantage. A further complication consists in a self-registering apparatus, analogous to that employed in the "*conformateur*" used by hatters to prick a small diagrammatic outline of the shape of the head. For practical utility the arrangement in use at the Utrecht clinic is to be commended; it consists of a blackboard, about three feet square, to the centre of which is pivoted a removable half-hoop of one foot radius; the blackboard serves for the direct mapping of limitations of the field within the limits of 45° from the point of fixation, and the arc is used for peripheral measurements. The divisions of the arc between 0 and 45° are projected upon the board in circles whose radii are equal to the tangents of the respective angles.[17] The