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Contributors

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AMERICAN

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THE AMERICAN ENCYCLOPEDIA AND DICTIONARY OF OPHTHALMOLOGY

EDITED BY

CASEY A. WOOD, M. D., C. M., D. C. L.

Late Professor of Ophthalmology and Head of the Department, Northwestern University Medical School; Ex-President of the American Academy of Medicine, of the American Academy of Ophthalmology, and of the Chicago Ophthalmological Society; Ex-Chairman of the Ophthalmic Section of the American Medical Association; Editor of a "System of Ophthalmic Therapeutics" and a "System of Ophthalmic Operations"; Mitglied der Ophthalmologischen Gesellschaft, etc.; Ophthalmic Surgeon to St. Luke's Hospital; Consulting Ophthalmologist to Cook County Hospital, Chicago, Ill.

ASSISTED BY A LARGE STAFF OF COLLABORATORS

FULLY ILLUSTRATED

Volume I—A to Azoviolett

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INTRODUCTION

In adopting the strictly alphabetical sequence of subject-headings it has been necessary to review for the first volume practically the whole range of the literature of Ophthalmology and its related sciences. It will, as a consequence, easily be understood how difficult it has been to collect and treat with complete satisfaction all the subjects commencing with the first letter of the alphabet, that directly and indirectly relate to the eye and its diseases. However, it is the belief of the Editor and his collaborators that no topic of importance has been neglected. When a heading that quite evidently should have been noticed has been omitted or, more likely, if new topics of interest arise after the publication of the volume to which they belong, alphabetically, they will receive due attention in the appendix.

In addition to the attempt to write and edit a comprehensive *Encyclopedia of Ophthalmology* the Editor has made an effort to combine with it a *Dictionary of* such English, Latin, French, German and Italian words and phrases as will be most useful to students of ophthalmology in general. This has been a heavy task, beset with many difficulties. In the first place, it is not an easy matter to decide whether a particular word or phrase is of ophthalmic interest, or not. Broadly speaking, the majority of medical and scientific subjects in the languages referred *should* be interesting and valuable to the educated ophthalmologist but, if most of the words and phrases utilized in general medicine and surgery were so included, the additions would pad this work to an unseemly degree. Even as it is, the inclusion of some of the terms already chosen (although they were all taken from ophthalmic text-books) may give rise to criticism and to the imputation of mere "filling."

It will, in this connection, be noticed that the array of German words is much larger than those in other languages. There are several reasons for this. In the first place, the German language occupies a pre-eminent position in the world of science, and many English-speaking ophthalmologists have received a considerable portion of their foreign education in Germany and from Germans. Consequently, the excess of German words naturally represents the largest proportion of foreign literature accessible to the average English reader. Again,

it has not been considered necessary to insert in the *Dictionary* foreign words that closely resemble their English equivalents; and, since our English scientific words and terms are mainly derived from the Latin and the Romance languages, it necessarily follows that many of these have been omitted. For example, **Ablepsie** (F.) and **Ablepsia** (L.) have not been entered in the dictionary list, as it is quite evident that they have exactly the same meaning as our English word **Ablepsy,** or **Ablepsia,** blindness. For the same reason it does not seem desirable to include such expressions as **Abrasione della cornea** (It.), as the ophthalmic reader will at once recognize its English equivalent.

It will be readily seen how inevitable it is that certain repetitions occur in a work of this kind and magnitude; and it may at once be said that at least the majority of them in this *Encyclopedia* are intentional. References to a section, a cut or a plate on another page, or in another volume, are often found with some difficulty, and even when the search has been successful the effort much interferes with the concentration of thought required to grasp the matter under consideration. In the interest of the reader, therefore, this drawback has, in certain instances, been avoided by duplication. For a similar reason the Editor has plentifully supplied ample cross-references, intended to aid the student in his search for information.

Since writing and editing two *Systems,* the Editor has seen no good reason to change his opinion as to certain orthographic rules, and he therefore repeats that in his humble judgment the spelling of words used by English peoples throughout the globe properly varies in different continents, and even in small subdivisions of these continents. It has long been his profound conviction that the English language—obviously a living, vigorous ,and progressive one, not reduced to the uniformity of certain other dead and dying dialects—in the very nature of things must exhibit transitional and evolutionary stages in different parts of the Anglo-Saxon world. Consequently, *any* spelling that can show a recognized authority, whether that authority be American, Canadian, British, Australasian or South African, is acceptable to him and is employed indifferently throughout this work. He contends that it is useless to lay down arbitrary rules for spelling or pronunciation, especially in a work intended to circulate among English-speaking people generally. In consequence of this belief he has decided not to attempt uniformity of spelling either on the part of his collaborators or of himself. In any event, it strikes him as unimportant whether cocaine is spelled with or without an "*e,*" whether one writes it "*physiologic*" or "*physiological,*" whether or not the second syllable of *anesthesia* is spelled with a diphthong, whether *tumor* terminates in *or*

or *our* or *center* in *re* or *er*. Each contributor is allowed to do as he pleases in this regard.

At first it seemed possible to adopt and apply some one of the various methods of pronunciation to ophthalmic terms, but the difficulties encountered were so great (for reasons that it is not necessary to elaborate) and the benefits to be derived so small that the attempt was abandoned.

In the preparation of a work of this kind the Editor and his collaborators are much indebted to ophthalmic literature of all times and all countries, but especiallly to those two principal monuments of ophthalmic industry, the Graefe-Saemisch *Handbuch der gesamten Augenheilkunde* and the *Encyclopédie française d'Ophtalmologie;* and, while they have endeavored to produce a work that will be of even greater value to English-reading ophthalmologists, yet they acknowledge a large debt of gratitude to the collaborators of these two Encyclopedias. The *Encyklopädie der Augenheilkunde,* although not yet completed, has also been of considerable service to the Editor. In addition to these the Editor is especially indebted to Norris and Oliver's *System of Diseases of the Eye,* the *Traité complet d'Ophtalmologie,* Czermak and Elschnig's *Die Augenärtzliche Operationen,* Beard's *Ophthalmic Surgery,* Terrien's *Chirurgie de l'Oeil,* Lewin and Guillery's *Die Wirkungen von Giften auf das Auge,* and to many other Monographs, Periodicals, Year-Books, Transactions and Manuals of Ophthalmology, particularly the Nagel-Michel *Jahresbericht,* the *Ophthalmic Year-Book, Modern Ophthalmology,* and the Italian Edition of Fuchs' Textbook. The Editor has also utilized much of the material, duly revised, contributed to Wood's *System of Ophthalmic Therapeutics* and *System of Ophthalmic Operations.*

Both the Editor and Publishers of this *Encyclopedia and Dictionary of Ophthalmology* wish to acknowledge, with thanks, the permission of Messrs. P. Blakiston's Son & Co., Messrs. Wm. Wood & Co., Messrs. Longmans, Green & Co., Messrs. J. B. Lippincott & Co. and Messrs. W. B. Saunders Co. to reproduce, with modifications, some of the cuts used in copyright works owned by them. Messrs. Hardy & Co. have kindly supplied some of the illustrative "electros." The Editor is also under obligations to so many other friends for assistance that it is hardly possible even to mention their names. He once more acknowledges the valuable services of the illustrator, Dr. Charles G. Willson of Chicago, as well as of Dr. A. Arkin, Miss Lillian Hummel and Miss H. A. Fox for their assistance while the proof-sheets were passing under review.

The initials of collaborators are signed to topics more than a few

lines in length; for unsigned rubrics the Editor is alone responsible. In addition, a few friends have, on invitation, written some parts and to their contributions the full name has been appended.

CASEY A. WOOD.

INITIALS USED IN VOLUME 1, TO IDENTIFY INDIVIDUAL CONTRIBUTORS*

A. A.—Adolf Alt, M. D., M. C. P. and S. O., St. Louis, Mo.

Clinical Professor of Ophthalmology, Washington University, St. Louis, Mo.; Author of *Lectures on the Human Eye; Treatise on Ophthalmology for the General Practitioner; Original Contributions Concerning the Glandular Structures Appertaining to the Human Eye and its Appendages.* Editor of the *American Journal of Ophthalmology.*

A. C. C.—Alfred C. Croftan, Ph. D., M. D., Chicago, Ill.

Author of *Clinical Urinology* and of *Clinical Therapeutics.* Member of the General Staff of the Michael Reese Hospital, Chicago. Formerly Physician-in-chief at St. Mary's Hospital; Physician to St. Elizabeth's Hospital; Physician to the Chicago Post-Graduate Hospital; Pathologist to St. Luke's Hospital. Late Professor of Medicine at the Chicago Post Graduate College and the Chicago Polyclinic; Assistant Professor of Clinical Medicine, College of Physicians and Surgeons (University of Illinois); Member of the American Therapeutic Society.

A. S. R.—Alexander Sands Rochester, M. D., Chicago, Ill.

M. D. Jefferson Medical College; Ex-Chief, San Lazaro Contagious Hospital, Manila, P. I.; Adjunct Ophthalmologist to St. Luke's Hospital, Chicago.

C. A. O.—Charles A. Oliver (Deceased).

Joint Editor of *A System of Diseases of the Eye;* Writer of numerous monographs on ophthalmic subjects.

C. F. P.—Charles F. Prentice, M. E., New York City, N. Y.

President, New York State Board of Examiners in Optometry; Special Lecturer on Theoretic Optometry, Columbia University, New York. Author of *A Treatise on Ophthalmic Lenses* (1886); *Dioptric Formulæ for Combined Cylindrical Lenses* (1888); *A Metric System of Numbering and Measuring Prisms (the Prism-dioptry)* (1890); *The Iris as Diaphragm and Photostat* (1895), and other optical papers.

C. H. B.—Charles Heady Beard, M. D., Chicago, Ill.

Surgeon to the Illinois Charitable Eye and Ear Infirmary (Eye Department); Oculist to the Passavant Memorial Hospital and the North Star Dispensary (Chicago); Member and Ex-president of the Chicago Ophthalmological Society; Member of the American Ophthalmological Society, Etc. Author of *Ophthalmic Surgery,* (1910); and of *Opthalmic Semiology and Diagnosis,* (1913).

D. H.—D'Orsay Hecht, M. D., Chicago, Ill.

Assistant Professor of Nervous and Mental Diseases, Northwestern University Medical School; Consulting Neurologist to the Cook County Institutions for the Insane at Dunning, Illinois; Attending Neurologist to the Michael Reese and St. Elizabeth's Hospitals, Chicago.

*A complete list of the contributors to this work will appear in the final volume.

E. C. B.—Edward C. Bull, Pasadena, Calif.

E. C. E.—Edward Coleman Ellett, B. A., M. D., Memphis, Tenn.
Professor of Ophthalmology, University of Tennessee, College of Medicine.

E. E. I.—Ernest E. Irons, M. D., Ph. D., Chicago, Ill.
Assistant Professor of Medicine, Rush Medical College; Assistant Attending Physician, Presbyterian Hospital; Attending Physician, Cook County Hospital; Consulting Physician, Durand Hospital of the Memorial Institute for Infectious Diseases, Chicago.

E. J.—Edward Jackson, C. E., M. A., M. D., Denver, Colo.
Professor of Ophthalmology in the University of Colorado; Former Chairman of the Section on Ophthalmology of the American Medical Association; Former President of the American Academy of Ophthalmology and Oto-Laryngology; The American Ophthalmological Society, and The American Academy of Medicine. Author of *Skiascopy and its Practical Application; Manual of Diseases of the Eye;* Editor of *Ophthalmic Year-Book* (nine volumes); *Ophthalmic Review; Ophthalmic Record;* and *Ophthalmic Literature.*

E. S. T.—Edgar Steiner Thomson, M. D., New York City, N. Y.
Surgeon and Pathologist, Manhattan Eye, Ear and Throat Hospital; Professor of Ophthalmology New York Polyclinic Medical School and Hospital; Consulting Ophthalmologist to Perth Amboy and Ossining Hospitals; Member of the New York Academy of Medicine, New York Ophthalmological, and American Ophthalmological Societies. Author of *Electric Appliances and Their Use in Ophthalmic Surgery,* in Wood's *System of Ophthalmic Operations,* and various monographs.

F. A.—Frank Allport, M. D., LL. D., Chicago, Ill.
Ex-Professor, Ophthalmology and Otology, Minnesota State University; Ex-President, Minnesota State Medical Society; Ex-Chairman and Secretary, Ophthalmic Section, American Medical Association; Ex-Professor, Ophthalmology and Otology, Northwestern University Medical School; Ex-President, Chicago Ophthalmological Society. Author of *The Eye and Its Care;* Co-Author of *An American Text-Book of Diseases of the Eye, Ear, Nose and Throat; A System of Ophthalmic Therapeutics,* and *A System of Ophthalmic Operations.* Eye and Ear Surgeon to the Chicago Board of Education and to St. Luke's Hospital, Chicago.

F. P. L.—Francis Park Lewis, M. D., Buffalo, N. Y.
President American Association for the Conservation of Vision; President Board of Trustees N. Y. State School for the Blind; President N. Y. State Commissions for the Blind (1903 and 1906); Chairman Committee on Prevention of Blindness, American Medical Association; Ophthalmologist Buffalo State Hospital and Buffalo Homeopathic Hospital; Consulting Ophthalmologist J. N. Adam Memorial Hospital; Fellow Academy Ophthalmology and Oto-Laryngology.

H. B. W.—Henry Baldwin Ward, A. B., A. M., Ph. D., Champaign, Ill.
Professor of Zoology, University of Illinois; Ex-Dean of the College of Medicine, University of Nebraska. Author of *Parasitic Worms of Man and the Domestic Animals; Data for the Determination of Human Entoza; Iconographia Parasitorum Hominis; Human Parasites in North America.*

H. S. G.—Harry Searls Gradle, A. B., M. D., Chicago, Ill.
Professor of Opthalmology, Chicago Eye and Ear College; Director of Ophthalmic Clinic, West Side Free Dispensary; Member of the Ophthalmologische Gesellschaft, American Medical Association, American Academy of Ophthalmology and Oto-Laryngology.

H. V. W.—Harry Vanderbilt Wurdemann, M. D., Seattle, Wash.

Managing Editor, *Ophthalmology*, since 1904; Editorial Staff of the *Ophthalmic Record* since 1897; Managing Editor, *Annals of Ophthalmology*, 1897-1904. Member American Medical Association; Ex-Chairman Section on Ophthalmology, American Medical Association; Hon. Member, Sociedad Cientifica, Mexico; N. W. Wisconsin Medical Society and Philosophical Society. Fellow American Academy of Ophthalmology and Oto-Laryngology. Author of *Visual Economics* (1901); *Injuries to the Eye* (1912); *Bright's Disease and the Eye* (1912); and numerous monographs on the eye and its diseases. Collaborator on many other scientific books.

J. G., Jr.—John Green, Jr., A. B. (Harv.), M. D. (Washington), St. Louis, Mo.

Assistant in Ophthalmology, Washington University Medical School; Ophthalmic Surgeon to St. Louis Children's Hospital; Ophthalmic Surgeon to St. Louis Eye, Ear, Nose and Throat Infirmary; Consulting Ophthalmic Surgeon to St. Louis Maternity Hospital; Consulting Ophthalmic Surgeon to St. John's Hospital, St. Louis.

J. L. M.—John Little Moffat, B. S., M. D., O. et A. Chir., New York City, N. Y.

Editor *Journal of Ophthalmology, Otology and Laryngology.* Consulting Ophthalmic Surgeon, Cumberland Street Hospital, New York; Member (v-p. 1905, 1908) American Homœopathic Ophthalmological, Otological and Laryngological Society; Member American Medical Editors' Association; Member (Senior) American Institute of Homœopathy; Senior member (ex-pres.) New York State Homœopathic Medical Society; Senior member (ex-pres.) King's County (N. Y.) Homœopathic Medical Society; Honorary member N. Y. County Homœopathic Medical Society.

J. M. B.—James Moores Ball, M. D., LL. D., St. Louis, Mo.

Dean and Professor of Ophthalmology, American Medical College of St. Louis, Medical Department of National University of Arts and Sciences. Author of *Modern Ophthalmology; Andreas Vesalius the Reformer of Anatomy.*

J. R. C.—James Raley Cravath, B. S., Chicago, Ill.

Electrical and Illuminating Engineer, Chicago; Vice-President, Illuminating Engineering Society; formerly associate editor *Electrical World;* joint author *Practical Illumination* by Cravath and Lansingh; joint author *Light—Its Use and Misuse,* prepared by committee of the Illuminating Engineering Society; author of *Illumination and Vision; Tests of the Lighting of a Small Room;* and numerous other monographs.

L. H.—Lucien Howe, M. A., M. D., Sc. D., Buffalo, N. Y.

Professor of Ophthalmology, University of Buffalo; Member of the Royal College of Surgeons of England; Fellow of the Royal Society of Medicine; Member of the *Ophthalmologische Gesellschaft* and of the *Société Française d'Ophtalmologie.* Author of *The Muscles of the Eye.*

M. S.—Myles Standish, A. M., M. D., S. D., Boston, Mass.

Williams Professor of Ophthalmology, Harvard University; Consulting Ophthalmic Surgeon, Massachusetts Charitable Eye and Ear Infirmary and Carney Hospital, Boston, Mass.

N. M. B.—Nelson M. Black, Ph. G., M. D., Milwaukee, Wis.

Author of *The Development of the Fusion Center in the Treatment of Strabismus; Examination of the Eyes of Transportation Employes; Artificial Illumination a Factor in Ocular Discomfort,* and other scientific papers.

P. A. C.—Peter A. Callan, M. D., New York City, N. Y.

Surgeon, New York Eye and Ear Infirmary; Ophthalmologist to St. Vincent's Hospital; Columbus Hospital and St. Joseph's Hospital, New York.

P. G.—Paul Guilford, M. D., Chicago, Ill.

Ex-Resident Surgeon, Wills Eye Hospital, Philadelphia; Attending Oculist and Aurist, St. Luke's Hospital; Attending Oculist and Aurist, Chicago Orphan Asylum; Consulting Oculist and Aurist, South Side Free Dispensary. Co-Author of *A System of Ophthalmic Operations.*

T. H. S.—Thomas Hall Shastid, A. B., A. M., M. D., LL. B., Marion, Ill.

Professor of the History of Medicine in the American Medical College, St. Louis, Mo.; Editorial Secretary of *The Ophthalmic Record.* Author of *A Country Doctor; Practising in Pike; Forensic Relations of Ophthalmic Surgery* (in Wood's *System of Ophthalmic Operations*); *Legal Relations of Ophthalmology* (in Ball's *Modern Ophthalmology*); *A History of Medical Jurisprudence in America* (in Kelly's *Cyclopedia of American Medical Biography*).

W. C. P.—Wm. Campbell Posey, B. A., M. D., Philadelphia, Pa.

Professor of Ophthalmology in the Philadelphia Polyclinic Hospital and Graduate Medical School; Ophthalmic Surgeon to the Wills, Howard and Children's Hospitals; Chairman of the Pennsylvania Commission for the Conservation of Vision; Chairman of Section on Ophthalmology, College of Physicians, Philadelphia. Editor of American Edition of Nettleship's *Textbook of Ophthalmology;* Co-Editor, with Jonathan Wright, of *System of Diseases of the Eye, Ear, Nose and Throat;* Co-Editor, with Wm. G. Spiller, of *The Eye and the Nervous System.*

W. F. H.—W. F. Hardy, M. D., St. Louis, Mo.

W. H. W.—William Hamlin Wilder, A. M., M. D., Chicago, Ill.

Professor and Head of Department of Ophthalmology, Rush Medical College (in affiliation with University of Chicago); Professor of Ophthalmology, Chicago Polyclinic; Surgeon, Illinois Charitable Eye and Ear Infirmary; Ophthalmic Surgeon, Presbyterian Hospital; Member American Ophthalmological Society.

W. O. N.—Willis Orville Nance, M. D., Chicago, Ill.

Ophthalmic Surgeon, Illinois Charitable Eye and Ear Infirmary; Late Oculist and Aurist to Cook County Hospital; President, Chicago Ophthalmological Society.

W. R.—Wendell Reber, M. D., Philadelphia, Pa.

Professor of Diseases of the Eye in the Medical Department of Temple University; Professor of Diseases of the Eye in the Philadelphia Polyclinic and College for Graduates in Medicine; Ophthalmic Surgeon to the Samaritan Hospital, to the Philadelphia General Hospital, to the Garretson Hospital; Consulting Ophthalmologist to the Friends' Asylum for the Insane; Member of the Council of the Oxford Ophthalmological Congress; Past President of the American Academy of Ophthalmology and Oto-Laryngology; joint author of a *Handbook on the Muscular Anomalies of the Eye.*

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AMERICAN ENCYCLOPEDIA AND DICTIONARY OF OPHTHALMOLOGY

A. Just as in modern times one often uses the initial letter of the name of a patient whose identity one desires to conceal, so the ancients occasionally employed the same device. This practice is exemplified in the abbreviated name of a classical patient, whose anamnesis and case-report are both very interesting on account of their "local color." They appear on a marble votive-tablet, exhumed in 1883, together with similar tablets, from the ruins of the temple of Asklepios at Epidaurus. A's tablet, which dates back nearly to the time of Hippocrates, reads as follows: "A. Was healed in the eyes. This man was struck in battle by a spear, and became blind in both eyes, and carried about with him the point of the lance in his face for an entire year. But, in the temple-sleep, he beheld a vision. It seemed to him that the god drew out of him the weapon, and placed back between the lids what is called the sight. As it became day, he went forth from the precincts, wholly cured."

For temple-sleep as a means of treatment, see **History of ophthalmology.**—(T. H. S.)

A. Abbreviation for accommodation.

Abadie's ciliarotomy operation in glaucoma. Abadie (Section de la zone ciliaire ou ciliarotomies. *Archiv. d'ophtalm.*, May, 1910, p. 262) under the supposition that irritation of the rich circular nervous plexus which covers the ciliary zone immediately behind the insertion of the iris, may induce glaucoma, undertakes to relieve the condition by division of the ciliary zone, or, as he terms it, by "ciliarotomy." The technique of the operation is as follows:

"A fold of the bulbar conjunctiva is raised by means of forceps towards the supero-external quarter of the cornea. The conjunctiva, raised with fine dull-pointed scissors, is divided in the direction of the corresponding meridian of the eye for about 1½ centimètres. The conjunctiva being thus cleft, one takes the superior flap and with ordinary strabismus scissors detaches it from the sclera while raising it up, taking care, in order to disengage it well, to liberate its attachment to the sclero-corneal limbus by small cuts of the scissors. The inferior flap is treated in a similar way. By these means a large triangular surface of the sclera is bared, the base of which is formed by the cornea and the apex by the terminal point

of the conjunctival opening made in the first instance. A couple of sutures are now passed through the two conjunctival flaps, whereby they may be brought together in order to cover the wound which is about to be made in the ciliary region.

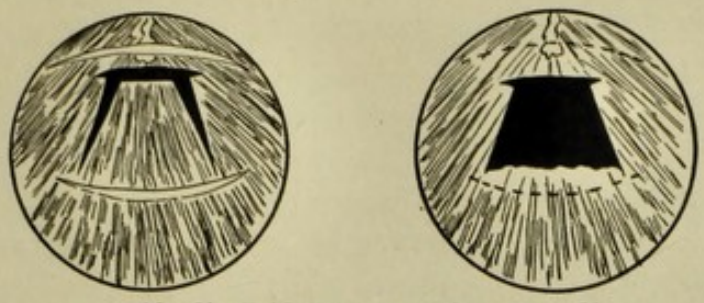
The sutures once in place, both are pulled outward in such a way as to expose the field of operation. Then, seizing with fixation forceps the conjunctiva and the episcleral tissue at the level of the inferior conjunctival flap, so as to keep the eye perfectly steady, the point of Richter's triangular knife is inserted just at the junction of sclerotic and cornea, immediately behind the insertion of the iris. It is gently plunged, so to speak, into the globe, its point being directed towards the centre, and its blade in the corresponding sense of the eye. In consequence of its triangular form, its propulsion towards the centre of the eye causes its cutting edge to divide the ciliary zone. By slight sawing movements of the blade, this section is enlarged in such a way that it attains a length of from 7 mm. to 8 mm.—that is to say—about the extent of the ciliary nervous plexus. The knife is then withdrawn. Contrary to what might be expected, only one or two drops of vitreous issue from the incision, which is only a mere slit.

Then, by tying the two sutures previously placed in the conjunctival flaps, the conjunctiva is brought together, thereby covering the scleral surface and the incision that has just been made."

Abadie asserts that his procedure is especially adapted to cases of glaucoma which persist despite iridectomy. The results have been uncomplicated, without luxation of the lens, or intraocular hemorrhage.—(W. C. P.)

Abadie's operation for intravitreous electrolysis. Abadie (Désorganication du corps vitré; électrolyse; restitution de la vision. *Annales d'Oculistique,* 114, August, 1895, p. 126) has used electrolysis for the dispersion of vitreous opacities. He introduces a platinum-iridium needle 8 mm. long into the depths of the vitreous. The needle is connected with the positive pole of a galvanic battery, the negative electrode being placed on the arm. A stream of three or four milliamperes is applied for five minutes. In a case described by him there was marked improvement in the local condition and in the eyesight.

Abadie's operation for iridoëctomy. Two corneal incisions are made at opposite sides of the same corneal diameter, each about 5 mms. in length, with lance knives. Then the pince-ciseaux, one blade of which has a sharp point, are entered with this blade through the one corneal section into the iris diaphragm, which is cut by two divergent



Abadie Iridoëctomy (after Beard).

incisions. Entering a hook or iris forceps through the opposite corneal incision, the iris flap is seized at its apex, drawn out and cut off.—(A. A.)

Abadie's sign. Spasm of the levator palpebræ superioris in exophthalmic goitre, elicited by simple inspection.

Retraction of the upper eyelid in Graves' disease, due, according to some, to spasm of all the fibres of the levator palpebræ superioris muscle, according to others, of the unstriped fibres only, i. e., the so-called Müller's muscle. The presence or absence of this sign is determined by simple inspection. The sign is present intermittently in the beginning of the disease (clonic spasm) but is apt to be continuous in the later stages (tonic spasm). Abadie's sign ought not to be confounded, on the one hand, with Graefe's sign, which consists of lagging of the upper lid when the patient looks down; or, on the other hand, with Stellwag's sign, which consists of infrequency and slowness of winking.

Abaissement. (F.), n. A lowering, as of the eyelids. Couching for cataract.

Abaisseur de la paupière. (F.), n. An instrument for depressing the lower lid.

Abaisseur de la pupille. (F.), n. The rectus inferior muscle.

Abaisseur de l'oeil. (F.), n. The inferior rectus muscle.

Abart. (G.) A degenerate; degeneracy. Also a variety or variation.

Abasie. (G.) Restlessness.

Abatio retinae. Detachment of the retina.

Abätzen. (G.), tr. v. To remove with caustic; to cauterize.

Abaxial. Not situated in the line of the axis.

Abbacinate. To deprive of sight by placing a red-hot copper basin close to the eyes: a mode of punishment employed in the middle ages. Also spelled *abacinate*.

Abbacination. The act or process of blinding a person by placing a red-hot copper basin close to the eyes. Also spelled *abacination*.

Abbaden. (G.) To cleanse by bathing; to bathe.

Abbagliamento per opacità corneali. (It.) Interference with vision from corneal opacity.

Abbähen. (G.) To foment thoroughly.

Abbälgen. (G.), tr. v. To enucleate.

Abbau. (G.) Breaking up; decomposition.

Abbeizen. (G.), tr. v. To remove by means of cauterants.

Abbe's intrinsic magnifying power. In *optics*, the ratio of the visual angle subtended at the eye by the image viewed through the instrument to the corresponding linear dimension of the object.—(C. F. P.)

Abbe's measure of the indistinctness of the image. In *optics*, a measure of the lack of detail in the image, which shows that the "indistinctness," on account of the spherical aberration, is proportional to the cube of the aperture of the bundle of object rays.—(C. F. P.)

Abbeugen. (G.) To turn away.

Abbeugen die Augen. (G.) To avert the eyes; to turn them to one side.

Abbiegung. (G.), n. Abduction.

Abbinden. (G.) To ligate; especially to tie off or remove with an écraseur.

Abbindewerkzeug. (G.) Instruments for ligating parts.

Abbindung. (G.) To tie off; or removal by ligature.

Abbiss. (G.) A biting off; the part bitten off.

Abblassen. (G.) To fade; to turn pale; to lose color.

Abblättern. (G.), intr. v. To exfoliate.

Abblätternd. (G.) Exfoliative.

Abblätterung. (G.) Exfoliation.

Abblätterungsmittel. (G.) An exfoliative.

Abbott, Frank Wayland. This well-known otologist and ophthalmologist, son of Rev. E. L. Abbott, missionary to Burmah, was born at Sandoway, Aracan, Burmah, Dec. 24, 1841. He was educated at Falley Seminary, Fulton, N. Y., at the University of Rochester, Rochester, N. Y., and at the medical department of the University of Buffalo. His medical degree he received in 1866. Devoting himself exclusively to diseases of the eye and ear, he settled in Buffalo. He was an active member of a number of medical societies, contributed numerous articles to various medical journals, and produced an excellent translation of Helmholtz's "*Recent Progress in Theory of Vision.*" He was attending ophthalmologist and aurist to the Buffalo General Hospital and to the Charity Eye and Ear Hospital of Erie Co., N. Y.

He married, June, 1869, Julia H. Baker, of Buffalo, New York.

Dr. Abbott was a very religious man and regarded as an ideal citizen. Concerning these salient aspects of his character, a friend writes as follows: "'We loved Abbott for the things he would not do.' He was incapable of a mean action and many can testify to the kind things he would do for a younger man; the writer was such a beneficiary on more than one occasion. If Dr. Abbott was not a great man in the sense of being widely known, he was at least great in being an honest man. He enjoyed a good story, and could tell one, and got considerable comfort from tobacco. He gave much time and energy to charitable work, and was greatly interested in the Charity Eye and Ear Hospital, of which he was one of the founders."

Dr. Abbott died at Buffalo, N. Y., April 9, 1901, after an illness of about three months.—(T. H. S.)

Abbrand. (G.) The oxide formed when a metal is heated in the air; the loss of material in the process of testing by heat.

Abbrechen. (G.) A tearing apart; a rupture.

Abbrennen. (G.), tr. v. To burn off or out.

Abbrennzange. (G.) Cautery clamp or forceps.

Abbruciamento. (It.) A burn.

Abbrühung. (G.) A scalding.

Abcédé. (F.), adj. Having formed an abscess.

Abcéder. (F.), intr. v. To discharge (as of an abscess).

Abcès. (F.), n. An abscess.

Abcès de l'oeil. (F.), n. Panophthalmitis.

Abd. Abbreviation for abduction.

Abdachung. (G.) A decline; a downward slope.

Abdampfapparat. (G.) An apparatus for a water-bath.

Abdämpfen. (G.) To evaporate; to cause to evaporate.

Abdampfkessel. (G.) An evaporating basin.

Abdampfrückstand. (G.) The residue after evaporation.

Abdampfschale. (G.) An evaporating pan or vessel.

Abdampfung. (G.) Evaporation; vaporation.

Abdestillieren. (G.) To distill.

Abdrehen. (G.) To twist off; to remove by torsion.

Abducens. (L.), n. The external rectus muscle, whose action it is to rotate the globe outward. It arises by two heads, one from the outer margin of the optic foramen; the other from the lower margin of the sphenoidal fissure. The tendon is inserted into the sclera near the outer margin of the cornea. See **Muscles, Ocular.**

Abducens. (L.), adj. Abducting. Acting as an abductor.

Abducenskern. (G.) Abducens nucleus.

Abducenslähmung. (G.) Paralysis of the rectus externus.

Abducensnerve. (G.) Abducens nerve.

Abducens paresis or paralysis. This term is generally regarded as synonymous with paralysis of the rectus externus. On account of its long course from the base of the skull and its intimate relation with the carotid artery, the abducens is often subject to paralysis, especially of basal origin. Paralysis of the nucleus occurs occasionally in processes that involve the rhomboid fossa in the fourth ventricle, while peripheral paralysis of rheumatic, syphilitic or traumatic nature also occurs. Paralysis of both abducentes occurs occasionally, and may be found in tabes, neoplasms about the base of the skull, basal meningitis, etc. See **Muscles, Paralysis of the ocular.**

Abducent. adj. Abducting. Relating to an abductor.

Abducere. (L.), tr. v. To abduct or draw a part away from the median line.

Abduciren. (G.), tr. v. To draw a part away from the median line of the body or of a limb. To abduct.

Abducirend. (G.) Abducent.

Abducirende Prismen. (G.) Abducting prisms, i. e., those whose apices are directed towards the temples.

Abduct. tr. v. To draw a part away from the median line of the body.

Abducteur. (F.), adj. and n. Abducting. Acting as an abductor. An abductor.

Abducteur de l'oeil. (F.), n. See **Abducens.** The external rectus muscle of the eye.

Abduction is a drawing of the eye outward, in the horizontal plane. It is produced primarily by the action of the external rectus. Under normal conditions, however, the eye is turned outward by the external rectus acting with the superior and inferior oblique. It is under control of the sixth nerve, of the branch of the third—which goes to the inferior rectus, and of the fourth nerve. It is consequently a complicated movement, involving three nerve centers.

The extent of abduction, as measured with a reliable form of the tropometer (q. v.), varies within certain limits. Volkmann gives it as 38° in the horizontal plane. Most other observers place normal abduction at about 42 to 45°. It not only differs somewhat in different individuals, but also possibly in the same individual at different times.—(L. H.) See **Muscles, Ocular.**

Abduction, Voluntary. A term (willkürliche Abduction) introduced by v. Graefe to indicate the efforts of the muscles and movement of the globe necessary to overcome abducting prisms.

Abductor. n. A muscle or nerve whose action it is to abduct a part, or draw it from the median line of the body.

Abductor oculi. (L.), n. See **Abducens.** The external rectus muscle.

Abduktion. (G.) Abduction.

Abduktionsbewegung. (G.) Movement of abduction.

Abduktoren. (G.) Abductors.

Abduktorsmass. (G.) An abductor's measurement of.

Abdul fudail b. Naqid. A Jewish ophthalmologist of the Arabian period, who practised in Cairo, and died A. D. 1158.

Abdunsten. (G.) To evaporate.

Abdunstung. (G.) Evaporation.

Abduttore. (It.), adj. Acting as an abductor.

Abduttore dell' occhio. (It.), n. See **Abducens.** The external rectus muscle (abductor) of the eye, whose action rolls the globe outward.

Abduzieren. (G.) To abduct.

Abduzierung. (G.) Abduction.

Abduzione. (It.), n. Movement from the median line of the body. Abduction.

Abengefit. One of the later Spanish-Arabian ophthalmologists who lived and practiced during the eleventh century. See **Abenguefit.**

Abenguefit. Abul Mutarrif Abd ar-Rahman b. Muhammed b. Abd al-Karim b. Jahja Ibn-Wafid al-Lahmi. Also called by his Latin translators Abengefit. One of the later Spanish-Arabian physicians, born of a distinguished Arabian family which settled in Spain, at Toledo, A. D. 998 (997?) He was noted in politics as well as in medicine, and became vizier to the Prince of Toledo as well as physician to the chief hospital in that city. The best of his works were those on general medicine: *De medicamentis simplicibus* and *De balneis sermo.* He wrote, also, a book on ophthalmology, entitled *Book of the Exact Consideration of the Diseases of the Sense of Sight.* This was not without influence in Spain for several centuries, but is not now extant in any language. Abenguefit died A. D. 1070 or 1074.—(T. H. S.)

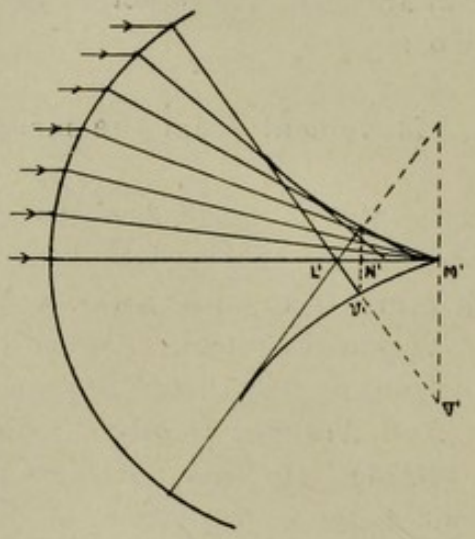
Aberrancy of curvature. In *mathematics,* the angle between the normal to a curve at any point and the line from that point to the middle point of the infinitesimal chord parallel to the tangent.

Aberratio chromatica. (L.) See **Aberration, Chromatic.** Unequal refraction of color rays.

Aberration. In *optics,* a deviation in the direction of rays of light when unequally refracted (by a lens) or reflected (by a mirror), so that they do not converge to a common point or focus, producing a distorted or indistinct image, with more or less color.

Coma aberration, is an unsymmetrical aberration of the image of a fairly extensive object demanding the incidence of wide-angle bundles of rays, these being differently deviated in the right-angled co-ordinate sections of the refracted bundle. For instance, the light-pattern projected by an objective upon a screen some times presents the appearance of a comet, with its tail turned either towards or away from the optical axis, which accounts for the origin of the name "*coma.*"

Chromatic aberration in a lens is due to the decomposition of white light produced by the inherent variable prismatic power of the lens, which is greater near its edge. The red rays of the spectrum being less refrangible than the violet rays cause the latter to



Lateral Aberration.

cross the optical axis nearer to the lens, so that the more remote focussed image is fringed with color, usually blue. The focal length of a lens is shorter for blue than for red rays, or the two principal foci for blue rays are nearer to the lens than those for red rays. The chromatic aberration for incident parallel rays is equal to the mean focal length of the lens, multiplied by the *chromatic dispersive power* (q. v.) of the substance of which the lens is made.

A lens may be constructed to be tolerably free from this defect, when it is called *achromatic,* (q. v.) and when an optical system is brought to its highest possible state of perfection, in this respect, it is said to be *apochromatic* (q. v.).

Lateral aberration, the radius of that circle (inside of which all the rays of the bundle cross the perpendicular image-plane at the cusp) which is produced by intersections of the extreme edge-

rays with the image-plane. Abbé employs this radius, M′V′, as the so-called *lateral aberration* of the extreme ray; and he defined the *Magnitude of the Lateral Aberration* as being equal to M′L′/N′L′× N′V′. Here M′L′ is the distance between the image-point (cusp) and the axial intersection, L′, of the extreme ray; N′L′, the distance between the least circle of aberration (q. v.) and the point L′; and M′V′, the radius of the lateral aberration. (For extended formulæ, see Southall, *Principles of Geometrical Optics,* Chapter XII.)

Longitudinal aberration, also commonly called *spherical aberration,* is due to a curvature of the lens or mirror, which while effecting a more or less sharply defined focus for the central rays, causes those rays which are refracted or reflected near the edge of the lens or mirror, respectively, to cross each other before reaching the focal point. These consecutive points of intersection generate in any principal axial plane a caustic curve (q. v.) whose cusp is at the focus. Consequently the refracted or reflected rays envelop a surface called the caustic which is the evolute of the refracted or reflected wave. Even actual point-images which are necessarily formed by bundles of rays of finite aperature (a narrow zone immediately surrounding the optical axis) are, in general, more or less associated with longitudinal aberration which is undetectable by the eye, owing to its comparatively poor resolving power. Furthermore, the rays of an isolated bundle which are obliquely incident upon a very small surface-element at the peripheral part of a lens or mirror are transformed by refraction or reflection, at a surface of any form, into a non-homocentric or astigmatic bundle of rays, all the rays of which, at least to a first approximation, intersect two infinitely short lines, the so-called image-lines of the bundle. This phenomenon is explained by Sturm, the originator of the theory of *astigmatism* (q. v.). A single lens is not free from this defect, but, through suitable combinations of lenses, it has been found possible to construct optical systems which, by means of wide-angle bundles of rays, will give a true image of an axial object-point or of a small surface-element placed at right-angles to the optical axis. Such systems are called *aplanatic* (q. v.). The longitudinal aberration is measured along the optical axis, being the distance between the focus of the paraxial rays and the nearer point of axis-intersection of the rays that emerge from the periphery of the aperture, and upon whose magnitude the aberration depends.

Longitudinal aberration of a thin lens, exposed to an object-point situated at infinity, is expressed by Prof. Southall's equation:

$$E'L' = -\frac{h^2\phi}{2(n-1)}\left\{\frac{(n-1)\quad(n+2)}{n}\frac{c^2}{\phi^2} - (2n+1)\frac{c}{\phi} + \frac{n^2}{n-1}\right.$$

wherein the value within the major brackets is the factor by which the thickness, $\frac{h^2}{2}\left\{\frac{1}{r_1} - \frac{1}{r_2}\right\} = \frac{h^2}{2}(c - c') = \frac{h^2\phi}{2(n-1)}$ of the lens has to be multiplied in order to obtain the longitudinal aberration, E'L', along the axis. In the above equations, he represents the semi-diameter of the lens; $\phi = 1/f$, the reciprocal of its primary focal length; n, the index of refraction; and $c = 1/r_1$ and $c' = 1/r_2$, the curvatures of the bounding surface of the lens in air. For instance, practical application of the above formulæ to a plano-convex lens reveals that the longitudinal aberration is greatest when its plane side is turned towards, and least when its plane side is turned away from, the object-rays. Since it is not practically feasible to entirely abolish longitudinal aberration in an infinitely thin lens that is exposed to an object-point situated at infinity, Prof. Southall gives the following equations for the curvatures c_0 and c_0' of the surfaces:

$$c_0 = \frac{n\,(2n+1)}{2\,(n-1)\,(n+2)}\phi \text{ and } c_0' = \frac{2n^2 - n - 4}{2\,(n-1)\,(n+2)}\phi,$$

which meet the requirement of minimum aberration (E'L') as expressed by the equation: $(E'L')_0 = -\frac{n\,(4n-1)}{8\,(n-1)^2\,(n+2)}h^2\phi$.

In order to secure this minimum degree of aberration in a thin lens exposed to an object-point at infinity, the curvature c_0 and c_0' must bear the following relation to each other:

$$c_0 : c_0' = \frac{n\,(2n+1)}{2n^2 - n - 4}.$$

Through the above equations, and the choice of an index = 3/2 it can be shown that a bi-convex lens has the least longitudinal aberration when the curvature of its front surface (c_0) is six times as great as the curvature (c_0') of its back surface. Within rational limits it is also feasible to vary the relative curvatures of the surfaces without altering the focal length; this procedure being called, "bending the rays," (q. v.).

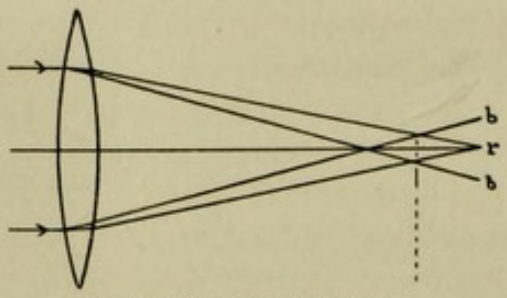
Least circle of aberration, a circle perpendicular to the axis, located within the amplitude of the longitudinal aberration, whose diameter is determined by intersections of the edge-rays with the

caustic surface after these rays have crossed the axis. The distance of the least circle of aberration from the image-point is approximately equal to ¾ of the longitudinal aberration of the extreme outside ray.

Least circle of chromatic aberration, the circle of colored light observed in experiments with convex lenses, and which lies between the points where the red and violet rays separately focus.

Spherical aberration, see longitudinal aberration above.—(C. F. P.)

Aberration, Chromatic. NEWTONIAN ABERRATION. Inequality in the refraction of the rays of different colors, so that colored images are produced about the focus of the lens.



Chromatic Aberration.

Aberration chromatique. (F.), n. Deviation of the rays of light from the principal focus of a curved lens or mirror, thus producing a colored image at the focal point.

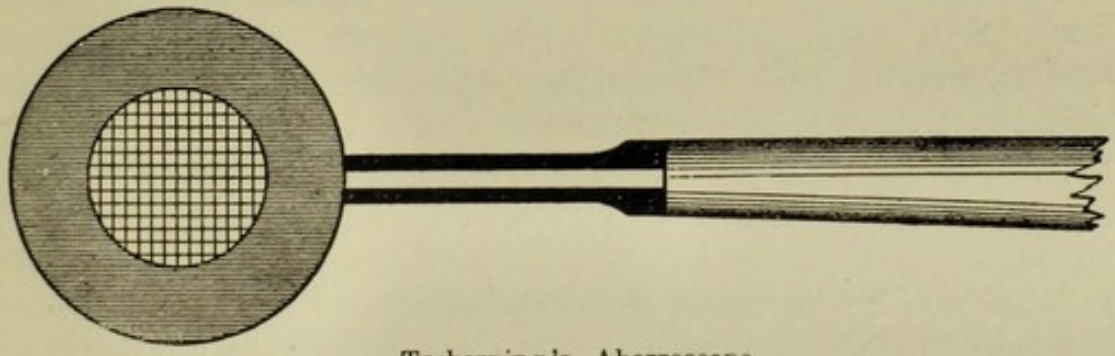
Aberration of light. In *optics,* comprises an extensive series of phenomena, one of which, discovered by Bradley in 1728, is the variation in the apparent position of a star, due to the motion of the observer with the earth.—(C. F. P.)

Aberration, Sphärische. (G.) Spherical aberration.

Aberrazione. (It.), n. See **Aberration.** Any deviation from the normal course.

Aberrazione cromatica. (It.) See **Aberration, Chromatic.**

Aberroscope. Tscherning has constructed this instrument, for determining the presence or absence of aberration in the human eye,


Tscherning's Aberroscope.

(see figure) consisting of a plano-convex lens which, on its plane side carries a micrometer in the form of little squares. One looks, in making the test, at a distant luminous point through the lens, moving it 10 to 20 centimeters from the eye in order to observe whether the lines then appear curved or not; if the latter there is no perceptible aberration.

Abfall. (G.) Subsidence; depression.

Abfallen. (G.) To fall off; to fall away.

Abfegend. (G.) Detergent.

Abfegung (G.). Depuration.

Abfeuchten. (G.) To moisten or wet.

Abfiltrieren. (G.) To separate by filtration; to strain.

Abflecken. (G.) To stain by losing a color; or to make stains.

Abfliessen. (G.) To flow off; to drain.

Abfluss. (G.) An outflow, a discharge.

Abflusschnur. (G.) A seton.

Abflusswunde. (G.) A wound made by a seton-needle; the tract of a seton.

Abführende Muskeln. (G.) Abductor muscles.

Abführgang (G.). Efferent duct.

Abgeblasst. (G.) Pallid.

Abgeflacht. (G.) Flat, shallow.

Abgegrenzt. (G.) Circumscribed.

Abgeheilt. (G.) Healed.

Abgesackt. (G.) Encysted, saculated.

Abgeschlagen. (G.) Fatigued, worn out.

Abgeschlagenheit. (G.) Exhaustion.

Abgeschwächt. (G.) Weakened, mitigated, diluted.

Abgesondert. (G.) Secreted (in the sense of being separated by secretion).

Abgespannt. (G.) Weakened, faint, relaxed, debilitated.

Abgespanntheit. (G.) Exhaustion.

Abgestorbenheit. (G.) Apathy, no feeling, deadness.

Abgestumpft. (G.) Blunted, dulled.

Abgestumpftheit. (G.) Bluntness, mental dullness.

Abgliederung. (G.) Disarticulation.

Abgrenzung. (G.) Limitation; demarcation.

Abhaaren. (G.) To epilate, or depilate.

Abhandeln. (G.) To discuss, treat of.

Abhärten. (G.) To harden, temper, inure.

Abhärtung. (G.) Hardening.

Abhärtungsmittel. (G.) Hardening or strengthening agent or remedy.
Abhäuten. (G.) To excoriate; to strip off the pelicle or cuticle.
Abhebeln. (G.) To displace by leverage.
Abhebelung. (G.) Displacement by leverage.
Abheilen. (G.), tr. and intr. v. To heal.
Abheilung. (G.) Healing.
Abheilungsperiode. (G.) The period of healing or of convalescence.
Abhelfen. (G.), tr. v. To remedy.
Abhelflichkeit. (G.) Remediable.
Abhellen. (G.) To clarify.
Abhellung. (G.) Clarification.
Abimeron. The most distinguished representative of Spanish-Arabian medicine. See **Avenzoar.**
Abirrung. (G.) Aberration, deviation.
Abirrung der Gläser. (G.) Dioptric aberration.
Abirrungskreis. (G.) Circle of aberration.
Abirrungsweite. (G.) Amplitude of aberration.
Abirrungswinkel. (G.) Angle of deviation.
Abkapseln. (G.) To become encapsuled.
Abkapselung. (G.) Encapsulation.
Abklären. (G.) To clarify.
Abklärung. (G.) Clarification.
Abklatschen. (G.) To slap or flip with wet towels.
Abklatschung. (G.) Wet-packing.
Abklopfen. (G.) To percuss.
Abknallen. (G.) To fulminate.
Abknicken. (G.) To bend; to flex; to kink.
Abkömmling. (G.) A derivative (in chemistry).
Abkränkeln. (G.) To be weakened from long illness.
Abkratzen (G.). To scrape.
Abkratzung. (G.) Abrasion.
Abkühl-Apparat. (G.) A refrigerating apparatus.
Abkühlen. (G.) To refrigerate; to cool.
Abkühlend. (G.) Refrigerating, cooling.
Abkühlung. (G.) Cooling, refrigeration.
Abkühlungsmittel. (G.) A refrigerant; cooling remedy.
Abkürzung. (G.) Shortening; partial removal.
Ablagern. (G.) To deposit.
Ablagerung. (G.) Deposit, infiltration; a metastasis.
Ablassung, Temporale. (G.) Temporal pallor.
Ablatio. (L.), n. The removal of a part by cutting. Ablation.

Ablatio chorioideæ. (L.) Detachment of the choroid.

Ablation. n. Cutting out or off a part, often used in connection with corneal operations. See **Abscission of the cornea.**

Ablation scissors, Briggs'. Wm. Ellery Briggs' ablation scissors *(Archives of Ophthal.,* Vol. XVI, No. 1) consist of two curved scissors, placed parallel so as to enable one to cut a section of the optic and ciliary nerves without cutting any of the ocular muscles.

In 1894 Briggs modified his ablation scissors by adding a pair of claws between the two scissors to insure the removal of the cut section of the nerves. (See *Trans. Sec. Ophth.,* A. M. A., 1894, p. 177.)—(P. G.)

Ablauf. (G.) Running off; course; end; outlet.

Ablaufen. (G.) To flow off.

Ablaufend. (G.) Decurrent, running.

Ablaütern. (G.) To clarify.

Ablaüterung. (G.) Clarifying.

Ablazione. (It.), n. The removal of a part by cutting. Ablation.

Ableben. (G.) Death; to die.

Ablefaria. (It.), n. Congenital absence of all or part of the eyelid.

Ableiten. (G.) To draw off; to derive; to act as a derivative.

Ableitend. (G.) Derivative.

Ableitende Gefässe. (G.) Afferent vessels.

Ableitung. (G.) Derivation, revulsion.

Ableitungskur. (G.) Treatment by revulsives or derivatives.

Ableitungsmittel. (G.) A revulsive remedy.

Ableitungsorgan. (G.) A derivative organ.

Ablenker. (G.) An abductor.

Ablenkung. (G.) Diversion, turning aside.

Ablenkung bei Lähmung. (G.) Deviation in paralysis.

Ablenkung bei Schielen. (G.) Deviation in strabismus.

Ablenkung des Augens durch Prismen. (G.) Deviation of the eyes by means of prisms.

Ablenkung, Primäre und secondäre. (G.) Primary and secondary deviation.

Ablenkungswinkel bei Prismen. (G.) Angle of deviation as measured by prisms.

Ablepharia. (L.), n. f. This is a term used to designate a congenital condition characterized by the absence of lids, wholly or in part. When completely absent the name total ablepharia is used, and when parts of the lids are present it is spoken of as partial or incomplete ablepharia. Whether the processes of the ectoderm, which spring from above and below and which go to and from the lids, fail to de-

velop or, having developed, are destroyed by the pressure of amniotic bands, one is unable to state in the light of present knowledge.

The condition is very rare. The incomplete forms are usually described under the heading of micro-blepharon in which cases the incomplete lids may take the form of nodules or narrow folds of skin surrounding an ill developed or rudimentary eyeball. Where micro-blepharon is present one frequently finds concomitant defects in the eyeball, clefts in the lids of the opposite eye or anomalies in other parts of the body.—(W. F. H.)

Ablepharus. (L.), n. m. One afflicted with ablepharia (q. v.).

Ablepsia. n. Blindness.

Ablepsie. (G.) Blindness.

Ablepsy. n. Blindness.

d'Able's optophone. This is an instrument intended to enable totally blind persons to recognize, locate, and even measure light by means of the ear. It is based upon well-known property of selenium of changing its resistance under the action of light. The principle on which the optophone is constructed is the following: A current from a small battery is sent through a network of four conductors known as a "Wheatstone bridge." Two of these conductors are wire resistances of a few hundred ohms each, the third is a selenium "cell" (now more appropriately termed a "selenium bridge"), and the fourth is an adjustable resistance, made of graphite deposited on ground-glass or unglazed porcelain. When the first two resistances are in the same ratio as the last two, then no current will flow across the network. But a current will flow as soon as one of the resistances changes, as does that of selenium under the action of light. It is this current, made audible in a telephone, which is utilized in the optophone. The instrument consists of two parts, is light and portable and requires very little current, a single pocket "refill" sufficing for days of working. It is believed that great possibilities of aid to the blind may lie in this instrument.

Ablösen. (G.), tr. v. To resolve, disperse.

Ablösend. (G.) Resolvent.

Ablösung. (G.), n. A detachment (as of the retina).

Ablösung der Netzhaut. (G.) Detachment of the retina.

Abmagerung. (G.), n. Emaciation; atrophy.

Abmatten. (G.) To fatigue or tire.

Abmeisseln. (G.), tr. v. To remove with a chisel.

Abmessen. (G.) To measure; to measure exact.

Abmessung. (G.) Measuring, measurement, adjustment.

Abnahme. (G.), n. Ablation or removal of a part by a cutting operation.

Abnahme der Netzhaut. (G.) Ablation or detachment of the retina.

Abnahme der Staphylom. (G.) Ablation of a staphyloma.

Abnorm. (G.) Abnormal, irregular.

Abnormalities, Congenital, in the ocular organs and appendages. See **Congenital anomalies of the eye.**

Abnormität. (G.) Abnormality, deformity, perversion.

Abplatten. (G.) To flatten.

Abplattung. (G.) Flattening.

Abpräparieren. (G.) To dissect off.

Abquellen. (G.) To boil.

Abrasieren. (G.) To shave off; also, to scrape off.

Abrasieren der Cornea. (G.) Abrasion or scraping of the cornea.

Abrasio corneæ. (Lat.) Abrasion or contusion of the cornea. Scraping away of a superficial opacity of the cornea with a knife. These opacities may result from mechanical irritation (trichiasis), calcium deposits, etc.

Abrasion. The rubbing or other superficial removal of tissue, e. g., of the corneal epithelium.

Abrauchschale. (G.) Evaporating vessel.

Abregeln. (G.) To regulate.

Abreibung. (G.) A rubbing off, an abrasion.

Abreissen. (G.) To tear off.

Abreissfraktur. (G.) Fracture by tearing off.

Abreissung. (G.) Tearing off, avulsion.

Abric. An old Arabic term for sulphur.

Abrichten. (G.) To measure exactly, to regulate, to adjust.

Abrin. This is the active principle of the jequirity bean, Abrus precatorius (q. v.). It is really a compound agent, composed of an albumose and a globulin, both of them poisonous. These may be separated from the bean by appropriate means. Any temperature above 122° F. weakens the action of abrin; exposure to a temperature of 185° F. destroys both component agents, the globulin being rendered inert at 176° F.

Abrin is used almost entirely in the treatment of chronic trachoma with pannus. Lapersonne claims that a one per cent. aqueous solution produces the best results. After cocainizing the conjunctiva the internal surface of the upper lid is thoroughly rubbed with a cotton wad soaked in the solution. This is repeated on the second and (perhaps) following days. On examining cases months after

a cure has thus been wrought by the drug the conjunctiva shows scars from the remedial inflammation. Lapersonne re-echoes the claims of many writers that as a remedy for pannus in trachoma it is unequaled.

Abrinden. (G.) To peel, to remove the surface.

Abrinnen. (G.) To run off, to run down, to flow down.

Abrus precatorius. JEQUIRITY. PRAYER-BEADS. CRAB'S-EYES. LOVE-PEAS. This species is indigenous to tropical Asia and Africa, although it has also been grown in America. It belongs to the Leguminosæ and all its parts are poisonous. The seeds only (see **Abrin**) are used in ophthalmic therapy.

Jequirity was first recommended by de Wecker in a half per cent. infusion for the treatment of trachoma and pannus. Infusions should be freshly prepared before use, as they readily undergo decomposition; or they should be made with a saturated solution of boric acid (four per cent.).

When instilled into the conjunctival sac it causes edema of the parts, followed by a serous and eventually a muco-purulent discharge. Swelling of the preauricular and submaxillary glands is frequently noticed, while corneal ulcer and even panophthalmitis have been recorded. For this reason jequiritol and the jequirity serum are safer and to be preferred when abrus preparations are indicated. The method of using these two remedies will be found on the containers and is fully described under the proper headings in this *Encyclopedia*.

Masselon reminds us of this ancient remedy for pannus trachomatosus, that it should be used only in those cases where granulations are unaccompanied by marked secretion; that it should never be applied where there is suppuration. It is especially indicated in old trachoma with pannus and sclerosis of the cornea; it should be thoroughly pulverized and applied to the conjunctiva with a camelhair brush, the lids being everted so that the cornea is protected. The powder is allowed to remain in contact with the lids two to five minutes, and is then brushed off. If the reaction is not marked, this application should be repeated next day. The subsequent inflammation should be treated by cold applications and mild antiseptic washes.

In America, Cheatham, many years ago, strongly advocated the use of this remedy, both powder and infusion, as the most efficacious agent we have for the clearing of pannus, and it is at this date used and recommended by many responsible ophthalmologists.

Although there can be no doubt but that abrus and the various

preparations derived from it (jequirity powder, jequiritol, jequirity serum, etc.) are extremely valuable and reliable in selected cases of trachoma—especially cicatricial trachoma with pannus—yet it must ever be borne in mind that there have been many serious results and some disastrous consequences following its applications, even in experienced hands. For this reason it is well to begin treatment with a weak dose of a watery mixture of the powder or, better perhaps, of some definite percentage of the active principle.

So far as the toxic or destructive effects of jequirity are concerned, in a few recorded cases superficial destruction of epithelium occurred, as well as ulcer and clouding of the cornea, followed by scars, diminution of vision, and even panophthalmitis, with total loss of sight, either from phthisis bulbi or because of a necessary enucleation.

Of 50 cases of jequirity therapy diphtheria of the conjunctiva occurred twice. One of these cases fortunately recovered with corneal nebula but good visual acuity; the other, who had $^5/_{200}$ vision before treatment, suffered loss of both eyes from atrophy of the globe. Dacryocystitis has also been observed, not to mention concurrent periostitis of the nasal and lachrymal bones, infiltration of the cornea, iritis, symblepharon, exophthalmos, lid abscess, hypertrophy of the upper lid, gangrene of the lid, facial erythema and erysipelas.

Absacken. (G.) To become encysted.

Absackung. (G.) Encystment, sacculation.

Absaubern. (G.) To clean, to cleanse.

Abscedieren. (G.) To form an abscess, to suppurate.

Abscedierung. (G.) The formation of an abscess; abscess formation.

Abscediren. (G.), intr. v. To suppurate.

Abscessänhlich. (G.) Abscess-like.

Abscessbildung. (G.) The formation of an abscess.

Abscess, Brain. This condition occasionally gives rise to ocular (focal) symptoms, as hemiopia, blindness, more or less complete, ptosis, conjugate deviation of the head, eyes or both.

A brief reference to the conduct of these cases may be in order.

Great importance attaches to proper asepsis in the treatment of all scalp wounds, infections and head injuries, adequate drainage of otitic and mastoid suppuration, careful attention to purulent nasal discharge, inquiry into possible infection of the accessory nasal sinuses, and the assurance of the best hygiene and sanitation for children convalescing from the acute infectious diseases, particularly scarlet fever, measles and pertussis.

Palliation as it applies to brain tumor and meningitis is hardly

worthy of a trial, except for a special effort directed at the control of vomiting by the use of ice pellets taken by mouth or mustard poultices applied to the epigastrium, thus reducing the liability of the abscess to rupture.

Starr has summed up the question of operative interference as follows: "When a cerebral abscess seems probable from the history of the case and from the symptoms which have developed, and the general progress of the case demonstrates the existence of an increasing and serious focal disease of the brain, it is advisable to operate, even though the symptoms may not be absolutely typical and may present many variations from their usual form. As to the surgical prognosis, Macewen says: 'In uncomplicated abscess of the brain operated upon at a fairly early stage recovery ought to be the rule.'"

Whether the focal symptoms, referable to the visual tract or elsewhere in the brain, will be favorably influenced by operation, and to what extent, can only be determined by the factors governing each case, and may not be categorically stated.—(D. H.)

Abscesschen. (G.) A little abscess.

Abscess der Augenlider. (G.) Abscess of the eyelids.

Abscess der Bienhaut. (G.) Abscess of the periosteum.

Abscess der Bindehaut. (G.) Abscess of the conjunctiva.

Abscess der Linse. (G.) Abscess of the lens.

Abscess des Glaskörpers. (G.) Abscess of the corpus vitreum.

Abscessen der Netzhaut. (G.) Abscesses of the cornea.

Abscessentwickelung. (G.) Development of an abscess.

Abscesseröffnung. (G.) The opening of an abscess.

Abscesshaut. (G.) Membrane; lining or wall of an abscess.

Abscessherd. (G.) Focus of an abscess.

Abscesshöhle. (G.) Abscess-cavity.

Abscess Lanzette. (G.) Abscess lancet.

Abscessmembrane. (G.) Skin, membrane, integument, pellicle, tunic.

Abscess of cornea, lids, orbit, and of other tissues of the eye will be discussed under headings descriptive of diseases of the parts in question.

Abscessöffnung. (G.) Mouth of an abscess.

Abscess, Prelachrymal. Abscess lying in front of the lachrymal sac. It has nothing to do, as a rule, with disease of the lachrymal apparatus, but occurs spontaneously or as the result of injury, generally to the bone, at the inner angle of the eye. The treatment is mostly surgical, but as the condition sometimes presents itself in luetic patients and does not very quickly heal the fact that general medica-

tion is sometimes needed to bring about resolution should be borne in mind.

Abscessreifung. (G.) Ripening of an abscess.

Abscess, Ringformig. (G.) Annular abscess.

Abscesssack. (G.) Abscess sac.

Abscessus cerebri. (L.) Abscess of the brain.

Abscessus siccus. (L.) A name given by the older ophthalmic surgeons to a condition resembling disk-like keratitis, in which although there is something like onyx or a circumscribed purulent deposit in the otherwise clear cornea yet no suppuration is noticeable—i. e., a "dry" abscess.

Abscessverkalkung. (G.) Calcification of an abscess.

Abscessverkäsung. (G.) Caseation of an abscess.

Abscessverkreidung. (G.) Calcification, calcination.

Abscesswand. (G.) Wall of an abscess.

Abschaben. (G.) To scrape off.

Abschabung. (G.) A scraping off, an abrasion.

Abschabung des Tarsus. (G.) Curreting or scraping of the tarsus.

Abschälen. (G.) Excoriate.

Abschälung. (G.) Excoriation, decortication.

Abschäumung. (G.) Desquamation.

Abscheiden. (G.) To separate, to eliminate, to divide.

Abscheidung. (G.) Separation, elimination, division.

Abscheren. (G.) To clip; to cut off with scissors.

Abschiefern. (G.) To exfoliate.

Abschieferung. (G.) Exfoliation, desquamation.

Abschilfernd. (G.) Exfoliative.

Abschleifen. (G.) To grind off.

Abschleifung. (G.) Attrition.

Abschliessung. (G.) Occlusion, obstruction.

Abschliff der Hornhaut. (G.) A corneal facet.

Abschneiden. (G.) To cut off, amputation.

Abschneidung. (G.) Cutting off, amputation.

Abschnitt. (G.) Section, segment, part.

Abschnüren. (G.) To ligature, to snare, to remove by ligature, to constrict, to undergo segmentation.

Abschnürung. (G.) A tying off, ligation.

Abschnürung des Linsenbläschens. (G.) Ecraseuring or snaring off a vesicle.

Abschnürungscysten der Orbita. (G.) The retention of cysts of the orbit.

Abschnürungsfalte. (G.) Segmentation fold.

Abschnürungsvorgang. (G.) The process of segmentation.

Abschuppend. (G.) Scaling, desquamating.

Abschuppung. (G.) Desquamation.

Abschwächung. (G.) Attenuation, weakening, mitigation, modification.

Abschwären. (G.) To separate by ulceration.

Abschwellung. (G.) Shrinking, to decrease.

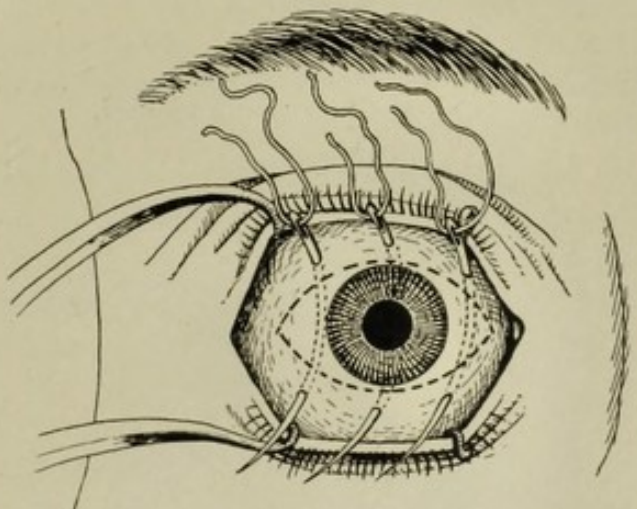
Abschwitzen. (G.) To sweat out.

Abscindern. (G.) Abscission.

Abscissa. In *optics,* a dimension used to designate the position of the point where a ray crosses the principal optical axis of a refracting or reflecting surface with respect to the vertex or pole of the surface as origin. In the case of reflection at a plane mirror the abscissæ are equal, but of opposite signs, or $v' = -v$, called the abscissa-equation for reflection; v, being the distance in front, v′ the distance behind the plane mirror; the positive direction being that which the light pursues in its propagation.

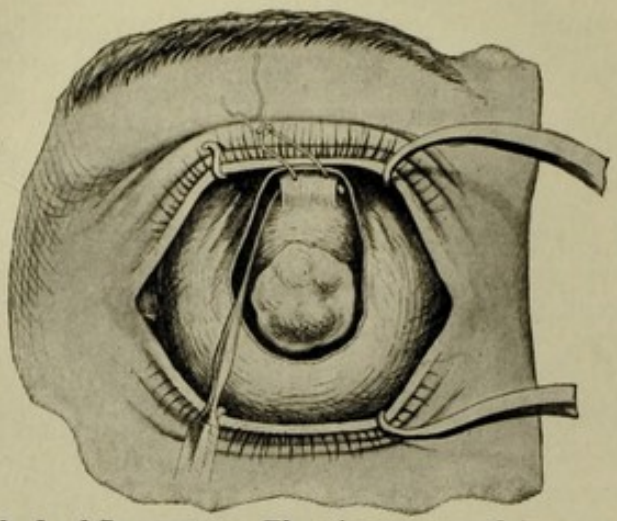
The abscissa-equation for refraction of paraxial rays at a plane surface is: $u' = -\frac{n'}{n} u$, wherein u in the distance in front, and u′ the distance behind the surface, n the refractive index of the first, and n′ the index of the second medium.—Southall, *Principles of Geometric Optics* § 50-53.—(C. F. P.)

Abscissio bulbi. (L.) Abscission of the globe (cornea).

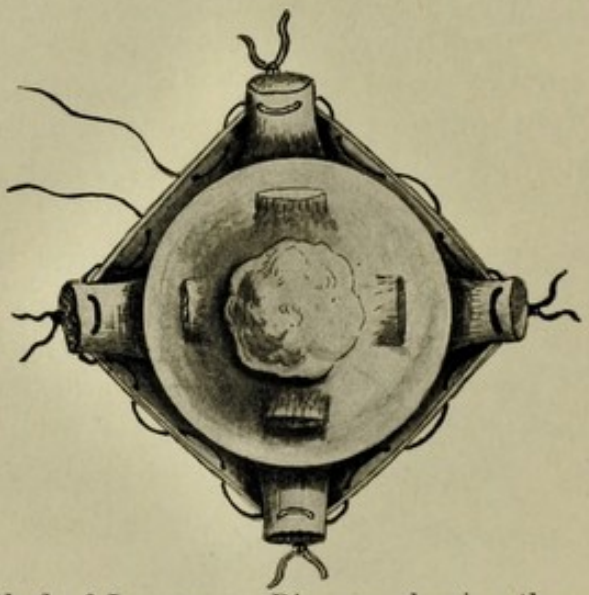


Abscission by Critchett's method. The needles are in position. Showing portion of the eyeball to be removed.

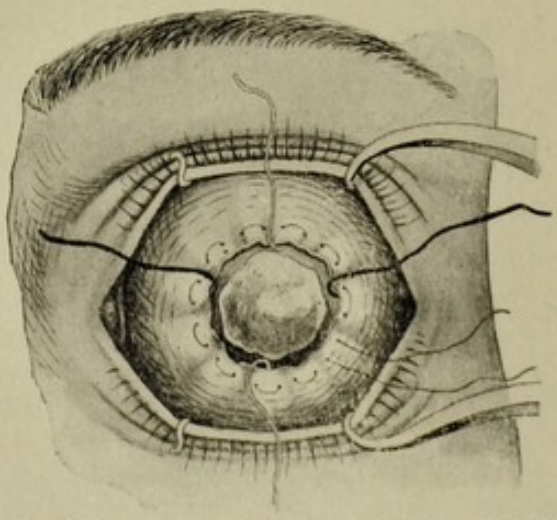
Abscission of the cornea. A term applied particularly to an operation upon a staphyloma corneæ. The more prominent portion is excised,



Abscission. Method of Lagrange. The circumcorneal incision has been made, the tendon raised on the hook and the suture passed through the tendon.



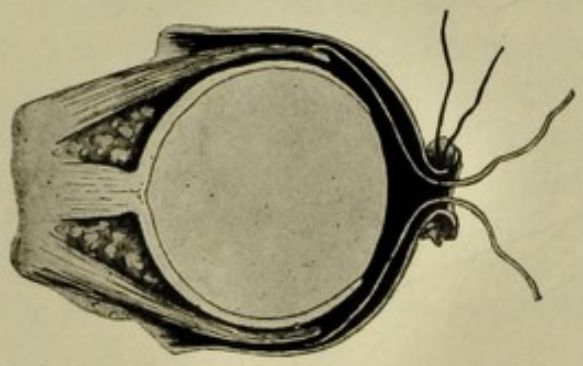
Abscission. Method of Lagrange. Diagram showing the muscles all sutured and the purse-string suture applied.



Abscission. Method of Lagrange. Showing the purse-string sutures holding the muscles protruding from the opening.

the cut edges sutured and the remaining globar tissues form a pad for an artificial eye. The operation was first proposed by Saint Ives in the 18th century, but since that time many operators have favored various forms of abscission (of the cornea), combined or not with evisceration of the globar contents. Two well-known operative procedures are by Critchett and Lagrange.

Critchett passed three curved needles, armed with sutures, through the sclera above and below the cornea, a little back of the area to be removed. The needles were left in position until an elliptical segment of the eyeball was cut out with knife and scissors. The segment included the cornea, iris, lens and some sclera. The needles hindered the escape of vitreous. After the amputation had occurred,



Abscission. Method of Lagrange. The relative positions of the sutures.

the needles were drawn through and the wound was closed by tying the sutures.

Lagrange modified the operation by making, first, the regular sclero-corneal incision and exposing the recti muscles, each one of which was secured with a suture before being severed. A purse-string suture was then passed around the conjunctival opening. Amputation of the anterior portion of the globe followed, after which the superior and inferior recti muscles were tied together and then the internal and external recti muscles. The purse-string suture was then tied and the operation completed.—(F. A.)

Abscission of the eye. See **Enucleation of the eyeball and substitutes for that operation.**

Abseifen. (G.) To remove or cleanse by soap.

Abseihen. (G.) To filter.

Abseihung. (G.) Filteration.

Absetzcisterne. (G.) In chemistry, a settling cistern.

Absetzen. (G.) A set apart, to remove; in chemistry, to percipitate, to deposit.

Absetzung. (G.) To set apart, to remove.

Absieden. (G.) To boil, to make a decoction of.

Absinthe, Oculo-toxic symptoms from. Absinthe is one of the most injurious of the liqueurs, cordials, and other perfumed alcoholic drinks. Besides the oil of absinthe many other poisonous agents enter into its composition.

Animals poisoned with absinthe oil are affected with tonic convulsions, dilated pupils and a congestion of the papillary and retinal vessels, which disappears at death.

A female absinthe drinker suffering from alcoholic epilepsy, showed almost the same symptoms noticed in poisoned animals, especially dilation of the pupil, which remained long after the convulsions had disappeared.

Absolute glaucoma. An advanced form of the disease in which all the usual signs, including total blindness and a high degree of intraocular tension, are present and well marked. See **Glaucoma.**

Absolute heterophoria. The total amount of muscle balance defect (see **Muscles, Ocular**) is, in contradistinction to the *manifest* amount, only to be measured after repeated examinations, especially by the wearing or use of prisms, and complete rest of the eyes of the patient.

Absolute Pupillenstarre. (G.) Absolute loss of pupil-reflexes, especially of light.

Absolute range of accommodation. This expression was introduced by Donders to indicate the monocular range or amplitude of accommodation as opposed to the binocular range.

Absolute scotomata. Defects in the visual field for both form and color. See **Field of vision.**

Absonderened. (G.) Secretory.

Absondern. (G.), tr. v. To secrete.

Absondernd. (G.) Secreting, excreting.

Absonderung. (G.), n. Secretion or excretion.

Absonderungsapparat. (G.) A secretory apparatus.

Absonderungsdrüse. (G.) A secreting gland.

Absonderungsflüssigkeit. (G.) A secretory fluid; secretion.

Absonderungsgefäss. (G.) A secretory vessel.

Absonderungsmittel. (G.) Agent or remedy for exciting secretion.

Absonderungsorgan. (G.) A secretory organ.

Absonderungsstoffe. (G.) Secretions.

Absonderungsstörung. (G.) A disturbance of secretory function.

Absonderungsvermögen. (G.) The power of means of secretion.

Absonderungsvorgang. (G.) The process of secretion.

Absonderungsweg. (G.) The secretory channel.

Absonderungswerkzeug. (G.) An organ of secretion; a secretory apparatus.

Absorbierend. (G.) Absorbent.

Absorbiren. (G.) To absorb, to imbibe.

Absorption. In *physics,* a taking in or reception of molecular or chemical action: as, absorption of gases, light, heat. *Absorption bands,* in *spectrum analysis* (q. v.), dark bands in the spectrum more or less broad and in general not sharply defined. *Absorption of color,* the phenomenon observed when certain colors are retained or prevented from passing through certain transparent bodies. Thus, pieces of colored glass are almost opaque to some parts of the spectrum, while allowing other colors to pass through freely. This is merely a special case of the absorption. *Absorption of light,* that action of an imperfectly transparent or opaque body by which some portion of an incident pencil of light is stopped within the body, while the rest is either transmitted through it or reflected from it. It is owing to this action that, for example, a certain thickness of pure water shows a greenish color, of glass a bluish-green color, etc. *Absorption lines,* in spectrum analysis, dark transverse lines produced in a continuous spectrum of the absorption of incandescent vapors through which light has passed, as in the solar atmosphere; they are in general sharply defined, and are referred to by letters of the alphabet, as a means of identification first suggested by Fraunhofer. In general, absorption-lines are seen only when the substance examined is in the form of a vapor and very highly heated, while *absorption-bands* (see above) may be produced by liquids and solids, as well as by vapors, and at low temperatures. *Absorption-spectrum,* a spectrum with absorption-lines.—(C. F. P.)

Absorptionsbefördernd. (G.) Promoting absorption.

Absorptionsfähigkeit. (G.) Capability of absorbing.

Absorptionsfarbe. (G.) Absorption color.

Absorptionskraft. (G.) Power of absorption.

Absorptionsstreifen. (G.) Absorption lines.

Absorptionsvermögen. (G.) Faculty, ability, power.

Abspalten. (G.) To split up.

Abspaltung. (G.) Splitting up.

Abspannen. (G.) To relax.

Abspannung. (G.) Relaxation, lassitude, debility.

Abspiegelung. (G.) Reflection.

Abspritzen. (G.) To syringe, to remove by syringing.

Abspülen. (G.) To rinse, to wash off.

Abspülung. (G.) Rinsing, washing off.

Abstammen. (G.) To descend from, to be derived from.
Abstammung. (G.) Descent, derivation.
Abstammungslehre. (G.) Theory of descent.
Abstand. (G.) Distance, interspace.
Absteigend. (G.) Descending.
Absterben. (G.) To die, to be benumbed, to become gangrenous or necrosed.
Absterge. (G.) To wipe away.
Abstergieren. (G.) To cleanse.
Abstergierend. (G.) Cleansing.
Abstinenzerscheinung. (G.) Phenomenon of abstinence.
Abstufung. (G.) Gradation.
Abstumpfen. (G.) To blunt, to dull or deaden, to neutralize; to become deadened or dulled.
Abstumpfend. (G.) In chemistry, to neutralize.
Abstumpfung. (G.) Blunting, dulling or deadening, neutralization.
Absüssen. (G.) A precipitate wash.
Abszess des Gehirnes. (G.) Abscess of the brain.
Abszess des Glaskörpers. (G.) Abscess of the vitreous.
Abszess der Hornhaut. (G.) Abscess of the cornea.
Abszesse, Periostale, der Orbita. (G.) Periosteal abscess of the orbit.
Abtasten. (G.) To palpate, to examine with the hand.
Abtauchen. (G.) To clean by submerging or dipping.
Abtöten. (G.) To kill, to destroy.
Abtötung. (G.) Killing, destruction.
Abtragen. (G.) To remove, excise, extirpate.
Abtragung. (G.) Ablation; to remove, excise, extirpate.
Abtragung des Ciliarbodens. (G.) To extirpate the ciliary part of the lid.
Abtragung des Haarzwiebelbodens. (G.) Excision of the base of the hair bulb.
Abtragung des Staphyloms. (G.) Exsection of a staphyloma.
Abtrennen. (G.) To separate, to dismember.
Abtrennung. (G.) Separation, dismemberment.
Abtrocknen. (G.) To wipe off, or dry by wiping.
Abtupfen. (G.) To cleanse or remove by mopping.
Abu Bekr Mohammed ibn Badjeh. An Arab-Spaniard philosopher and oculist who lived mostly in Fez, about 1172. See **Avempace.**
Abu-Bekr Muhammed b. Zacharijah ar-Razi. One of the names of the celebrated Arabian philosopher and medical teacher—Rhazes—who flourished during the ninth century of the Christian era. See **Ar-Razi.**

Abubertus. One of the many names of Rhazes, the famous Arabian physician and ophthalmic writer who lived during the ninth century of the Christian era. See **Ar-Razi.**

Abubeter. One of the numerous names of the celebrated Arabian physician and ophthalmic writer, Rhazes, who flourished about A. D. 880. See **Ar-Razi.**

Abu Gafar b. Harun at-Targali. A Spanish-Arabian oculist, who practised at Seville in the 12th century. In his later years he became paralysed, but continued to give advice. He left no writings.—(T. H. S.)

Abul Barakat al-Katai. Body physician to Saladdin; died at Cairo, 598. He was a distinguished operator on the eye, but wrote nothing concerning that organ.—(T. H. S.)

Abulcasis. A distinguished Arabian physician and ophthalmologist. See **Abul Kasim ben Abbas al-Zarawi.**

Abulfadl Abdalmumin b. Omar al-Andalusi. A Spanish-Arabian poet and ophthalmologist, who removed from his native country to Damascus at the beginning of the 13th century. He was called The Physician of His Epoch, yet practically nothing is known to-day concerning him.—(T. H. S.)

Abul Farag b. at-Tajjib. A Nestorian priest and philosopher of the 11th century, known to have composed a book *On the Diseases of the Eye.*—(T. H. S.)

Abul Haggag Jusuf. An oculist of the Arabian period at Cairo. He was known to have taught the father of Usaibia.—(T. H. S.)

Abulkasim. A distinguished Arabian physician and ophthalmologist. See **Abul Kasim ben Abbas al-Zarawi.**

Abul Kasim ben Abbas al-Zarawi (also known as ABULKASIM, ABULCASIS, ALBUCASIS, BUCASIS, ALZAHARAVIUS, etc.). This author, the greatest of all the Arabic writers on surgery, was a Spaniard. The place and date of his birth are not known, but he died, extremely old, at Cordova, Spain, A. D. 1013. His surgery formed only a part of his great general work on medicine, *al Tasrif* (The Explanation). Based chiefly on the teachings of the Greeks, especially Paulus of Aegina, it exhibits, nevertheless, considerable evidence of a rich personal experience and the keenest powers of observation. The illustrations of surgical instruments in this work are particularly interesting. Like many another prophet, Abul Kasim was largely without honor, not merely in his own land but even in his own age. A much belated, but well deserved, recognition was, however, accorded to him, ultimately, throughout Western Europe; and, indeed, it was chiefly owing to the fact that the masterful and comprehensive al Tasrif

was translated into excellent Latin and then widely circulated in mediaeval Christendom that the attention of European scientists was eventually directed to the highly valuable writings of Arabian ophthalmologists. Even at the present day, al Tasrif constitutes easily the most copious and most valuable fountain of knowledge concerning Arabic surgery, ophthalmic and general, and its distinguished author must be accorded a place in Arabic medicine second perhaps only to those of Rhazes and Avicenna.

The ophthalmic parts of the great book are scattered more or less throughout the surgical division. The surgical section falls into three books: the first of these relates to cauteries, the second to incisions and bloody operations in general, the third to the setting of dislocated bones. In the second book occur most excellent descriptions of the following operations on the eye, as these were performed about 1000 A. D.

Chap. 8. Removal of Lid-Warts.
Chap. 9. Treatment of Chalazion.
Chap. 10. Operation for Hydatids.
Chap. 11 and 12. Five Operations for Diseases of the Cilia.
Chap. 13. Operation for Lagophthalmos.
Chap. 14. Operation for Ectropion of the Under Lid.
Chap. 15. Operation for Symblepharon.
Chap. 16. Extirpation of Pterygium and of Swollen Caruncle.
Chap. 17. Operation for Wild Flesh and Chemosis.
Chap. 18. Pannus.
Chap. 19. Operation for Lachrymal Fistula.
Chap. 20. The Reposition of Prolapsed Eyeballs.
Chap. 21. The Excision of Prolapsed Iris.
Chap. 22. The Treatment of Hypopion.
Chap. 23. Cataract Operation.

Though all these operations are described very briefly, the language is simple and clear. Abul Kasim as an ophthalmologist is only excelled, among the Arabs, by Ammar and by Ali ben Isa.—(T. H. S.)

Abul Mutarrif Abd ar-Rahman b. Muhammed b. Abd al-karim b. Jahja Ibn-Wafid al-Lahmi. The Arabian name of a distinguished Spanish-Arabian physician and ophthalmic author who lived during the eleventh century of our era. See **Abenguefit.**

Abul Qasim Hibat-Allah b. Fadl. A physician and poet of Bagdad, (1086-1162 A. D.) who is said to have made a specialty of diseases of the eye.—(T. H. S.)

Abumeron. One of the names of an illustrious Jewish oculist who lived in Spain at the end of the eleventh century. See **Avenzoar.**

Aburchung. (G.) Segmentation, subdivision.

Abu Ruh. bin Mansur bin Abi Abdallah bin Mansur alyamani. He was also known as ZARRIN-DAST, or "Goldhand"—not, probably in allusion to his earning-power, but to his gentleness and skill. A distinguished Persian ophthalmologist of the 11th century, born at Gurgan on the Oxus, and educated both in his native Persian and in Arabic. His work, *The Light of the Eyes*, constituted the standard ophthalmologic text-book in Persia for many centuries. The title of the volume was selected, according to the author himself, because he who reads and understands the work will preserve the light of his own eyes and never require the services of the ignorant physician. The book is written in a prolix style and in question-and-answer form, after the fashion of the work of Hunain (q. v.).

The Light of the Eyes consists of ten chapters, or books. The first treats of the Anatomy of the Eyes; the second, of Ocular Diseases Perceptible by the Senses; the third, of Ocular Diseases not Perceptible by the Senses; the fourth, of the Treatment of Curable Diseases of the Eye; the fifth, of the Incurable; the sixth, of Ocular Hygiene; the seventh, of Ocular Surgery; the eighth, of Glaucoma; the ninth, of Simple, and the tenth of Compounded Medicines for the Treatment of Ocular Disease.

In the seventh (the surgical) book of his work, Zarrin-Dast presents the following list of operations, which, in his day, were performed upon the eye—a list which is especially valuable, because by far the most complete now extant from the Arabic middle ages:

1. The Scratching Out of Granulations.
2. The Removal of Chalazia.
3. The Removal of Calculi.
4. The Separation of Symblepharon.
5. The Trussing-Up of Superfluous and of Incurving Hairs, and the Operation for Entropion.
6. The Transplantation of Superfluous Hairs, when These are not Numerous, by means of the Needle.
7. The Burning of Superfluous Hairs with Chemical Caustics and with Fire, and the Gluing [fixing] of the Hair with Mastich.
8. The Eradication of Hydatids.
9. The Removal of Excresences from the Lid.
10. The Removal of the Ant-Like Ulcer.
11. The Relief of Lagophthalmos.
12. The Removal of Warts.

13. The Removal from the Lid of Encysted Tumors.
14. The Cure of Furuncles.
15. The Shaving Off of Lid-Scabs.
16. On the Opening of Tear-Abscesses in the Beginning.
17. The Burning Out of Tear-Abscesses and the Scraping-Out and Shaving-Off of the Carious Bone.
18. The Trephining of Bone Become Carious as a Result of a Tear-Abscess.
19. The Removal of the Lachrymal Papilla.
20. The Removal of Pannus.
21. The Removal of Pterygium.
22. The Removal of Proud Flesh.
23. The Removal of Foreign Bodies from the Conjunctiva.
24. The Relief of Prolapse [Exophthalmos].
25. The Removal of Hypopion.
26. The Cataract Puncture with the Cataract Needle, either Solid or Hollow.
27. The Drawing Out of the Temporal Artery.
28. The Burning of the Temporal Artery.
29. The Excision of the Temporal Artery.
30. On the Letting of Blood, which, in the case of Diseases of the Eyes, must be Performed Either in the Veins by the Corners of the Eyes, or of the Forehead, or of Both Temples, or of the Wings of the Nose, or of the Upper and Lower Margins of the Orbits.

This book, because of its richness and fullness and its highly practical character, is (despite its prolixity and the question-and-answer form plainly indispensable to a complete understanding of the ophthalmology of the Arabian middle ages. Only two other ophthalmographers of the time are worthy to be ranked with Zarrin-Dast—Ali ben Isa and Ammar.—(T. H. S.)

Abu Zakarija Juhanna b. Masawaih. (He was also called FILIUS-MESUE, because of his sonship to Masawaih Abu Juhanna). This rather unimportant Arabian ophthalmographer (777-857 A. D.) is known to us chiefly because of the numerous references made to him in the *Continens* of Razes; also because of his two books: *Knowledge of the Examination of Oculists* and *Alteration of the Eye.*—(T. H. S.)

Abversion. The turning of one or both eyeballs outward.

Abwaschen. (G.) To wash off.

Abwaschung. (G.) Lotion.

Abwechseln. (G.) To alternate, to intermit.

Abwechselnd. (G.) Intermittent, alternating.

Abweg. (G.) A diverticulum.
Abwehrmittel. (G.) A prophylactic.
Abweichen. (G.) To deviate, to soften.
Abweichend. (G.) Abnormal, deviating, irregular, aberrant.
Abweichung. (G.) Anomaly, deviating, deflection.
Abweichungswinkel. (G.) Angle of deviation.
Abweinen. (G.) To expiate by tears, by weeping.
Abzapfen. (G.) To tap, to drain.
Abzapfer. (G.) A trocar, a catheter.
Abzapfung. (G.) Tapping, drawing, draining, paracentesis, paracentesy.
Abziehaugenmuskelnerv. (G.) Trochlear nerve.
Abziehen. (G.) To draw away, to abduct.
Abziehend. (G.), adj. Abducting. Functionating as an abductor.
Abziehender Augenmuskel. (G.) The external rectus muscle.
Abziehermuskel. (G.) Abductor muscle.
Abzieher. (G.) An abductor.
Abziehung. (G.), n. Movement from the median line of the body, or of an extremity. Abduction.
Abziehungsvermögen. (G.) Power of obstruction, abstractive faculty.
Abziehmuskel des Auges. (G.), n. See **Abducens.** The external rectus, the action of which is to roll the globe outward.
Abzug. (G.) Drain.
Abzugskanal. (G.) A drain, a conduit.
Acacalis. (L.), n. f. An Egyptian shrub mentioned by Dioscorides, the seeds of which were used by the ancients as a remedy for ophthalmia. It has been supposed to be a variety of Acacia arabica.
Acacia. Gum arabic. This is the dried exudate from various species of the leguminose acacia, obtained mostly from Egypt and the Soudan. It is seen in commerce in the shape of rounded tears or irregular fragments.

It consists chiefly of compounds of arabic acid with calcium and other bases. The adulterations are mostly starch and inferior or cheaper gums.

Gum acacia has a soothing action on mucous membranes and is generally employed as a mucilage. In this form it has an occasional use in burns of the eyeball from most agents. In the form of fine powder it is occasionally used as a vehicle for other powders. It is now and then employed in collyria.
Academisch. (G.) Academical, academic.
Acahi. An old name for alum water.

Acanthope. (F.), adj. An animal whose eyes are furnished with spinous processes.

Acanthosis nigricans. This condition presents superficial papillomatous outgrowths on the intermarginal space of the eyelids, as described by Birch-Hirschfeld.

Acaro. (It.) Acarus or louse.

Accessoire. (F.), adj. and n. Accessory.

Accessoires de l'oeil. (F.) The appendages of the eye, i. e., eyebrows, lids, lachrymal apparatus, etc.

Accessorisch. (G.) Accessory.

Accessory sinuses. See **Cavities, Neighboring, Ophthalmic relations of.**

Accidental colors. In *optics,* complementary colors seen when the eye is turned suddenly to a white or light-colored surface, after it has been fixed for a time on a bright-colored object. If the object is blue, the accidental color is yellow; if red, green, etc. Thus, if we look fixedly at a red wafer on a piece of white paper, and turn the eye to another part of the paper, a green spot is seen.

Accidental light. In *painting,* a secondary light which is not accounted for by the prevalent effect, such as the rays of the sun darting through a cloud, or between the leaves of a thicket, or the effects of moonlight, candle-light, or burning bodies, in a scene which does not owe its chief light to such a source.

Accident insurance in ocular affections. See **Injuries to the visual apparatus**; also, **Legal relations of ophthalmology.**

Accidents, Prevention of ocular. See **Injuries of the eye; Railway employees, Eyes of; Hygiene of the eye.**

Accommodation. n. The process by which the refractive condition of the eye is changed in accordance with the distance at which an object is to be viewed, so as to secure effective focusing of the image on the retina.

When an eye is at rest rays coming from a distant object (20 feet) are practically parallel, and are focused on the retina. Rays from a point nearer than 20 feet are more divergent and are focused behind the retina, causing a blurred image. In order that these divergent rays may be brought to a focus on the retina the eye must so increase its refractive power that the image of a near object focuses exactly at the macula lutea and forms a clear and distinct picture. The change that in this way takes place is called the accommodation. According to the theory of Helmholtz it is brought about by a contraction of the ciliary muscle which relaxes the suspensory ligament and allows the crystalline lens to become more convex.

There are other alterations in the ocular apparatus that accompany this lenticular change. The ciliary fibrillæ which are attached posteriorly to the choroid by fibres, known as the tensor choroideæ contracts, drags the choroid forward; the pupil at the same time becomes narrow (thus reducing aberration) and the internal rectus muscle draws the eye inward, so that a proper relation between convergence and accommodation is secured. The crystalline lens, being soft and elastic, tends, as a passive process, to bulge forward anteriorly and assume a more spherical shape during this act. In consequence of the pushing forward of the whole lens-system in this way the iris approaches the posterior surface of the cornea and the anterior chamber becomes slightly more shallow.

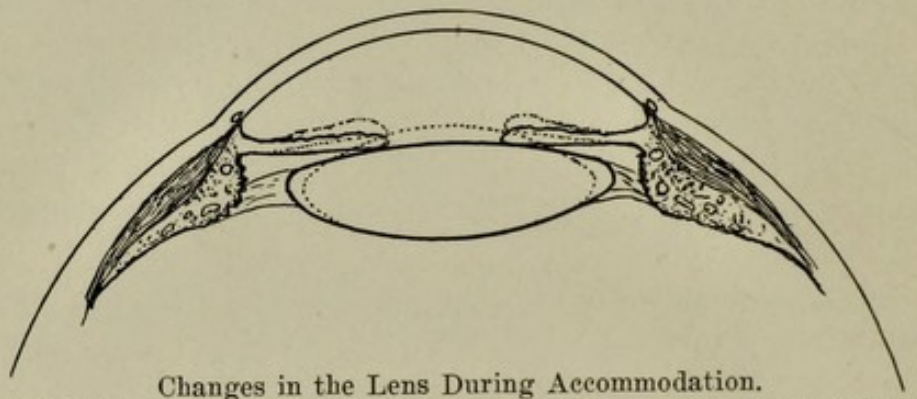
The lens is most elastic and flexible during early childhood. Each year it loses a certain amount of elasticity until about 60 years of age it fails to respond to the contractions of the ciliary muscle at all and all power of accommodation is lost. As will be seen by reference to the headings that follow, the theory of Helmholtz is not the only one that offers an explanation of the method by which the visual apparatus adjusts itself for clear vision at different distances. See **Accommodation, Schoen's theory of. Accommodation, Tscherning's theory of.** See **Refraction and accommodation; Physiological optics.**

Accommodation, Amplitude of. See **Amplitude of accommodation.**

Accommodation, Apparent. PSEUDO-ACCOMMODATION. It was long ago noticed that *aphakic* individuals can see almost equally well at different distances. This was explained by action of the extrinsic eye-muscles, which were supposed to lengthen the axis of the eyeball and thus, to a certain degree, replace the accommodation of the lens. Investigations by Sattler and others have shown that this view is not correct. Such "accommodation" can be better explained by comparing it with the reading of very fine print, which we can still read even if the image does not fall directly upon the retina, but is seen more or less in diffusion-circles. Furthermore, the different parts of the cornea do not have the same refractive index, which may vary several diopters about the pupillary region. Thus, at different distances of the object different parts of the refracted cone of rays may come to a focus upon the retina and be sufficient for vision, giving the impression of accommodation.

Kröner rejects the explanations that have generally been given for apparent accommodation in aphakic eyes, such as changes in the cornea, lens remains in the pupil, changes in the curvature of the vitreous, index of refraction, length of optic axis, or in the

position of the spectacle glasses. He does find some connection between such accommodation and astigmia, but the latter is not the only factor, for some astigmic eyes do not accommodate, while some anastigmatic ones do. And it is not in Donders' sense that the eye makes use now of one of the foci and then of the other, for the region of such accommodation does not correspond to the optical distance between these two points. It is generally greater in eyes with little astigmia and less in the highly astigmatic. Irregular astigmia, imperfect centration, and especially *spherical aberration* (q. v.) which is largely compensated by the lens in the normal condition, are all contributing factors. In general it results from influences which by diminishing visual acuity lessen the necessity of exact focussing, but the phenomenon seems independent of the size of the circles of diffusion so far as the latter are capable of exact measurement. (*Ophthalmic Year Book,* Vol. VIII, p. 59.)



Changes in the Lens During Accommodation.
Dotted lines show swelling of anterior surface during accommodation.

Accommodation, Binocular range of. Donders distinguished between binocular and monocular (or absolute) range of accommodation. He believed that with the ordinary methods the monocular near point is nearer to the eye than the binocular. He explained this on the assumption that in monocular vision the lens is more strongly curved because the ciliary muscle contracts more strongly, owing to the stronger convergence.

According to Hess, the monocular near-point is only apparently nearer to the eye than the binocular near-point because, with the ordinary methods of examination, the pupil is more decidedly contracted in the former case than in the determination of the binocular near-point. If all these errors are eliminated—by instruments based on the Scheiner experiment, for instance—it is found that the monocular and binocular near-points are equidistant from the eye.

Accommodation, Cramer's theory of. Cramer attributed the accommodation of the eye for near vision to the contraction of the iris. He believed that in a state of repose the organ became greatly

swollen in front, while during the accommodative act there was a simultaneous contraction both of the *dilator* and *sphincter iridis*. In this way pressure is exerted on the periphery of the lens. The ciliary muscle at the same time contracts, exerts contraction on the choroid, and these combined influences push the vitreous forward. The lenticular tissues, thus subjected to pressure throughout their whole mass except in the pupillary area, swell up at this central point. The theory of Cramer was accepted in many quarters until von Graefe published an account of his well-known case of complete aniridia in which he demonstrated that the amplitude of accommodation was, even in the entire absence of the iris, completely intact.

Accommodation, Carmona y Valle's theory of. The act of accommodation is accomplished by the compression of the periphery of the crystalline lens through the action of the circular fibers of the ciliary muscle. This compression acts upon the anterior fibers of the zonula, squeezes the soft portion of the lens and crowds it toward the center where it produces a sort of lenticonus. As the lens is supported posteriorly by the vitreous the anterior surface is necessarily mostly affected.—(*Annales d'Oculistique*, March, 1900.)

Accommodation, Field of. See **Amplitude of accommodation.**

Accommodation, Grossmann's theory of. Grossmann was able to observe in a case of congenital aniridia the following changes during the accommodative act: The diameter of the lens equator becomes smaller; the antero-posterior diameter of the lens increases; the anterior pole of the lens moves forward, and its posterior pole backward; both the anterior and posterior surfaces of the lens form a lenticonus; the lens *in toto* moves upward and inward.—(deSchweinitz.)

Accommodation, Line of. The line of accommodation is that distance in space along which an object is distinctly seen, even though the image-rays do not fall accurately upon the percipient retina. The length of this line depends upon the width of the pupil, the capacity of the retina, the refractive power of the optical apparatus, etc. It corresponds to a dioptric value of 0.066 D. for the lens-containing reduced eye; that is, if two points can be seen distinctly when their distance apart on the retina is 0.004 mm. For an aphakic eye the same conditions would correspond to 0.043 D. These figures hold good only if it is assumed that all parts of the macular region are of the same refraction; but as this is seldom true, the line of accommodation is usually greater than that of the reduced eye. See **Refraction and accommodation. Physiological optics.**

Accommodation, H. Muller's theory of. After he had discovered what he regarded as circular fibres in the ciliary muscle this scientist be-

lieved that the changes in form which we know the lens undergoes during the act of accommodation might be brought about by direct pressure of the muscle. This hypothesis was, of course, abandoned when it was known that the ciliary does not come in contact with the crystalline body.

Accommodation, Negative. In this condition all the structures that take part in the act of accommodation (q. v.) are supposed to be at rest; both eyes gaze into infinity and there is no effort to fix an object. However, the nearest approach that can be made to realizing absolute negative accommodation is when not only these conditions prevail but when the eyes are also thoroughly atropinized.

Accommodation, Painful, of Donders. This is a name given to an hysterical disorder of accommodation—probably the most common eye symptom of hysteria. It is of the nature of spasm and the patient is often unable to make any use of the eyes for near-work. See **Amblyopia, Hysterical.**

Accommodation phosphenes. An entoptic phenomenon occurring during strong voluntary accommodation. The most frequently observed phenomenon of this kind is that of Purkinje—a dark spot in the region of the point of fixation, especially when one regards an object on a white background. *Czermak's phosphene* is the appearance of a bright border around the visual field during a sudden relaxation of accommodation in the dark, said to be due to dragging on the retina about the ora serrata.

Accommodation, Pseudo. See **Accommodation, Apparent.**

Accommodation, Range of. See **Amplitude of accommodation.**

Accommodation, Relative range of. By this term is meant the faculty of increasing or diminishing the accommodation in correspondence with the convergence. Curves of relative range of accommodation have been constructed repeatedly. Hess has advanced the following law intended to express the relation between convergence and accommodation: with each convergence-innervation there goes an accommodative effort of a certain extent which, with fixed convergence, can be increased or decreased within certain limits. The extent of the increase or decrease is about the same for all degrees of convergence, if the accommodation is manifest. In other words the margin within which the accommodation can be separated from the medium convergence is independent of the absolute extent of the convergence. The same relations which exist between convergence and manifest accommodation most likely exist between convergence and contraction of the ciliary muscle.

Accommodationsbreite. (G.) Range of accommodation.

Accommodationsbreite, Binocular and monoculare. (G.) Range of accommodation, binocular and monocular.

Accommodationsbreite, Relative. (G.) Relative accommodation.

Accommodation, Scheinbare. (G.) Apparent accommodation.

Accommodation, Schoen's theory of. The contraction of the ciliary muscle produces the same effect on the lens as it does on a rubber ball when the latter is held in both hands and compressed with the fingers. See **Refraction and accommodation; Physiological optics.**

Accommodationslähmung. (G.) Paralysis of accommodation.

Accommodationslinie. (G.) Accommodation lines.

Accommodationskrampf. (G.) Spasm of accommodation.

Accommodationsmuskel. (G.) Ciliary muscle.

Accommodation, Spasm of. ACCOMMODATIVE CRAMP. Under this heading a number of phenomena have been included. The most common is apparent myopia in young persons, which partly or entirely disappears after the use of atropine. Several authors believe that this form of spasm (that is nearly always accompanied by short sight) is quite common (20 per cent. to 40 per cent. of all school children) and that it may develop into true, axial myopia. The reported cases can partly be explained by the known decrease in the refraction of the periphery of the cornea and lens, parts that become visually active after atropine applications. The typical picture of accommodative spasm can be produced by eserine instillations. If the pupil is much contracted, the near-point approaches the eye, and the range of accommodation is apparently increased. Generally, however, the near-point is not nearer to the eye than it can be brought by strong voluntary effort at accommodation. The far-point, in such cases, approaches the near-point more or less, and the range of accommodation is shortened, and this certainly suggests myopia.

Other causes of accommodative cramp are hysteria, irritation of the eye from injury, inflammatory changes, etc.

Accommodationsschwäche. (G.) Accommodative weakness.

Accommodationsvermögen. (G.) The power of accommodation.

Accommodation, Tscherning's theory of. By the contraction of the anterior part of both the radiating and circular fibers of the ciliary muscle the ciliary processes are drawn backward, the suspensory ligament is pulled backward and outward, and the pressure exerted by the anterior portion of the muscle brings about an increased convexity of the lens. See **Refraction and accommodation; Physiological optics.**

Accommodation, Weakness and paresis of. This condition is, in effect,

a decrease in the power of the ciliary muscle resulting in the recession of the near-point. As Hess points out, the old idea that a normal near-point indicates normal function of the ciliary muscles is not necessarily true, since paresis of the ciliary muscle is not noticed in accommodation until it is greater than the latent accommodation. Owing to the fact that the latter increases with advancing age, old people may be afflicted with a considerable paresis of these muscles, and still the near-point may be normal. This fact has been frequently overlooked, and for this reason it has been erroneously stated that cocaine does not affect the accommodation. After an instillation or subconjunctival injection of cocaine the near-point invariably recedes from the eye in young persons, while the recession is difficult to detect in older people. Just as atropin may not have any influence upon the near-point of a man of seventy, regardless of the fact that it paralyzes the ciliary muscle, a weak cocaine solution may not appreciably affect the accommodation of a man 40 to 50 years of age. If we read that a patient 50 or 60 years old has a normal near-point, and from this draw the conclusion that he has a normal accommodation, we must see at once that such a conclusion is not tenable, since the ciliary muscle may be completely paralyzed regardless of the fact that the accommodation is normal. It is for this reason that subjective disturbances resulting from ciliary paresis or weakness must in young persons be more pronounced than *ceteris paribus* in older people. Moreover, such disturbances are less marked in myopes than in emmetropes, and less in the latter than in hypermetropes. Common to all these disturbances is this recession of the near-point while the far-point remains in its normal locality.

The most common clinical cause of accommodative paresis is diphtheria, which affects the ciliary muscles only, the iris musculature remaining intact. The paresis usually occurs in from 2 to 3 weeks after the diphtheric infection, and in most cases recovery is complete after 3 to 4 weeks. Among other causes of paretic accommodation are: partial or total paresis of the third nerve, various cerebrospinal diseases, hysteria and a number of intoxications—ptomaine poisoning, for example.

The prognosis depends upon the nature and curability of the primary disease; as far as diphtheria is concerned the ciliary paresis as a rule gets well. The so-called hysterical paresis of accommodation is, of course, purely psychic. (See *Encyklopädie der Augenheilkunde*. A. B., p. 6.)

Accommodative. adj. Pertaining to the function of accommodation (q. v.).

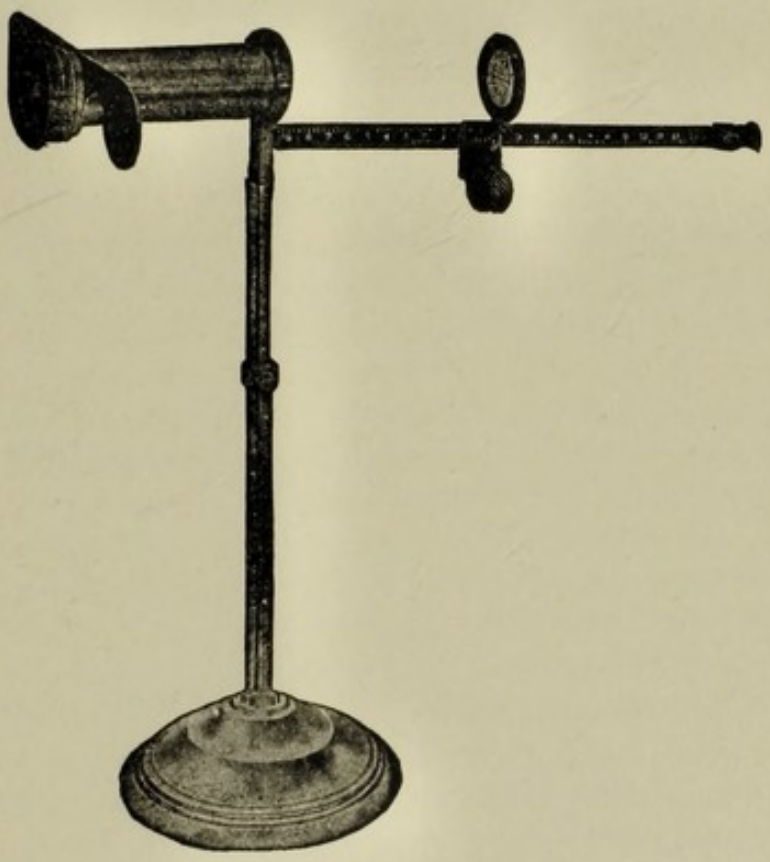
Accommodative associated movements. This term is sometimes applied to the movements of convergence and divergence, accompanying binocular fixation and focussing at varying distances, which involve a corresponding change in the accommodation.

Accommodative asthenopia. Asthenopia due to congenital weakness in or to an overworked ciliary muscle. This weakness is mostly due to errors of refraction and accommodation and the consequent strain on the ciliary muscle in its efforts to overcome the defects.

Accommodative Augenbewegungen. (G.) Accommodative ocular movement.

Accommodazione. (It.), n. Accommodation; i. e. the process by which the refractive condition of the eye is changed in accordance with the distance at which an object is viewed.

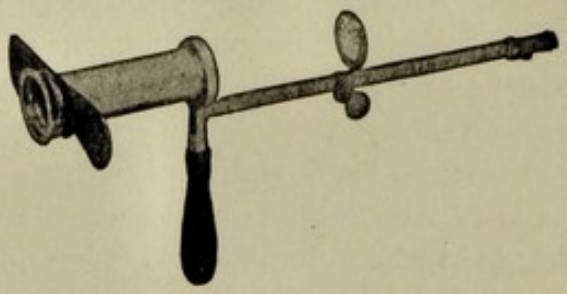
Accommodometer. Also called, PUNCTUMETER and ROD-OPTOMETER. An instrument, devised by Adam, for measuring the region and the



Accommodometer.
Counter Form.

range, or amplitude, of the accommodation. Its construction is sufficiently obvious from the annexed illustrations, one of which shows the hand-, the other the counter-form. The little object-carrier slides to and fro on a graduated scale, and the object which it carries

is either a bit of fine print or some conventional device—e. g., two fine threads stretched at right angles across the carrier's aperture.



Accommodometer.
Hand Form.

The eye-piece may or may not be furnished with lenses. The purpose of the instrument is to determine, with or without lenses, the distance at which the objects are most plainly seen, and so the refraction for near. Accommodometers were formerly much used, especially by opticians, but of late have almost entirely disappeared. —(T. H. S.)

Accompagnement de la cataracte. (F.) An obsolete term for a whitish, viscid substance supposed to occupy the place of the crystalline lens after the removal of cataract.

Accompaniment (of the cataract). An obsolete term for secondary or recurrent capsular cataract; opacity of the capsule following an operation for cataract; or for a viscid substance supposed to take the place of the extracted lens.

Acconamosali. Said to have been an Armenian. This man was the author of a celebrated work in Arabic on the diseases of the eye. See **Canamusali de Baldach.**—(T. H. S.)

Accrescenz. (G.) Accretion.

A. C. E. mixture. An inhalant compound containing one part of alcohol, two of chloroform and three of ether. It is supposed to be indicated in general anesthesia when neither ether nor chloroform can be taken alone. See **Anesthesia in ophthalmic surgery.**

Aceognosia. (L.), n. f. A knowledge of remedies.

Aceology. n. Therapeutics in general, especially operations and mechanical appliances.

Acetaldehyd. (G.) Acetaldehyde.

Acetameisensäure. (G.) Acetoformic acid.

Acetanilid, also called antifebrin and phenylacetamid, occurs as white, shining, crystalline scales. It is odorless and has a slightly burning taste. It is soluble in about 180 parts of cold and 18 parts of boiling water. Antifebrin has but a slight application in ophthalmology but has been recommended as a dusting powder after operations

(as a substitute for iodoform), but is not as effective as that ill-smelling drug. Taken in toxic doses it has produced temporary blindness with retinal anemia.

Antifebrin (as it is commonly called) in toxic doses not infrequently causes mucous and dermal eruptions, from which the lids and ocular conjunctiva are not exempt. No doubt when severe symptoms, as temporary blindness with retinal anemia, follow a relatively small dose it is due to an idiosyncrasy. After taking 0.60 gram of antifebrin a patient had an erythematous eruption over the entire body, including the conjunctiva. In one recorded case a woman had a conjunctival exanthem from taking half a gram of the remedy, the eruption being accompanied by a pricking sensation in the eye as well as lachrymation.

The pupils are also affected in some examples of poisoning. In one instance after a dose of 3 grams they did not react to light; in another case the same result followed a 4-gram dose. In still another case, 2½ hours after 7 grams were administered, the pupils were very small and had also lost the usual reflexes. Occasionally mydriasis has been noticed. Rarely double vision and marked amblyopia occur.

In many cases the poison acts like a quinine intoxication. Thus, after the ingestion of 3 grams of antifebrin, some patients experience vertigo and tinnitus, and in more than one case the visual acuity sank to a minimum in both eyes and the patient was unable to find his way about the room.

In another instance of intoxication the pupils were dilated and lost their reflexes while hand-movements were perceived with difficulty at a few feet. The field of vision was greatly restricted, the papillæ were pallid, and the caliber of the vessels narrowed. Amyl nitrite was administered, followed after the first inhalation by improved vision. The face reddened, the pulse increased, and the improvement in sight continued during the two hours of inhalation. The cause of these serious visual disturbances is probably an acute anemia of the nerve centers from vascular spasm, as are paleness of the face and the blanching of the mucous surfaces. The effect of the amyl nitrite treatment also indicates such a process as directly affects the end vessels as well as the central vascular supply.

The retinal veins have in a few instances been described as dilated after the ingestion of large amounts of antifebrin, but in most cases this was not observed. See **Toxic amblyopia**.

Acetessigester. (G.) Aceto-acetic acid.

Acetessigsäure. (G.) Aceto-acetic acid.

Acetic acid. $HC_2H_3O_2$ or CH_3COOH. The acid of common vinegar.

Almost all the acetic acid of commerce is obtained by the destructive distillation of wood, although domestic vinegar is derived from the acetous fermentation of grain.

Dilute vinegar is of some value in neutralizing burns of the conjunctival sac and eyeball from caustic soda, potash and lime. Of course it should be applied at once, preferably warmed and used with an undine or medicine dropper to wash out the deleterious substances, at the same time converting them into less destructive compounds.

Warts of the palpebral skin may be removed by the application of the glacial acetic acid. This is an anhydrous, crystalline form of the acid which liquefies at 60°F. into a colorless fluid with a strong vinegar odor and a pungent, acid taste. It should be applied with care, as it is a powerful caustic and may involve a wider area than the diseased growths. For the removal of warty excresences the fuming nitric acid is to be preferred.

G. C. Savage advises in corneal ulcer the application to the lesion of one drop of acetic acid in five to seven drops of water once in twenty-four hours. His method is to touch the ulcer gently with a piece of absorbent cotton (wrapped around a tooth-pick) and saturated with the above solution. The advantage of acetic acid over other agents is that while it destroys germs, as the other agents do, it does not destroy cell life, connective tissue or the epithelium.

Acetomilchsäure. (G.) Acetolactic acid.

Aceton. (G.) Acetone.

Acetozone. BENZOSONE. This compound, whose formula is $(C_6H_5CO.COCH_3)\ O_2$, occurs in colorless crystals that melt at 98° F., and are soluble in 1 to 10,000 to 1000 of water (according to its temperature) and 35 parts of oil. It resembles hydrogen dioxide in structure and, like it, is a valuable antiseptic, germicide and oxidizing agent. It has been recommended in corneal ulcer, purulent blennorrhœa and gonorrhœal ophthalmia in watery or oily solvents, 1:1000 or stronger. Ointment of acetozone is available as strong as 1 per cent. although it is best to begin with a 1:1000 mixture.

J. G. Roberts uses this remedy in 1-1000 solution in all purulent affections of the eye, preceding operation and (in strength of 1-3000) to irrigate the anterior chamber during cataract extraction.

Acetylchlorür. (G.) Acetyl chloride.

Acetyloxyd. (G.) Acetic acid.

Acetyloxydhydrat. (G.) Acetic acid.

Acetylsalicylic acid. $C_9H_8O_4$. Another name for aspirin. This

compound is obtained by heating acetyl chloride in a flask to 302° F. (150° C.). It is found as small, acidulous, colorless crystals, slightly soluble in water, more so in alcohol and ether.

It is a willow preparation, allied to salicin and salicylic acid, and in gram doses three or four times daily, is of decided value in severe cases of iritis and other uveal affections. It is best administered in capsules, with or without sodic bicarbonate. Wicherkiewicz has employed it with success in chronic conjunctivitis due to long standing gonorrheal infections, in iritis, iridocyclitis, scleritis and episcleritis, rheumatic choroiditis with vitreous exudations and glaucomatous manifestations. It is less prone to produce tinnitus, and gastric disturbances than the salicylates.

Wm. G. Craig employs aspirin, generally in doses of 15 grains night and morning, in all such painful eye diseases as iritis, keratitis, corneal ulcer, glaucoma, and after injuries and operations. He is so impressed with the value of this drug that he uses it to the exclusion of all other anodynes.

Acetylsäure. (G.) Acetic acid.

Acetylwasserstoff. (G.) Aldehyde.

Achicolum. (L.), n.n. The sweating-room of an ancient bath.

Aching, as an ocular symptom. This is a symptom often complained of by ophthalmic patients, apart from headache or acute neuralgic pains due to such intraocular diseases as glaucoma, iritis, etc. Jackson describes it as a sort of extreme spontaneous soreness, as in inflammatory disease with swelling and tension of sensitive parts; or it may be a nerve pain of the same character as headache, sometimes described as "a headache in the eyes." The inflammatory ache may be spoken of as burning, especially where there is conjunctival or corneal disease present. Its significance is mainly as evidence of severe tension of the parts from inflammatory exudate. It may be quite marked in corneal disease, but is more apt to be most severe in iritis, cyclitis or glaucoma. Aching of the eyes, independent of inflammation, most frequently arises from eye-strain; but sometimes it occurs through choroidal congestion, and sometimes through cramp or tire of the ciliary muscle.

It is frequently stated by the patient that the eyes are free from pain, but that there is "aching or pain back of them." This frequently means that the pain is really in the eyeball; and not upon its surface or in the lids; that it has a different location from that produced from something getting into the eye.

But, in some cases it seems fair to refer such pain to the region of the orbital muscles or their attachments. Any severe pain affect-

ing the eyeball is likely to be referred to adjoining parts. Thus in glaucoma or iritis, the pain may be complained of as situated mainly in the brow or cheek. In such cases, however, the history generally shows that it started in the eye and then spread to the adjoining parts.

The *pain* of acute conjunctivitis may be spoken of as aching, though probably true aching when present is connected with considerable swelling of the neighboring parts, or involvement of the deeper tissues of the eyeball.

Achloropsia. Green-blindness.

Achloropsie. (G.) Green-blindness.

Achlys. (Obs.) Cloudiness of the cornea.

Achne. (Obs.) Mucus upon the eye.

Achorion Schoenleinii. The fungus of *favus*, a dermal infection found in both man and domestic animals, several subspecies of which have been described. This fungus is readily grown on ordinary media at body-temperatures. Its incubation period is from three to four days. Mass-like processes form at the periphery of the growth and extend downward. The color of the culture is at first gray; later yellowish. Microscopically, one sees a radiating mycelium whose hyphæ are of different size and bifurcate. The characteristic yellow, sharply defined favus colonies are occasionally seen on the eyelids.

Achroma. Absence of color, especially of physiologic pigment; a condition also known as achromasia, achromatia, achromatosis, achromodermia, and leukoderma.

Achroma. (G.) Achromasia.

Achromasia. Freedom from chromatic aberration (q. v.). Achromatism. All common spherical lenses show chromatic aberration. Therefore, achromasia can be obtained only by the union of several (generally two) spherical lenses. The common achromatic lenses are made by a biconvex lens of crown glass and a concavo-convex lens of flint glass. The adjacent surfaces of the two lenses have the same radius and thus fit into each other accurately and completely. Flint glass refracts color-rays much more strongly than crown glass, so that a proper combination of the two naturally furnish an achromatic compound lens. Achromatic dispersion-lenses are composed of a bi-concave lens of crown glass and a compound meniscus of flint glass.

Absolute achromatism is, however, never realized in lenses because each system is always achromatic for only one pair of complementary colors (usually blue and orange).

Attempts have been made to manufacture heavy achromatic spectacle lenses for high degree hypermetropes and persons operated on for cataract, but it is questionable whether these patients are much more benefited by them than by the ordinary form of lens.

Achromatic. adj. Non-productive or devoid of color. Achromatic lenses consist of a combination of lenses of different material and shape so that, instead of the unequal refraction of the rays of various colors, which either alone would produce, all the rays combine in a single focus, and the image of an object seen through such a lens is free from coloration.

Achromatic. *Achromatic lens,* a lens consisting of superposed spherical convex and concave lenses, usually united by means of balsam and respectively made of glass having different refractive and dispersive powers, with their curvatures so accurately determined that the chromatic aberration (see **Aberration**) produced by the one is counteracted by the other, thus effecting absence of color in the image produced by the multiple lens. *Achromatic prism,* a prism composed of a combination of prisms made of different substances having unequal powers of refraction and dispersion (see **Chromatic dispersive power**), superposed, with their bases placed opposite to each other, and their angles so relatively proportioned as to still obtain deviation without any appreciable amount of dispersion or decomposition of light into its spectral colors. It is also possible to produce prisms that will produce dispersion of the rays without deviation. See **Achromatism.**

Achromatic cells of the retina. The retinal ganglion cells were found by Dogiel to contain two distinct substances, one readily stained (which he called chromophilous) and another (*achromatic* cells) unaffected by staining material.

Achromaticus. (L.), adj. Devoid of color.

Achromatique. (F.), adj. Achromatic.

Achromatisch. (G.) Achromatic.

Achromatism. In *optics,* the state of being achromatic (q. v.). Newton discovered that solar rays are separated through refraction by a prism into rays of different color and direction, as shown in the solar spectrum (see **Spectrum analysis**). This phenomenon is called "dispersion of light" or "chromatic dispersion." Newton considered that it was impossible to produce achromatism, since, in his opinion, it necessarily involved also the abolition of ray-deviation. Seventy-five years later Euler, basing his argument upon the erroneous assumption that the human eye is an achromatic combination of lenses, theoretically deduced that similar combinations were pos-

sible. However, nothing practical was accomplished until 1757, when Dolland, an optician in London, found that the dispersion could be corrected without destroying the refraction, and constructed an achromatic telescope by the use of two kinds of glass called "crown glass" and "flint glass," of which the former is the weaker in respect to both refraction and dispersion. In this combination the convex lens was made of crown glass and the concave lens of flint glass. Dolland's success revived interest in the subject, but no further material progress was made until Fraunhofer, an optician in Munich, in 1814 independently re-discovered the dark bands of the solar spectrum that had been detected by Wollaston in 1802. The spectrum of solar light is not continuous, as Newton supposed, but is crossed by a number of dark lines irregularly distributed over the entire extent of the spectrum, and although their actual position is altered by substitution of a prism of different material, the order of the lines and of the colored intervals between them is always the same, so that any particular line may be readily recognized. Fraunhofer, perceiving that each of these fixed lines, about 600 in number, corresponds to a definite wave-length of light, employed them to determine the refractive index of any substance for such wave-length. For this purpose he designated the more conspicuous lines with capital letters of the alphabet from A to H; the violet end of the spectrum, as nearly as he could locate it, being designated by the letter J. Therefore, until the kind of light that is being used is specified, the so-called refractive index of a medium is ambiguous, since a medium has just as many indices of refraction as there are different kinds of glass. Achromatism, therefore, depends upon the selection of two different kinds of glass of different dispersion identified by the lines of the spectrum. Although Fraunhofer and others had tried to produce new kinds of glass, it was not until Abbe and Schott, of Jena, succeeded in making a variety of pairs of different kinds of crown and flint glass, such that the dispersion in the various parts of the spectrum is for each pair as nearly as possible proportional, that it has been possible to take the fullest advantage of Fraunhofer's discovery.

An optical system which produces two colored images of a given object at the same place and of the same size is said to be completely achromatic for these two colors. The images of other colors will, however, generally be different as to both size and position, and the effect on the resultant image usually appears in a colored margin or "secondary spectrum." Usually the best that can be done is to obtain a partial achromatism of some sort, and especially one of the two following kinds: *achromatism with respect to place* (so that the two

colored images, although of unequal sizes, are both formed in the same image-plane), or *achromatism as to magnification* (so that the two colored images, although differently situated, are of equal size). As a rule, it may be stated that for an optical system which produces a real image, it is more desirable to have achromatism with respect to the place of the image; whereas if the image is virtual, achromatism with respect to the magnification is likely to be the more important requirement.

In creating an achromatic combination of lenses it depends upon whether the lens is to be exposed to centrally or obliquely incident rays. In the former case the pencils of different colors into which an incident pencil is separated have a common axis in which their points of divergence or convergence lie, and the combination is achromatised by making as many as possible of these points coincide. But in an obliquely incident pencil the axes of the refracted colored rays have different directions, so that there is an angular separation of their points of divergence or convergence—as seen by an eye in a given position—and the condition of achromatism will be that which will render the axes of as many as possible of these colored pencils parallel—since rays which enter the eye in a state of parallelism affect the eye in the same way as if they were coincident—or very nearly so.

Condition for achromatism of two thin lenses when exposed to paraxial (centrally incident) rays, the stipulation that the sum of the products of the despersive powers and reciprocals of focal lengths shall be zero; in other words, when the following equation is satisfied:

$$\frac{n_b - n_r}{n - 1} \cdot \frac{1}{f} + \frac{n'_b - n'_r}{n' - 1} \cdot \frac{1}{f'} = 0.$$

This, and the equation $\frac{1}{F} - \frac{1}{f} + \frac{1}{f'}$, make it possible to determine the focal distances f and f′ of two thin lenses that constitute an achromatic combination whose focal length is F. In practice it is found that the best results are obtained when the yellow D rays, and the bluish-green F rays of the spectrum, are brought to a focus at the same point. Then n_r and n_b signify the refractive indices of the first lens for the D and F rays respectively, while n_r' and n_b' have a similar significance with regard to the second lens. The indices for the middle of the spectrum are n and n′ for the lenses whose

foci are f and f′, respectively. The radii r_1 and r_2 of curvature are determinable through the equation:

$$\frac{1}{f} = (n - 1)\ \left(\frac{1}{r_1} - \frac{1}{r_2}\right).$$

Condition for achromatism of two prisms, the stipulation that is satisfied by the equation:

$$(n_b - n_r)\ \angle = (n_b' - n_r')\ \angle'.$$

This determines the angles $\angle$ and $\angle'$ of the combined prisms, in order that the transmitted light shall be approximately free from color. The deviation of the transmitted light is equal to: $\delta - \delta' = (n - 1)\ \angle - (n' - I)\ \angle'$.

In these equations the indices (n, n′, etc.) have the significance previously mentioned.—(C. F. P.)

Achromatize. tr. v. To render achromatic.

Achromatopsia. (L.), n. f. Total color-blindness. All colored objects appear gray to achromatoptic individuals. See **Color-blindness.**

Achromatosen. (G.) Affections of the skin characterized by absence or deficiency of pigment.

Achromatosis. Any disease characterized by deficiency of pigmentation in the integumentary tissues.

Achse. (G.) An axis.

Achse des Auges. (G.) Optic axis.

Achsendrehung des Sehnerven. (G.) Axial torsion of the optic nerve.

Achsenfügung. (G.) Axial articulation.

Achsenhypermetropie. (G.) Axial hypermetropia.

Achsenmyopie. (G.) Axial myopia.

Achsenstellung der Cylindergläser. (G.) Notation of the axis of cylindrical lenses.

Achse, Optische. (G.) Optic axis.

Achtäugig. (G.) Octonocular. Having eight eyes.

Achtertour. (G.) A figure-eight bandage.

Achttägig. (G.). Occurring every eight days.

Achttäglich. (G.) Occurring every eight days.

Acid, Bichloracetic. See **Acid, Dichloracetic.**

Acid, Boracic. Boric acid. H_3BO_3 or $B(OH)_3$. This acid was discovered in 1702 by Homburg and for over a century went under the name Sal sedativum Hombergi until its composition was demonstrated.

Its commercial origin is borax. It is obtained by treating that salt with hydrochloric acid and allowing the crystals to separate.

Boric acid occurs in white, translucent, six-sided, pearly scales that are greasy to the touch, odorless and of a slightly acid, acrid

taste. It is soluble in 15 parts of alcohol, 4 parts of glycerine, 25 parts of cold and 3 parts of boiling water.

This agent is a mild and non-irritating antiseptic. A number of official and proprietary preparations are used in eye diseases. The chief of these is the glycerite of boroglycerin, U. S. or ointment of boric acid, Br. This form of the ointment is not so commonly employed as a simple mixture of the finely divided powder with vaseline or some similar excipient.

No remedy is as largely prescribed by the ophthalmic surgeon or so widely known to the laity as boric acid, with whom it has displayed, as a popular eyewash, many well authenticated virtues. This is doubtless due to its main qualities—that of a soothing detergent and mild antiseptic. In virtue of these actions it is utilized alone and in combination with other drugs, in solution, as an ointment and in the form of powder.

In solution it is prescribed in strengths varying from ½ per cent. to the point of saturation (4 per cent.). These mixtures are used for sub-conjunctival injections (generally 2 per cent.), sprays (1 per cent. to 3 per cent.), douches (2 per cent.), large irrigations (1 per cent. to 4 per cent.), and as hot or cold compresses (1 per cent.).

One of the most effective (because both soothing and mildly antiseptic) of the collyria is the combination with borax and corrosive sublimate:—borax, boric acid, of each 2 grms.; solution of corr. sublimate (1:10,000) 60 grms.

This solution is intended for use in all forms of hyperemia of the conjunctiva and the less severe forms of conjunctivitis where a non-irritating, antiseptic and cooling wash is indicated. It may also be used, like the simple solution, in the irrigator and undine for washing out, disinfecting and removing toxins, mucus, and other discharges from the conjunctival sac. Of the numerous combinations so widely prescribed as simple collyria the following is also a fair sample: boric acid, 2 grms.; bitter almond water, 40 grms.; rose water, 100 grms.

Boric acid is also a (weak) preservative of alkaloids and other compounds prone to decomposition. For this purpose it should be used as a saturated solution.

Boric acid is often used in ointments, in which case petroleum or yellow vaseline furnishes a good excipient. There is no reason for prescribing in salves a larger proportion of the acid than one or two per cent. as even less than that amount is soluble in the water of the vaseline or in the secretions of the eye. Much larger quantities (5 to 25 per cent.) are, however, recommended for various com-

plaints. Rabow, for example, has this formula, a 10 per cent. mixture: boric acid, 5 grms.; lanoline, 20 grms.; petrolatum, 30 grms.

When applied in ointments only the finest powder should be used and all the constituents thoroughly mixed. Probably boracic salve is an inferior form of ointment and is not the equal of other preparations of the kind.

As a finely divided, dry powder boracic acid has been applied to the conjunctivæ and to the dermal surface of the lids as an antiseptic and protective. When the powder is of the impalpable variety it answers the purpose very well since it is free of odor, does not irritate and is not likely to "cake." At the same time it is questionable whether it takes the place of calomel and iodoform in most of the uses to which these remedies are put. For dusting on the conjunctiva and palpebral skin it is occasionally combined with iodoform: powdered iodoform, 10 grms.; powdered boric acid, 1 grm.

Mix in a mortar. (Ed.)

Acid, Boric. See **Acid, Boracic.**

Acid, Carbolic. The most important uses of this agent are described under its more correct name, *phenol* (q. v.). It may be said here that it is best known in ophthalmic practice as a valuable and effective application to the minor varieties of corneal ulcer and to the margins of infected wounds, especially to infiltrated incisions after cataract operations. The eschar formed by this cauterization can easily be limited to the diseased area on the cornea or sclera by a fine glass or wooden point, which should hold very little of the fluid. If a single application is not sufficient it may be repeated until the diseased area appears uniformly white. If necessary the treatment can be repeated the following day. The patient must keep the eye steadily fixed so as to confine the cauterant to the ulcerated surface. The acid takes effect upon the living tissue in a few seconds, and it is advisable to hold the lids apart in order to prevent the acid from coming in contact with any part of the conjunctival sac.

In *ulcus serpens,* the effect of the phenol may be much increased by applying to the previously carbolized surface the point of a wooden tooth-pick soaked in 30 per cent. nitric acid; or the acid may be further fortified by the addition of tincture of iodine or iodine crystals. See, also, **Phenol.**

Acid, Chromic. Chromium trioxide. CrO_3. This agent, obtained by the action of sulphuric acid on potassium dichromate, occurs as small, purplish needles of a metallic lustre. They are odorless, deliquescent in moist air and very destructive of animal tissues. It is

very soluble in water and decomposes in the presence of ether, alcohol and glycerine. It fuses at 380° F. into a glass-like, black mass. The watery solution is of an orange color.

As a caustic application to corneal ulcer this agent is of considerable value. The acid, fused on the tip of a silver probe, should be carefully applied to the cocainized eye so as to destroy as little as possible of the healthy tissues. The ulcer must be previously stained with fluorescein and afterwards gently irrigated with a 2 per cent. sodium chloride solution. The crystals, applied by means of an iris forceps, are also used in Hungary for the removal of trachoma granules, the cauterization being followed by immediate cleansing with sterile water.

Acid, Chrysophanic. There are two forms of this acid; a so-called "medicinal" acid, better known as chrysarobin, also called purified Goa powder, a substance deposited in the wood of Vouacoupoua araroba. Chrysarobin is an orange-yellow, crystalline powder, turning brownish on exposure and yielding true chrysophanic acid on oxidation. In the form of powder it is exceedingly irritating to the eyes and if allowed to enter them may set up a violent keratoconjunctivitis. As an ointment, 1 to 3 per cent., it is occasionally used in palpebral eczema.

The second form of this acid is rhein or rhubarb-yellow, the coloring matter of rheum officinale. It closely resembles chrysarobin, and like it, is prescribed in diseases of the lid skin in 2 to 5 per cent. salves. The powder (yellow, microscopic crystals) should be kept from the eyes and not exposed to light.

Acid, Citric. $H_3C_6H_5O_7$ or $C_3H_4(OH)$ $(COOH_3)$.

The acid of lemon and lime juice is made in large quantities from these and other fruit juices, as well as from grape-sugar. It crystallizes in colorless prisms of an agreeable, acid taste. It is very soluble in water and alcohol. Its uses in diseases of the eye are quite limited.

Although citric acid is rarely employed as a topical remedy, lemon juice, substantially a dilute form of the acid, has been recommended in several pathological eye conditions. de Schweinitz mentions it as one of the local applications to the exudate in diphtheria of the conjunctiva. In this and similar affections the fresh juice is said to be preferable to dilute solutions of the acid or of the citrates.

Simi, of Florence, has advised the instillation of a strong (50 to 75 per cent.) solution of this drug as an absorbent in nebulæ and leucomata corneæ. He claims that, dropped into the sac daily for

a number of months, it will accomplish the purpose in the majority of cases.

Eversbusch freely treats all forms of membranous conjunctivitis, including both the so-called croupous, pseudomembranous and diphtheric varieties with fresh lemon juice filtered through paper and instilled with a glass rod from one to three times daily. The juice does not irritate but seems to act merely as an astringent. For example, if to the acid juice a small quantity of pure glycerine is added, it penetrates the false membrane more easily. The addition of a 1 per cent. solution of morphia prevents the otherwise disagreeable burning sensations set up by the acid and glycerine. When the diphtheric infiltration of the conjunctiva is deep it is better to apply the lemon juice directly on the everted lids or affected area, rubbing it in while the patient is under a general anesthetic.

Acid, Dichloracetic. BICHLORACETIC ACID. URNER'S LIQUID CHLORACETIC ACID. $C_2H_2Cl_2O_2$. A colorless liquid, soluble in water and alcohol.

Like the other chloracetic acids it acts well when applied undiluted as an escharotic for the removal of warts and other growths from the lids. In corneal ulcer it has been found very useful as a cauterant, applied by means of a tooth-pick soaked in it, after staining and cocainization.

Acid, Digallic. See **Tannin.**

Acid, Diiodosalicylic. See **Sanoform.**

Acid, Formic. This peculiar agent, whose formula is $H_2 CO_2$, occurs naturally in red ants [hence its name (*formica*), an ant] in muscle, in stinging nettles and in some mineral waters. It is a colorless, sharp-smelling liquid, which crystallizes at 0°C., melts at 8.6°C., and boils at 100.8°C. It mixes freely with water, ether and alcohol. It readily decomposes and forms salts called *formates*.

Formic acid is rarely used in ophthalmic practice, but A. S. Percival (*Ophthalmic Review*, Nov., 1910) has reported good results from its internal administration in miner's nystagmus, even in patients who continue their work underground. M. Ohlemann gives his observations on this subject based upon his experience in the mining districts near Bochum, Westphalia. He chose twelve cases, all men who were off work, and treated all of them with formic acid in doses similar to those mentioned by Percival, for a period of three weeks; but the treatment was unsuccessful in every instance. He believes that in every case in which improvement is noted in this anomaly the change is due to giving up underground work, and the enjoyment of a period of rest, followed by work above ground. In examining patients in this stage (after complete cessation of mining

work) the nystagmus may not be noticeable except when the eyes are directed upwards, and sometimes only in a darkened room.

After a rest of varying duration, depending on the length of time the disease has been present, the age and strength of the patient, and perhaps his habits as to alcohol and tobacco, some patients are able to resume work underground. Generally, however, a return to work in the mine is followed by a relapse of the disease. The writer has also treated these cases with strychnine, but without success, and he believes that no drug has yet been shown to be capable of curing the condition, and that rest is the real cause of the improvement noted in many cases.

Schwarz has used this agent in the treatment of trachoma. After cocainization, he washes out the conjunctival sac and very lightly rubs the conjunctiva with a cotton tampon moistened with a 5 per cent. solution. This treatment may be repeated daily or at intervals of a day or two, as the case requires. In pannus and trachomatous infiltration it is better to rub the diseased area with the solution for several seconds, avoiding the normal tissue as much as possible. The lid should then be kept everted for several seconds while the patient looks in the opposite direction. This will prevent the cornea from coming in contact with the treated conjunctiva; it also prevents the otherwise unpleasant burning sensations. The remedy loses its effect to some extent after prolonged treatment. The secretion from the trachomatous eye is at first slightly increased the morning after each treatment, but in a short time a diminution of the discharge is noticed. Home-treatment with the conventional remedies may be continued while the formic acid applications are going on. In long standing cases applications should be made once every week for a long period, even after all visible follicles have disappeared as this will prevent relapses.—(Ed.)

Acid, Gallotannic. See **Tannin.**

Acid, Glycerite of boric. See **Glycerite or glyceride of boric acid.**

Acid, Hydrochloric. MURIATIC ACID. HYDRIC CHLORIDE. HCl. This valuable article of commerce is made by the action of sulphuric acid on sodium chloride. The official acid is a colorless liquid, emitting white vapor when in contact with the air. The strong acid is a powerful escharotic and poison. It should be applied to the human tissues with great care.

As a cautery agent in corneal ulcer this acid has been used in 10 to 20 per cent. watery solution, but in our judgment it is more likely to damage the surrounding tissues than most other applications. Birnbacher recommends, for the removal of calcareous de-

posits in the cornea, that the chalky infiltration be touched with a 5 per cent. solution which should be at once neutralized by the same strength of sodium carbonate.

Acid, Hydrocyanic. PRUSSIC ACID. HCN. The dilute acid of the U. S. P. contains about 2 per cent. of the strong, anhydrous acid and is a colorless liquid, having an odor of oil of bitter almonds. It occurs in the free state in the various almond trees, the cherry laurel and in other plants. It is a rapid and powerful poison for which there is no competent antidote.

Instead of using cherry laurel water some ophthalmic surgeons prefer a collyrium made up with dilute hydrocyanic acid, of which the following is a fair example, useful in conjunctival hyperemia: dilute hydrocyanic acid, one drop; boric acid, half a dram; borax, 40 grains; water, two fluid ounces.

Lawson suggests the following as a soothing application to the conjunctivæ: liquid extract of opium, one fluid ounce; dilute hydrocyanic acid, 30 minims; distilled water to eight fluid ounces.

Acid, Iodic. HIO_3. Iodic acid is found as colorless, rhombic crystals, soluble in one part of water but less soluble in alcohol. It forms numerous iodates, some of which are important and are detailed elsewhere under respective headings.

This remedy has been employed as an application in trachoma and other eye diseases, in the form of pencils and has been made up for that purpose in sticks containing 15 per cent. of the pure acid. In from one to three per cent. solutions it is recommended as a collyrium in indolent corneal ulcer.

In trachoma, where lunar caustic or copper sulphate pencils are contraindicated, Schiele strongly advises the use of the solid stick and claims that it does not produce scarring.

Acid, Lactic. $HC_3H_5O_3$. This acid, obtained from cheese, sour milk, "sour-krout" factories and other sources, is a syrupy, odorless, colorless fluid, of a strongly acid taste. It mixes in all proportions with water.

As a cautery in rodent and other ulcers of the cornea it has been used to advantage although, in our experience, it is not equal to phenol or the actual cautery. Dolschenkow recommends it for this purpose, diluted one-half with water. It is applied by means of a pointed glass rod or with a wooden toothpick soaked in the fluid.

Acid, Monochloracetic. $C_2H_3ClO_2$. This is a very deliquescent, colorless, crystalline mass. It is decidedly caustic and cauterant and should be handled with care. It is very soluble in water and is generally applied as an escharotic, almost pure, to warts and other

growths. It is also employed like trichloracetic acid in 50 per cent. solution to corneal ulcers.

S. B. Muncaster advises the use of monochloracetic acid for the removal of xanthoma. A solution of one part to two of water is applied by means of a piece of cotton on the end of a tooth-pick. In a few seconds after the application the yellow discoloration becomes white; on the second day there is swelling; in about a week a scab forms and falls off, about ten days thereafter, leaving a clean surface without any scar. In some cases it is necessary to make a second or, perhaps, a third application at intervals of four to six weeks.

Acid, Muriatic. See **Acid, Hydrochloric.**

Acid, Nitric. HNO_3, or NO_2, OH. Pure nitric acid is a colorless, fuming liquid, staining animal tissues yellow. The so-called "fuming nitric acid" is of a brown-red color, emitting suffocating vapors of the same color. All the strong acids are powerful cauterants and poisons.

The "fuming" acid forms an effective escharotic for the removal of palpebral warts. When properly applied there is little or no scarring and the method is decidedly superior to the use of cutting instruments, glacial acetic acid, citric acid and the like. The papilloma should first be well disinfected and dried. Soak a match or wooden toothpick in the acid and remove all excess of fluid with blotting paper. Carefully tattoo the top of the wart with the wooden point. Some burning follows that soon subsides. At each application, which may be made every two or three days but only when there is no soreness, repeat the disinfection and drying of the growth until the wart dries up or crumbles away.

Solitary "wild hairs" may be effectually destroyed by first enlarging, with the aid of a loup and the end of a sharp-pointed hardwood toothpick, the hair follicle and thrusting into the opening the same toothpick subsequently soaked in strong nitric acid. The preliminary boring is made by a careful rotary motion of the wooden "drill." There is no bleeding; pain is prevented by cocainizing the eye and the globe is protected by thoroughly swabbing the lid after this procedure with a 5 per cent. solution of soda. The eyelash generally drops out within twenty-four hours and if the operation is skillfully performed the follicle is entirely destroyed at one sitting.

Some surgeons use 5 per cent. to 10 per cent. solutions of nitric acid for cauterizing corneal ulcers, but the editor much prefers other agents as less painful and quite as certain.

Acid, Nucleotinphophoric. See **Sclurol.**

Acid, Ortho-oxybenzoic. See **Acid, Salicylic.**

Acidosis. A condition in which a group of toxic substances, largely acetone bodies, are circulating in the body tissues. Although no direct eye-symptoms arise from this condition, yet asthenopia and other evidences of "weak" eyesight may result, as from any other intestinal toxemia.

Acid, Phenic. See **Phenol.**

Acid, Phenylic. See **Phenol.**

Acid, Picric. CARBAZOTIC ACID. PICRINIC ACID. TRINITROPHENOL. This agent is obtained by the action of nitric acid on such organic compounds as salicin, indigo, etc., and occurs as inodorous, yellow needles of an acid, bitter, acrid taste. It forms a bright yellow solution in 90 parts of water—more soluble in ether and alcohol.

It is incompatible with all alkaloids, is explosive with sulphur and phosphorus and is a deadly poison. It stains all tissues a bright yellow and is rarely used in ophthalmology.

A saturated aqueous solution is used by E. M. Alger in burns of the lids and herpes zoster ophthalmicus.

With some surgeons picric acid is a favorite remedy for painting the lid edges in ulcerative forms of blepharitis. For this purpose it is used as a 1 per cent. solution, afterward wiping it off with a cotton swab dipped in a 5 per cent. salt solution.

Salem advises the use of picric acid lotion in the treatment of blepharitis, acute infective conjunctivitis, phlyctenular disease of the conjunctiva and cornea, trachoma and ophthalmia neonatorum. He employs the following collyrium: picric acid, one decigram; glycerine, distilled water, of each, 5 grams.

Businelli and A. Fortunati found that picric acid may be used with advantage in burns of the eyes, from fire or chemical substances. It is said to be of special benefit in burns produced by quicklime. For this purpose the following ointment may be applied two or three times a day:

℞

Acid. picric.	0.20 (gr. 3)
Vaselin. alb.	10.00 (gr. 150)

A little cocaine solution may be instilled previously, to prevent pain.

Acid, Prussic. See **Acid, Hydrocyanic.**

Acid, Salicylic. ORTHO-OXYBENZOIC ACID. $HC_7H_5O_3$. Although salicylic acid occurs free and in combination in the flowers and leaves of several plants it is mostly prepared from phenol. It is seen as

small, white, odorless needles, of a sweetish astringent taste, slightly soluble (1:450) in water, but very soluble in alcohol and ether. It is a local antiseptic and astringent.

Of all the willow compounds this agent, among the earliest and most frequently used, is now rarely heard of in ocular therapy. It is not so well borne internally as aspirin, salicin or its sodic and potassic salts, and locally is more irritating than sodium salicylate. Hirschberg is not enthusiastic over its local employment. Fick has recommended a salve formula with zinc oxide in which some zinc salicylate is probably formed. His formula is as follows: zinc oxide, 1 grm.; salicylic acid, one decigram; vaseline, 10 grms.

He uses this in the squamous form of blepharitis.

As a disinfectant lotion for use with Anel's syringe in lachrymal infections the following prescription may be employed: boric acid, 10 grms.; salicylic acid, two and a half grms.; distilled water, 500 grms.

Salicylic acid in solution 1 to 348 is also recommended by Eversbusch as a preservative for collyria.

E. M. Alger uses the following prescription in the scaly forms of blepharitis: salicylic acid, 5 grs.; yellow oxide of mercury, one to five grains; petrolatum to make up half an ounce.

In Germany it has been prescribed in one per cent. solutions as a collyrium in simple catarrh of the conjunctiva (and in xerosis) with warm chamomile tea as a solvent. It is also the active ingredient in Sattler's solution.

Acid, Tannic. See **Tannin.**

Acid, Thyminic. See **Solurol.**

Acid, Trichloracetic. $HC_2Cl_3O_2$. This agent is prepared by the action of nitric acid on chloral. It is found as colorless, rhombic crystals that are very deliquescent, possess a weakly pungent odor and are very soluble in alcohol and water.

It is an effective cauterizing agent for corneal ulcers, to be applied pure on the end of a wooden toothpick or pointed match soaked in it, any excess of acid to be removed from the applicator before the cautery is begun. It forms an effective agent in the removal of warty growths from the lids, producing a dry eschar that falls off in a few days leaving a smooth surface.

In diplobacillary infections of the cornea Homer E. Smith has used locally a 20 per cent. solution of this remedy associated, of course, with other treatment.

Acide azotique. (F.), n.n. Nitric acid.

Acide borique. (F.), n.n. Boric acid.

Acide phénique. (F.), n.n. Carbolic acid (phenol) purified for medicinal use.

Acidiren. (G.) To acidify.

Acido azotico. (It.), n.n. Nitric acid.

Acido borico. (It.), n.n. Boric acid.

Acido cromico. (It.), n.n. Chromic acid; chromium trioxide.

Acido fenico. (It.), n.n. Carbolic acid (phenol) purified for medicinal use.

Acidology. The science of surgical instruments and appliances.

Acidum boracicum. (L.) Boric acid.

Acidum boricum. (L.), n.n. Boric acid.

Acidum chromicum. (L.), n.n. Chromic acid; chromium trioxide.

Acidum nitricum. (L.), n.n. Nitric acid.

Acidum pyrogallicum oxidatum. See **Pyraloxin.**

Acidum spiricum. See **Salicylic acid.**

Acidurgia. (L.), n.f. An obsolete term for operative surgery.

Acier. (F.), n.f. Keenness of vision. The pupil of the eye.

Acies. (L.), n.f. Keenness of vision. The pupil of the eye.

Acies diurna. See **Hemeralopia.**

Acies vespertina. See **Nyctalopia.**

Acinal. Like a racemose gland. See **Acinous.**

Acine. (F.), n.m. The cavity, or saccule, of the finest lobule in a racemose gland.

Acineux. (F.), adj. Pertaining to an acinus. Resembling a racemose gland.

Aciniform. adj. Like a cluster of grapes. A term applied by Ingrassias to the choroid coat of the eye, and by other writers to the layer of pigment on the posterior surface of the iris.

Aciniforme. (F.), adj. Resembling a cluster of grapes.

Acino. (It.), n.m. The cavity, or saccular recess, in a lobule of a racemose gland.

Acinose. See **Acinous.**

Acinous. adj. Having acini; like a conglomerate or compound racemose gland.

Ackerkamille. (G.) Wild chamomile.

Aclastic. adj. Transmitting rays of light without refracting them.

Acne, Ciliary. Inflammation or infection of the sebaceous glands of the hair follicles close to the margin of the eyelid. It presents the appearance of one or more small nodules.

This disease may be defined as an acne vulgaris of the margin of the lids, with inflammation of the glands of Zeiss, the hair follicles and periglandular tissue—all followed by the formation of small

nodules about the free border. According to Stellwag von Carion, the disease seems to be caused by the bacillus of Unna and Hodara, and it may be solitary or diffuse. It may accompany a facial acne or comedones and is generally subject to relapses. The nodules may disappear gradually or pass into the indurated form of acne ciliaris (cicatricial hardening of the nodules), or they may be affected by pus cocci, when small abscesses appear in the shape of suppurating styes.

Treatment includes the removal of all sources of infection, thorough epilation, the strictest cleanliness and disinfection of the lid margins. Apply an emollient ointment, e. g., 5 per cent. ointment yellow oxide. If pus forms it should be evacuated.

Acne der Augenlidränder. (G.) Inflammation of the glands of the hair follicles causing one or more small nodules along the ciliary margin of the lid. Ciliary acne.

Acne mentagra. (L.) This disease may be regarded as one of the varieties of ciliary acne. It is also called *sycosis vulgaris,* and is a confluent folliculitis and perifolliculitis with a tendency to suppuration, generally caused by purulent cocci or, occasionally, by molds. It may affect the eyebrows, the epidermis of the eyelid or the border of the eyelid. The first signs are reddish-white nodules (which eventually become yellow) around the hair-follicles. If the sebaceous glands and the periglandular tissues are affected, it may result in suppuration of the hair-follicles with loss of both the cilia and supercilia. It is not uncommonly associated with various forms of conjunctivitis, chronic dacryocystitis, etc. *Mentagra hyphomycetica* may be confined to the eyelid or it may spread to it from the surrounding structures, but it is seldom found alone on lid margins. From the nodules, the favus fungus, *achorion Schonleinii* (q. v.), may be isolated, but the *trichophyton tonsurans* is more frequently the morbific agent. The latter disease is related to the trichophytomatous infections of animals, especially cattle. In this latter form the border of the eyelid is covered with a heavy layer of scales which, when removed, exposes small abscesses that surround broken and degenerated cilia. Examination of these cilia reveal the spores of trichophyton that, according to some investigators, grow more often within the hair sheath than on the outside of them.

The treatment is the same as for blepharitis in general: epilation, disinfection with mercuric chloride (1 to 5,000) and inunction with yellow oxide ointment. (*Encyklopädie der Augenheilkunde,* p. 9.)

Acne of the cornea. An eruption, that generally goes under the name of phlyctenules (q. v.), may accompany and be a part of acne

of the cheeks, face, and nose. Corneal acne is found only in persons who have passed the period of adolescence. These papules are accompanied by marked redness of the edges of the eyelids, are extremely rebellious to treatment, and are likely to relapse. The systemic condition should be treated in such cases; while the local therapy is that of phlyctenular keratitis.

Acne rosacea der Lidhaut. (G.) Acne rosacea of the palpebral skin.

Acne rosacea of the palpebral skin. This form of lid infection is usually secondary to, or at least a part of, facial acne rosacea. It is a chronic erythema with dilation of the superficial veins, in which the skin affected shows a network of vessels. Infection with purulent organisms (which enter the mouths of the sebaceous glands) leads to papular or acneform eruptions, which in turn form pustules. Generally, this is the limit of the disease, as far as the eyelids are concerned. The form which affects the eyelids is often observed in women suffering from dysmenorrhea, those who are at the menopause, or those who have other stomach or uterine disturbances. In general, people who are inclined to auto-intoxication (q. v.) are quite susceptible to the disease.

Treatment must include the elimination of possible stomach, intestinal and uterine disturbances. So far as local applications are concerned, a good formula is: precipitated sulphur, glycerine, of each, 10 grams; spirits of camphor, 10 to 15 grams; distilled water, 160 grams. If irritative symptoms are complained of, apply in the morning an ointment of benzoated lard 80.0, with zinc oxide, 10 to 15.0 grams.

Acne tarsi. An inflammatory affection of the Meibomian glands.

Acne vulgaris of the eyelids. Acne vulgaris palpebrarum, or inflammation of the sebaceous glands and lanugo hair follicles, is the result of infection with the bacillus of Unna and Hodara. It appears as hard, raised nodules, each surrounded by a circumscribed swelling. The disease may progress into a pustular form should an infection with *staphylococcus pyogenes aureus* or *albus* occur. This may lead to the formation of small abscesses—*acne suppurativa.* Acne vulgaris of the lid margin is elsewhere described as acne ciliaris (q. v.), which is accompanied by styes and a disseminated facial form of the disease in young, pale and anemic persons, who also suffer from intestinal disorders. The treatment is the same as of acne ciliaris, that is, attention to the digestive tract and the usual local salves and watery disinfectants.

Acoin. This local anesthetic and substitute for cocaine is a synthetic hydrochloride of dipara-anisyl-mono-phenetyl-guanidine.

It produces local anesthesia about as quickly as cocain or eucain but it is much more irritating than either of these remedies. On the other hand it does not increase the intra-ocular tension, dilate the pupil or paralyze the accommodation. It is commonly used in 1:300-400 solution. It is said to be more satisfactory than cocain for subconjunctival injections.

From the experiments of Randolph and Hirsch we know that acoin is a satisfactory substitute for cocaine in certain cases.

It is claimed that mixtures of acoin and cocain act much more satisfactory as anesthetics than either agent alone. For instance, Krauss speaks very enthusiastically of acoin-cocain anesthesia and advises this formula:

℞

Acoin.	0.025 (gr. 0.4)
Cocain.	0.05 (gr. 0.833)
Sol. sod. chlor. (0.75 per cent.) ad.	5.0 (gr. 75)

C. Barck employs the following subconjunctival injection when indicated: acoin and potassium iodide, of each, one and a half decigrams; distilled water, 15 grms.

It is painless, not irritating and its absorption into the interior of the globe has been proved by von Pflugk.

He strongly recommends a one per cent. solution of acoin in oil as the best analgesic for painful eyes from any cause. It is non-irritant and a few drops relieve the pain for several hours. The mixture is also non-toxic and does not affect the cornea, the accommodation, the pupil or the intraocular pressure. He has used it in hundreds of miscellaneous cases and it has never disappointed him.

Perhaps the most satisfactory use of acoin as a local analgesic is shown in combination with mercuric cyanide or oxycyanate. Solutions of these remedies, 1:2,000 to 1:40,000, when used subconjunctivally, are of signal value in hypopyon ulcer and other purulent or deep-seated infections of the eye, but, even in the profoundly cocainized eye, are unbearably painful; so much so that many surgeons felt obliged to abandon their use in this fashion. When combined with one per cent. acoin solution, however, the pain is trifling, although the palpebral and conjunctival chemosis are generally marked.

Aconite, Oculo-toxic symptoms from. Reports of aconite poisoning besides symptoms of cerebral origin speak of various visual disturbances. These are dependent neither upon respiratory nor cardiac intoxication, but upon the action of the poison on the central

nervous system. It is also possible that in those cases in which there is a subacute aconite poisoning from small amounts of the agent and the toxic action on the respiratory center does not disguise all other symptoms, visual disturbances can occur from functional retinal changes, because aconitin, after a transient stimulation, paralyzes the end-apparatus of the sensory and motor nerves. No ophthalmologic observations to explain these visual disturbances seem to have been made.

The use of an English make of aconitin in the form of a salve on one eye of animals brought about contraction of the pupil in three minutes. After five minutes it was hardly one-sixth as large as the other eye. When the contraction was most marked the reaction to light disappeared; as long as it was incomplete the pupil still retained its motility. The myosis persisted for nine hours. It was also produced by an alcoholic solution of aconitin. The absorption of the (German) drug from local applications or from long continued internal use, produces the following ocular symptoms: itching of the eyelids, lachrymation, dilation of the pupils, more rarely miosis and rigid pupil, disappearance of the corneal reflex, photophobia, diplopia, dimming of vision, and transitory blindness.

A criminal, who took 4 grms. of radix aconiti, presented among other symptoms dizziness, convulsions (in which the eyes participated) cyanosis and three attacks of transitory blindness. He recovered. Persons to whom aconite was given by mistake exhibited dizziness, headache, feeling of anxiety, cyanosis and dilated pupils.

Aconite leaves may also cause ocular changes. A seven year old boy who ate the leaves showed congestion of the brain and delirium, followed by a comatose condition for several days, during which the pupils were immobile.—(Lewin and Guillery.)

Aconitine. This alkaloid, as well as extract of aconite, has been employed as a miotic, but neither of them has ever been seriously advocated as a rival to eserine, pilocarpine or arecoline (q. v.).

Aconitinsalbe. (G.) Aconitine salve.

Acopia. (L.), n.f. Freedom from fatigue.

Acorea. (L.), n.f. Absence of the pupil.

Acorie. (F.), n.f. Absence of the pupil of the eye.

Acorus. (L.) A genus of perennial herbs of the natural order Aroideæ. The name is said to be derived from a priv., and kopn, the pupil, because (in ancient times) it was supposed to be useful in eye diseases.

Acqua. (It.), n. Water.

Acqua antiottalmica di Loche. (It.) A lotion for chronic ophthalmia,

epiphora, etc., containing 96 parts, each, of melilotus-water and distilled water, 4 of alcohol, 1, each, of alum and sulphate of zinc, and 0.60 of tincture of aloes.

Acqua oftalmica di Yves. (It.) A collyrium made by digesting 8 parts of zinc sulphate, 3 of copper sulphate, and 9, each, of saffron and camphor in 1,000 of water.

Acqua zeffirina. (It.) An astringent and resolvent collyrium containing 300 grams of lime-water, 1 gram of ammonium chloride, and 0.30 of verdigris.

Acrania. This is a division of the animal kingdom (acraniata or headless animals) whose members do not possess eyes in the ordinary sense. The worm-like amphioxus (q. v.) is a typical member of the class. See, also, **Comparative ophthalmology.**

Acrel, Olaf af. This famous Swedish surgeon, sometimes called The Father of Swedish Surgery, was born in 1717. He studied at Göttingen, Strassburg, and Paris; and, returning to his native country, was soon appointed surgeon-in-chief to the Seraphim Hospital at Stockholm. His most important work is *Chirurgiska händelser,* (Surgical Cases.) He was widely known as an operator on the eye, but, inasmuch as he wrote very little concerning ophthalmic subjects, he has nearly been forgotten in his capacity as an oculist. He died in 1806.—(T. H. S.)

Acrel's pterygium operation. Acrel (*Die Krankheiten und Misbildungen des menschlichen Auges und deren Heilung,* p. 13) cut through the pterygium on the cornea, and according to Richter, was the first surgeon to advocate and practise removal of the head.—(W. T. S.)

Acridinsäure. (G.) Acridic acid.

Acritochromacy. Colour-blindness.

Acrochordon. (L.), f.n. A small soft tumor, often pendulous, of areolar or glandular structure, occurring on the eyelids and elsewhere. It is an obsolete term.

Acroesthesia. (L.), n.f. Exaggerated sensibility, forming one of the phenomena of hysteria.

Acroisa. Blindness.

Acromatico. (It.), adj. Achromatic, i. e. free or non-productive of color.

Acromatopsia. (It.), n.f. Color-blindness.

Acromegaly, Eye symptoms of. (MARIE'S DISEASE). In accordance with neurologic literature acromegaly has tentatively been classified with other disorders supposedly of trophoneurotic origin and without known anatomic basis. It is an affection regarding the

probable nature of which many theories have been advanced. Marie, in his "theorie hypophysaire," expressed the belief that all the phenomena of the disease, constituting as they do a systematized dystrophy, are caused by primary changes in the pituitary body. von Recklinghausen and others have maintained that the disease is first a trophoneurosis with secondary changes in the pituitary body and thyroid, causing a perversion or absence of secretion in these glands. Benda's view of over-activity of the cells in the anterior lobe of the hypophysis has led to a conclusion that the gland may be the "growth center." These few opinions are cited merely to emphasize the fact that in acromegaly the hypophysis has nearly always been found diseased and hypertrophied, but all else concerning pathogenesis and etiology remains obscure.

An enlarged pituitary gland is capable of exerting pressure symptoms in all respects analogous to those of brain tumor in the same location, compressing the chiasm, optic nerves and other adjoining areas. From this it must follow that bitemporal hemianopsia, ocular palsies and optic atrophy (40 per cent.) occur as important physical findings in a symptom-complex further characterized by headache, vomiting, vertigo, glycosuria, sexual disturbance and enlargement of the face, hands, trunk and feet.

So long as we are in doubt or ignorance as to the pathogenesis of acromegaly, we must be content to rely upon such remedial measures as will palliate but in no sense cure. The disease to date has acquired no promising surgical aspect. Some isolated instances are recorded in which osteoplastic resection was done for relief of pressure headache or peripheral neurectomy for neuralgia (Keen-Hinsdale). Extirpation has been undertaken in cases of tumor of the hypophysis (Caton, Paul, Horsley), but no deductions should follow from a few single instances with negative results. For the closely related condition of coutiasis ossea Kanavel, in an excellent and comprehensive discussion of treatment, advocates a palliative operation for relief of "cerebral compression and encroachment upon the orbital and nasal cavities." It would seem rational therefore to advise a decompressive operation as palliative for choked disc and chiasmic symptoms due to enlargement of the pituitary (See **Brain tumor**).

Animal extracts have been suggested for this condition, but the slight transitory relief afforded in only a few cases warrants mere mention of their questionable utility. Thyroid extract, when pushed to its physiological and even toxic effect, has been of benefit in minimizing such subjective symptoms as headache, nervousness and in-

somnia (Putnam). It may be given in dry powdered gland form, beginning with gr. i, three times a day, after meals, and increased until grs. xv are given daily or every second day.

The pituitary extract is best given in tablet form, gr. iii t. i. d., but in one case under my personal observation the cephalalgia was so intensified by its use that after several trials it had to be discontinued. Its therapeutic value, of which we know almost nothing, will remain indifferent, until more knowledge of the physiological value of the hypophysis will be forthcoming.

Mercury and iodide are said to have a good effect in some cases admittedly not of syphilitic origin.

For the relief of headache, which may be agonizing and intractable, acetanilid or phenacetine and similar coal tars in larger dosage than ordinarily given, gr. vi to xv, are indicated and do much good.

When the disease begins to seriously impair the general health, weight and strength, tonics, good food and conservation of energy are necessary.—(D. H.)

The operative treatment of hypophysis tumor has been a matter of gradual development. As late as 1905, Cushing was led to say that in the near future operations on the hypophysis cerebri might be carried to a successful issue.

A brief review of the steps that have led to our present technique may be of interest in tracing the progress of this most recent triumph of modern surgery.

Of the operations proposed, two principal routes have been chosen to reach the hypophysis; first, the intracranial; second, the extracranial or trans-sphenoidal. Through the former the hypophysis may be reached either by way of the anterior or the middle cranial fossa. The major part of the operation may be accomplished by working outside of the dura, or the dura may be opened in the beginning and the work done entirely within its cavity.

The possibility of reaching the hypophysis through the middle cranial fossa was first proposed by Caton and Paul, but was not carried out by them. Horsley is generally quoted as following this route.

Stumme quotes a personal communication from Petrien, in which he credits Dahlgren with an operation conducted through the middle fossa. In this the dura was opened and the hypophysis reached by retracting the brain. Nothing is said of the details of the operation or of the result.

Krause suggested what appears to be the most rational intracranial method of reaching the hypophysis. He proposed to open

the cranial cavity by an osteoplastic resection of the frontal bone and to proceed, extradurally, through the anterior cranial fossa until the lesser wing of the sphenoid is reached, and then to open the dura and remove the tumor by means of a small, hook-shaped knife devised for that purpose. Krause, from his experience gained only by operation on the cadaver, believed that by following this extradural route all or most of the obstacles which other operators had encountered would be eliminated.

Borchard attempted to remove a tumor of the hypophysis by the Krause method, and was forced to abandon it because of the hemorrhage. Later, he operated successfully on the same patient by the trans-sphenoidal route, as practiced by Schloffer.

Killiani, in discussing tumors of the chiasm, suggests an operation which is similar to that of Krause, excepting that the dura is opened immediately after entering the cranial cavity. The longitudinal sinus is ligated, the frontal lobe lifted from the base of the skull, and the tumor attacked above the chiasm and the transverse sinus by means of a sharp spoon.

Silbermark suggests a temporal intracranial method similar to that employed by Paulesco and Cushing, in their experimental work on dogs. This consists in a bilateral craniectomy, the counter opening being made to permit of the temporal lobe being dislocated without the risk of serious compression. The operation proposed by Silbermark and by him performed on the cadaver has never been tried on the living subject.

The relative merits of the intracranial method, as compared to the trans-sphenoidal, is still a matter for discussion.—(A. E. H.)

The history of a patient, sixty-five years of age, with bitemporal hemianopsia and well-marked features of acromegaly is given by S. D. Risley (*Oph. Record*, Sept., 1912). The symptom-complex pointed to disease in the pituitary region and *x*-ray study showed an enlargement of the sphenoid, the anterior and posterior clinoid processes bending toward each other, forming an incomplete foramen, but left the presence of any enlargement of the soft parts or the presence of a tumor in doubt. The patient regarded herself in good health, had no pain, but suffered an uncontrollable drowsiness. She was first seen in October, 1910. In December, 1911, and February, 1912, there was no notable change in her condition. In March, 1912, she died of an intercurrent lobar pneumonia. An autopsy showed at the base of the brain a large tumor 5 cm. in length and 5 cm. in width and $3\frac{6}{10}$ inches thick, oval in shape, resting on the frontal lobes, anterior to the optic chiasm and compressing both

optic nerves, making a distinct concavity in the mesial aspect of the frontal lobes. Lying in front of the chiasm, it was slightly separated from it. On the lower surface of the tumor, near its middle, was a smooth, cup-shaped depression 2x2½ cm. in depth caused by the projecting posterior ethmoidal cells. The tumor was well encapsulated, finely nodular on the surface and the capsule very vascular. In the anterior fossa in front of the sella turcica the floor of the skull was raised in an irregular manner, in an area the size of a small walnut. The bone here was thin, porous, dark in color and when chiseled away the posterior ethmoid cells were found to contain a large amount of thick, yellow, purulent material. The tumor seemed to have entirely replaced the pituitary body. The brain otherwise showed nothing abnormal. The tumor proved to be, on examination, a highly vascular spindle-celled sarcoma. In the sections made no trace of the pituitary body was found.—(Ed.)

Acryläthylester. (G.) Ethyl acrylate.

Acrylsäure. (G.) Acrylic acid.

Actina. This is a nostrum whose activity depends upon the exposure of the eye in a cup to the fumes of oil of mustard. The counter-irritation set up by it sometimes relieves asthenopic symptoms, but as "one end is used for the ear and the other for the eye" it does not need much penetration to assign its proper place in ocular therapeutics.

Actinic lens. In *optics,* a lens system so constructed that its chemical and luminous foci coincide.

Actinic process. A generic name for any photographic process; specifically any photo-engraving process.

Actinic rays. In *optics,* rays that produce chemical combinations and decompositions. A pencil of rays when decomposed by refraction through a prism is known to possess three properties, namely, the heating, the luminous and the chemical or actinic.—(C. F. P.)

Actinism. The radiation of heat or light, or that branch of physics which treats of the radiations of heat or light. The property of the sun's rays which, as seen in photography, produces chemical decompositions.—(C. F. P.)

Actinium. One of three chemical elements found in pitchblende. The others are polonium and radium. All three substances continuously emit radiations which affect photographic plates.

Actinograph. An instrument for measuring and registering the vibrations of actinic or chemical influence in the solar rays. The intensity of this influence bears no direct relation to the quantity of light, but varies at different periods of the day and year. There are

several forms of actinograph, all of them using the same test, namely, the depth of the blackening effect of chemical rays allowed to fall on a sensitive piece of paper for a given time.

Actinology. That branch of science which investigates the chemical action of light.

Actinometer. An instrument for measuring the intensity of the sun's heat-rays.

Actinometry. The measurement of the intensity of solar radiation.

Actinomyces. (L.), n.m. A genus of parasitic organisms probably belonging to the Fungi.

Actinomycosis of the ocular structures. LUMPY JAW. HOLDFAST. Gould defines this to be a parasitical, infectious, inoculable disease first observed in cattle, and also occurring in man, and characterized by the manifestations of chronic inflammation, with or without suppuration, often resulting in the formation of granulation tumors. He further says that it is due to the presence of a characteristic micro-parasite, the ray fungus, Actinomyces bovis, which is composed of fine mycelial threads and club-shaped bodies. The most frequent and most curable type is when the abscesses form about the jaws and teeth. The best mode of staining the threads is by Gram's method. To stain the clubs as found in man is difficult; the best results have been obtained with orange rubin or eosin. The only treatment of the disease is removal of the infected tissue. When the parasite has found a nidus in the lungs or digestive tract, all treatment is so far useless. It rarely attacks the human eye but has been found in the lachrymal canals. Bach in the *Encyklopädie der Augenheilkunde* says that this organism forms peculiar granules containing pus, which by German writers have long been called "Drüsen," of gray, yellowish, reddish, or occasionally greenish color and varying consistency. The individual granules are composed of rosettes in which three structures can be isolated: (1) a central core of branching filaments, irregularly disposed, but with a general radial arrangement; (2) at the periphery club-shaped bodies; (3) spherical coccus-like bodies. The filaments, but not the clubs, stain with Gram, while the club-shaped bodies take a counter-stain, such as saffranin or carmine. Cultures may be successfully obtained on most media and at ordinary temperatures. The best cultures result from growths on serum or serum-agar. The contents of actinomycotic abscesses should be first crushed in a mortar. Diagnosis is generally possible without cultivation.

Actinomyces colonies have been found mostly in the lower lachrymal canals—more frequently than in the upper. In the canaliculi

a greenish-yellow concretion of the size of a pea has also been discovered. The fungus of these deposits was formerly called *streptothrix Foersteri*, but later investigations point to actinomyces.

Actinomycosis of the eyelids with the characteristic symptoms is not infrequent. Actinomycosis of the orbit (as a primary infection) has also been reported. Recently a fungoid infection of the conjunctiva in the shape of small, yellowish-white, raised dots, with a smooth surface, has been described as belonging to the same species.

Actinomykose. (G.) Actinomycosis.

Actinomykose der Thränenröhrchen. (G.) Actinomyces of the canaliculus.

Actinophone. An apparatus for the production of sound by actinic rays. See **Radiophone.**

Actinophthalmic. adj. Having eyes whose chorioidal tapetum strongly reflects light.

Actinotherapy. The therapeutic use of actinic rays.

Active convergent strabismus. This term was given by Donders to those cases of esophoria or, more correctly, to cases of excessive convergence in patients who are able to mask their asthenopia by strong adduction efforts. He regarded the typical convergent strabismus of hyperopes as an active form of that anomaly.

Active immunization in bacterial infection. The chronic pus infections of the skin, such as acne and furunculosis, offer one of the best fields for the demonstration of the value of bacterial therapy. Certain of these cases, intractable to other methods of treatment, have yielded to injections of killed cultures of the associated organisms. In some cases good results are obtained with stock vaccines, but it is usually found of advantage to prepare the vaccine from the autogenous organism. Different strains of staphylococci, even though resembling each other in cultural characteristics, may differ widely in toxicity and in their power of producing immunizing responses in a given individual and it is hence desirable to use for immunization a culture obtained from the lesion under treatment. Two or more organisms may be associated in a lesion, such as a sinus, and here we may immunize against one organism, and then the other, causing each to disappear in turn. Thus favorable results are reported in chronic suppurations of the accessory sinuses of the frontal and ethmoid bones.

Grey-Edwards found staphylococcic vaccine of value in 3 cases of hypopyon ulcer, and Maddox reports good results from vaccine in a staphylococcus infection after cataract operation.

Immunization in pneumococcus infections has so far not been attended with any permanent benefit. Römer has suggested the combination of active immunization with passive serum immunization in serpiginous ulcer, but no conclusive data are at hand as to the value of the method.

In ulcerative endocarditis of staphylococcus, streptococcus and pneumococcus origin, injections of vaccines prepared from the autogenous organisms have so far not been successful in curing the disease. One case is reported by Wright in which the injections of vaccines was followed by recovery, but there is some question as to whether the symptoms were not due to sepsis, without active ulceration of the heart valves. There seems to be no doubt however that a temporary period of clinical improvement follows the injections in some instances, so that we are justified in adopting the treatment in this class of cases, so hopeless under other therapy.

In chronic gonococcus infections, gonococcus vaccines have apparently been of value in hastening the healing of arthritis and other metastatic lesions. In gonococcus infections of the mucous membranes, vaccines have usually been of little value, although Allen reports successful cases in conjunctivitis in adults.—(E. E. I.)

Active plane. In *optics,* the principal section of a prism or cylindric lens in which the chief refraction occurs, and as distinguished from the parallelogram-section, or *passive plane,* which is indifferent to refraction and at right angles to the active plane.—(C. F. P.)

Activity, Optic. The property of certain molecules to rotate the plane of polarization.

Actol. Silver lactate. Aktol. $C_3H_5D_3Ag$. It occurs as brownish or colorless, acicular crystals, soluble in fifteen parts of water and easily affected by light.

This is one of the best of the germicidal inorganic silver salts used in ophthalmic practice and was introduced by Credé. It makes satisfactory antiseptic solutions, as for instance in the drying and sterilizing of catgut sutures, and is employed as a substitute for silver nitrate in solutions of 1:500 to 1:2000.

Actual cautery. See **Cautery, Actual.**

Actual rest. This term is generally employed in connection with the extrinsic ocular muscles to describe their complete relaxation. When it occurs there is often a tendency to deviate from the primary position. The condition is also known as *apparent* rest.

Actuarius, John. Actuarius was not really a surname though it has generally been so treated in the case of this man—but an official title, meaning Court-Physician. A Graeco-Christian physician and phi-

losopher of the 14th century (the son of one Zachariah), actuarius at the court of the Paleologi, and author of a number of valuable medical works. Of these the most important are *Materia Medica* and *Therapeutics*. In the first-named work there is some ophthalmologic matter, but none of great importance. Another well-known work is the treatise *On the Urine*, in which the author distinguishes, as scientifically perhaps as was possible in that day, the various sorts of urinary sediments, and in which, furthermore, he speaks of graduated glasses for the purpose of measuring the amount of such deposits. A work *On the Animal Spirits* was highly valued in its day, but, being wholly of a speculative nature, is no longer of use.—(T. H. S.)

Acuitas. This term is proposed by Siklossy, who while studying the so-called normal visual acuteness found, as others have done, a large proportion of eyes with better than "normal" vision by the Snellen types. He proposes a new unit of visual acuteness, estimated by which normal vision of the Snellen scale would be designated as A (acuitas)=35 (or more exactly 34,376). In general the acuity of vision would be indicated by whole numbers. The use of such a scale would serve to emphasize the differences actually presented in eyes that are commonly all classed together as having "normal" vision. (*Ophthalmic Year-Book*, 1906, p. 39.)

Acuità visiva. (It.) Visual acuity.

Acuité visuelle. (F.) The keenness or perfection of vision at the macula lutea.

Acuity. n. Acuteness.

Acuity of vision for points. This is one of the two common varieties of central visual acuity, the best known being that for form—as made with ordinary test types. The second variety is that determined by the ability to distinguish a single, small point from its surroundings, termed acuteness of vision for points.

Acuity of vision, Methods of determining the. See **Examination of the eye.**

Acuity, Visual. Acuteness of sight in the perception of small or distant objects. It is generally intended to refer to the kind of (central) vision obtainable at the fovea or macula. See **Examination of the eye.**

Acupressure. n. A method of arresting hemorrhage from divided blood-vessels by means of pressure exerted by a needle passed into the tissues.

Acus. (L.), n.f. A needle.

Acus ad cataractam. (L.) See **Cataract needle.**

Acus cataractaria. (L.) See **Cataract needle.**

Acus ophthalmica. See **Cataract needle.**

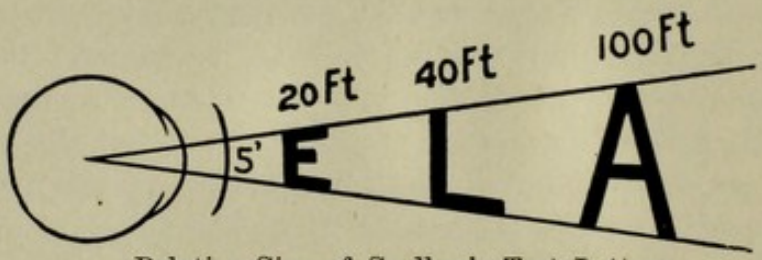
Acusticustumoren. (G.). Tumors of the auditory nerve.

Acuténacle. (F.), n.m. A needle-holder.

Acutenaculum. (L.), n.m. A needle-holder.

Acuteness of vision. Practically, this is the power the eye possesses of observing the shape, form (hence *form sense*), color and size of objects.

When a clear image of an object is desired, the individual looks directly at it so that the rays of light fall on the retina at the *macula lutea*, that being the point of most acute vision. This is called *central vision.* The acuity of central vision is tested for both distant and near objects.

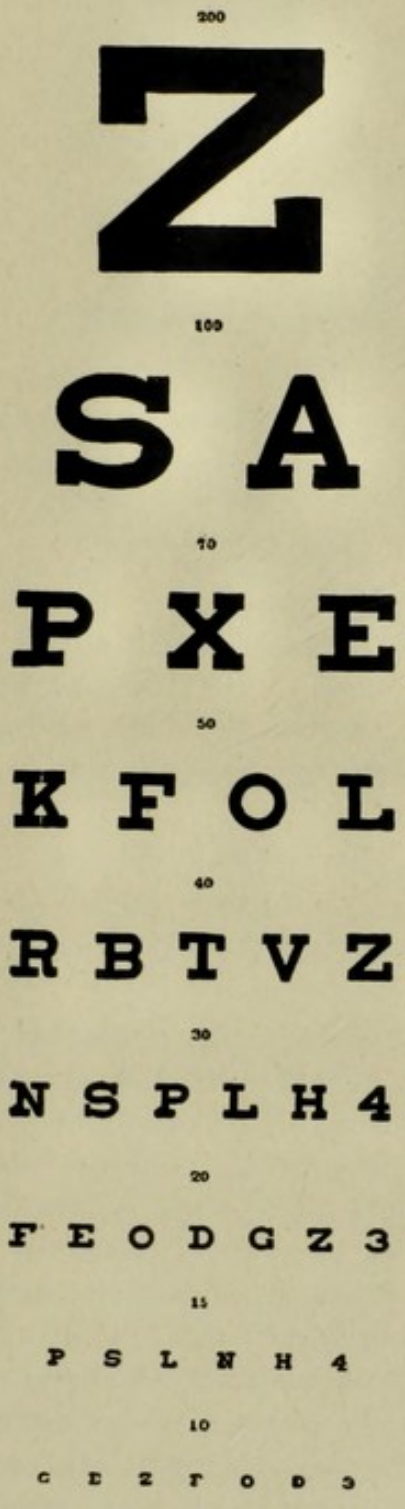


Relative Size of Snellen's Test Letters.

To determine the distant vision the patient is placed six meters or twenty feet from and facing the test types, with his back to the window, if the illumination be from that source, although artificial light is usually employed and arranged in such a way that it falls directly upon the test letters. The letters used are of various sizes and are known as *Snellen's test types.* They consist of square letters so constructed as to subtend an angle of five minutes at the distance at which they should be seen by the normal eye. Each part of the letter and each space are equal to one-fifth of the whole and subtend an angle of one minute.

The reason the test types are situated twenty feet or six meters in front of the patient is that rays of light which enter the eye from this distance are practically parallel. The largest letter is of such a size that it should be read at 200 feet, or sixty meters, and those following decrease in size from above downwards, and should be read at 100, 70, 50, 40, 30, 20 feet, or their corresponding values in meters, respectively.

Each eye should be tested separately, and the result expressed by a formula in which V stands for vision. This is expressed by a fraction in which the numerator corresponds to the distance the patient



Snellen's Test Types.

is seated from the test types and the denominator the distance at which the letters should be read by the normal eye.

A Single Test Letter.

If the patient seated at twenty feet from the test type reads the letters numbered 20, then

$$V=\frac{20}{20}$$

or is normal. If he cannot read smaller letters than those numbered 50 (letters which should be seen by the normal eye at 50 feet)

$$V=\frac{20}{50}$$

If the patient seated at twenty feet is unable to read the large letter which should be seen at 200 feet, he walks toward the chart until the distance is reached at which he reads this largest letter. If, for example, it is ten feet, then

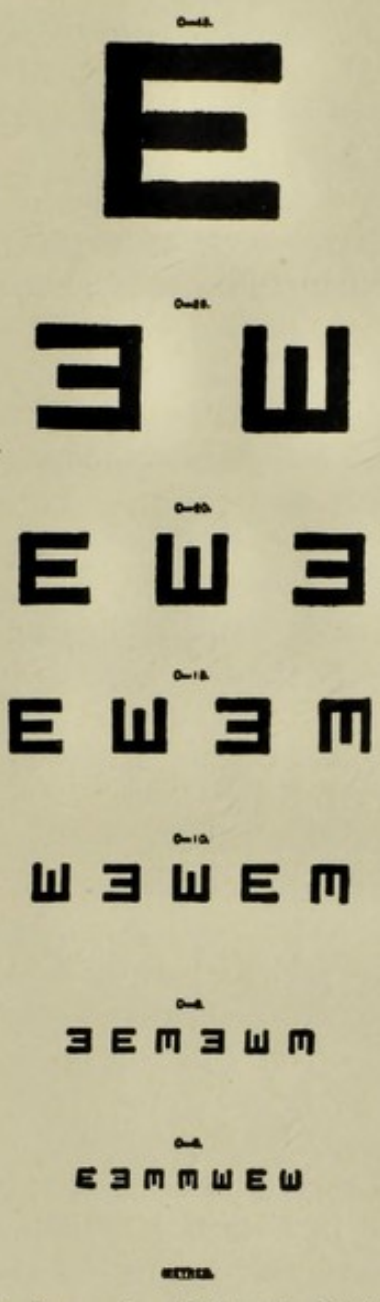
$$V=\frac{10}{200}$$

the numerator being the farthest distance from the chart at which he can read the largest letter.

When the patient's vision is so poor that he is unable to recognize the large letter at any distance, the distance is obtained at which he is able to count the examiner's fingers held against a black background. Suppose he is able to do this at ten inches or twenty-five centimeters, then V = "counting fingers" at that distance. If he is unable to count fingers, the hand is moved in different directions in front of the eye, and the patient required to tell in what direction it is moved. If he is able to do this, V= hand movements. If there is inability to distinguish hand movements, the eyes are alternately covered and uncovered, and if he is able to perceive the difference between light and darkness, V= light perception (p. 1.).

If the patient is illiterate, test types are used in the form of E's, in which the openings are turned in various directions and the

smallest row where he is able to detect the openings indicates the visual acuity.



Test Types for Illiterate Patients.

In testing near vision the patient is seated in a good light and each eye is also tested separately. Useful test types consist of the various sizes of ordinary printer's type, technically called Jaeger's test types, the smallest corresponding to diamond print. More scientific and accurate are those corresponding with Snellen's distance types. The former are numbered 1, 2, 4, etc., according to the size of the type. If these are used and the patient reads the finest print at the ordinary reading distance, 10-13 inches, V=Ji;

if he reads that numbered 4, V=Jiv, etc. See, also, **Examination of the eye; Physiological optics.**

Acutezza visuale. (It.) The keenness of vision at the macula lutea.

Acyanoblepsia. (L.), n.f. Acyanopsia or blue-blindness (q.v.).

Acyanopsia. Inability to distinguish blue colors. Blue-blindness.

Acyoblepsia. Same as **Acyanoblepsia.**

Adacrya. (L.), n.f. A deficient secretion of tears.

Ada-Kodien. The Malabar name of a plant, supposed to belong to the Apocynaceæ, used in India as a general astringent and in eye diseases.

Adam's accommodometer. An instrument for the measurement of the amplitude of accommodation, and of the refraction for an indicated near point. See **Accommodometer.**

Adams, Edward C. This well-known ophthalmologist, born in 1858, received his professional degree at the Northwestern Medical College, St. Joseph, Mo., in 1886. Making a specialty of diseases of the eye and ear, he settled in St. Joseph, where he practised until his death, which occurred as the result of cerebral hemorrhage, May 15, 1910.

Adams was a small, dark man, a bachelor and a ventriloquist of no mean ability.—(T. H. S.)

Adams, George A. A famous London optician, who was born in 1750, and died August, 1795. A tireless worker, he devoted all his energies to optics and mechanics, and acquired a world-wide reputation as a maker of spectacle and microscope lenses. He was also a writer of note. Among his most celebrated works are: *History of Vision, Explaining the Fabric of the Eye and the Nature of Vision* (London, 1789; German trans. by Kries, Gotha, 1794, 2d ed. 1800); *Essays on the Microscope* (London, 1787).—(T. H .S.)

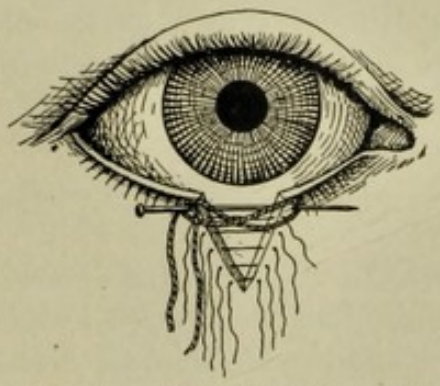
Adams, Sir William. A famous London ophthalmologist, born in Cornwallis, 1760, and died in February, 1829. He became Physician to the Greenwich Hospital, and Oculist to the Infirmary for the Eye at Exeter. He invented what he conceived to be a new and valuable method for treating trachoma, and, in consequence of this, Lord Palmerston, then Secretary of War, "created a new place for him; that of ophthalmic surgeon to the army, with a salary of £1,500 a year; which has given much offence to the regular military surgeons." (*Pantheon of the Age,* vol. I., p. 14.)

He wrote a number of books and articles dealing for the most part with keratoconus, cataract, ectropion, and formation of the artificial pupil. His chief work is entitled *Practical Observations on Ectropion, or Eversion of the Eyelids, with the Description of a New Operation for the Cure of that Disease* (London, 1812).—(T. H. S.)

Adams' operation for artificial pupil. Adams (*Treatise on Artificial Pupil*, 1819, p. 34) modified Cheselden's operation by using a small iris scalpel of his own design, which had a straight, dull back, a

Adams' Iris Knife-Needle.

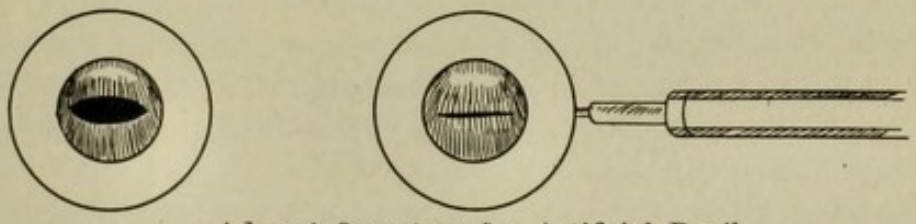
long, straight cutting edge and a rounded point. With this he made his puncture back of the limbus on the temporal side, passed it directly through the iris from behind into the anterior chamber, across to the nasal side, keeping the edge of the knife turned back against the iris throughout the whole maneuver. He was thus able



Adams' Operation for Ectropion. (After Beard.)

by the most delicate pressure to make a horizontal incision. If the incision was too short he again carried the knife forward and again partially withdrew it, always cutting in the same plane.—(M. S.)

Adams' operation for atonic ectropion. Adams boldly excised from the center of the lid a wedge that included conjunctiva, skin and tarsus. He then closed the resulting notch by means of fine, inter-



Adams' Operation for Artificial Pupil.

rupted sutures and a hare-lip pin. This operation removed the excessive tissue of the sagging lid but always left a prominent scar which frequently failed to heal properly at the lid margin, resulting in a disfiguring cleft.—(C. H. B.)

Adams' operation for conical cornea. Adams (On the Restoration of

Vision when Injured or Destroyed in Consequence of the Cornea Having Assumed a Conical Form. *Journal of Science and Art.* Vol. 11, 1817, p. 402) advocated the "breaking up of the crystalline lens in order that the rays of light might fall upon the retina and not be brought by the increased refractive power of the cornea and lens to a point far short of the sentient apparatus of the organ of vision." This procedure undoubtedly consisted of the so-called "needling operation," and appears to be the first surgical procedure employed in conical cornea. (W. O. N.)

Adaptation der Netzhut. (G.) Adaptation of the retina.

Adaptation of the retina. The faculty possessed by the retina of accommodating the vision to the amount and quality of the illumination. Thus one speaks of an eye as being "dark adapted" or adjusted to diminished light, as in a darkened room. Per contra, a "light adapted" eye is one adjusted to a more brilliant illumination or to ordinary daylight.

Aubert found that sensitiveness to light is 25 times greater than normal after 10 minutes, and 35 times greater after 2 hours' confinement in the dark.

That adaptation of the retina which occurs upon the exclusion of light (dark adaptation) has been tested by Horn in various diseases affecting the ocular fundus. In myopia, even high degrees, he finds it is not altered. Where it is disturbed this disturbance must be ascribed to the accompanying choroidal changes. In cases of congenital amblyopia there was a marked departure from the normal, which was particularly well demonstrated in squinting eyes. The disturbance of adaptation, both as to amount, time and character, was marked in the hemeralopia of chronic alcoholism, nephritis, diabetes without ophthalmoscopic changes, atypical retinitis pigmentosa, hereditary syphilitic chorio-retinal changes, and tabetic optic atrophy. Severe choked disk or detachment of the retina can occur without disturbance of adaptation. But glaucoma lowers it, and this may be an early symptom. Choroiditis, recent or old, and commotio retinæ affect it. In color blindness adaptation seems not to reach the normal.

The adaptation of the retina to varying degrees of light and shade has been utilized for the diagnosis and prognosis of ocular diseases. The following review of the subject is extracted from the *Ophthalmic Year Book,* Vol. VIII, p. 195: Behr has used Piper's apparatus in a series of investigations as to adaptation processes, especially for dark, and their relation to various diseases of the optic nerve chiasm and tract. As regards the physiology of the test he finds that the increase of sensitiveness in the dark is much influenced by synchro-

nous continued illumination of the other eye, the final adaptation value being reduced by about half. The function of the rods appears to be greatly disturbed in optic atrophy (even with normal visual acuity); and in chiasmal disease in the non-affected halves of the field. The function of the rods can be affected in complete relative tracthemianopsias; but this disturbance is lacking in such hemianopsias due to intracerebral causes. Mosso found the adaptation process most disturbed in chronic amblyopias and tabetic atrophy; whereas in retinal detachment it persisted more or less for various periods of time. Best offers some modifications in Piper's "adaptation rule." He finds that if adaptation is severely affected the process occupies much more time than with a normal eye, falls short of normal maximum, and in unfavorable cases is finally lost altogether. Best does not believe that examination of pericentral and peripheral retinal areas offers a means of distinguishing between rod and cone adaptation.

Wölfflin says that not merely one point of the retina should be tested, but many and over a large area. For this purpose he uses an arrangement by which the eye fixes a luminous red point, the distance and direction of which in relation to the white light used for the test can be varied at will. He finds normally a decided decrease of adaptation at 20 to 22 degrees to both the nasal and the temporal side of the fovea. In two cases of hemianopsia homonyma dextra, clinically proved to be due to lesions beyond the primary optic center, there was in the affected half of the visual field a complete lack of light sensation after an hour of adaptation for dark. Adaptation was absent in a case of retinal detachment and did not recur in the area of the lesion after reattachment. Wölfflin thinks that the fovea has moderate power of adaptation for dark, and points out that this would be in opposition to the view that the visual purple is closely associated with such adaptation. Stargardt finds that the Fukala lens operation for myopia appears to lessen dark adaptation. In anisometropia the dark adaptation of the two eyes more commonly differs. Squint amblyopia is sometimes attended by reduction, sometimes not. The author thinks disturbance of dark adaptation in retinitis pigmentosa to be due to choroidal disease. He also offers the view that a normal visual field for dark adaptation safely excludes a diagnosis of retinal detachment.

Wölfflin has investigated the *influence on adaptation of strychnin and brucin*. He finds that they exert a notable influence, increasing the sensitiveness of the retina in eyes adapted to darkness.

Adaptationsstörungen. (G.) Adaptation disturbances.

Adaption. An obsolete form of adaptation.

Adaptometer, Nagel's. An instrument for determining the quality and measuring the relative amount of dark and light adaptation (q. v.). A full description of the instrument, its application to ophthalmology, theoretical and practical, is fully set forth in the third edition of the Helmholtz *Handbuch der physiologischen Optik*, 1911.

Adattamento. (It.), n. The adjustment of the size of the pupil to the amount of light that reaches the eye. By some authors, the term refers to the accommodation.

Adattamento della retina. Dark and light adaptation (q.v.) of the retina.

Addario's trachoma operation. This operator has modified the usual method of excision of the tarsus in chronic trachoma by removing the upper two-thirds of the tarsal mucosa, and upper third of the tarsus and transplants healthy conjunctiva from the eyeball to fill the gap.—(J. G.)

Addison's disease, Ocular symptoms of. With the exception of a few pigmented areas in the sclera and conjunctiva no complications, so far as the eyes are concerned, have been observed in this disease. The tendency toward degenerative and inflammatory alterations in the organs supplied by the sympathetic, that usually appear in the later stages of Addison's disease, may affect the eye, but as its secretory and vasomotor disturbances, as well as the ocular papillary changes, are so slightly marked they are easily overlooked. As might be expected, the general debility occurring during the progress of the disease may also be responsible for such functional disturbances of the visual apparatus, as weakness of the accommodation and insufficiency of convergence. Should the pathologic process seriously affect the kidney structures, ocular complications involved in the renal changes may also arise.

Adducens oculi. (L.) The internal rectus muscle.

Adducirende Prismen. (G.) Adductive prism.

Adducirender Augenmuskel. (G.) The internal rectus muscle.

Adducteur de l'oeil. (F.) Internal rectus muscle.

Adduction is a drawing of the eye inward in the horizontal plane. This movement is produced principally by the action of the internal rectus, but the eye is also turned inward by the internal acting together with the superior and inferior recti. This act is therefore entirely under control of the third nerve.

When the extent of adduction is measured by the tropometer

(q. v.) it is found to vary a little within physiologic limits. Most students have placed the limit of this inward rotation at about 45°. Schnurmann gives it 45, Volkmann 42, Hering 44, Kuster 45, Schneller 52 to 56, Landolt 44, Duane 51.

It must be confessed, however, that many difficulties arise in the exact measurement of this arc, principally because the observer cannot see distinctly the reflection from the cornea on account of the projecting bridge of the nose. In all measurements of adduction this element of doubt must be taken into account.—(L. H.) See **Muscles, Ocular.**

Adductive power, Weakness of. Defective convergent power may be due to a number of causes, but prominent among them is any systemic weakness, especially that due to defective nutrition, anemia, loss of blood, parturition, influenza, typhoid fever, etc. Defective development of any or all the adductor muscles will account for an unknown percentage of cases of insufficient convergence. It is to be remembered that two or more of the foregoing causes may combine to bring about weakness of adduction.

Adductor oculi. (L.) Internal rectus muscle.

Adduktion. (G.) Adduction.

Adduzione. (It.), n. Drawing a part towards the median line of the body. Rotating the eyeball toward the nose.

Adelmann, George F. B. A distinguished Russian surgeon and ophthalmologist, born at Fulda, June 28, 1811, died June 16, 1888. He studied at Marburg and Würzburg; then for a time engaged in general practice at Fulda. In 1837 he returned to Marburg, in order to become assistant in the Surgical Clinic of Ullman. In 1841 he was called to the combined chairs of Surgery and Ophthalmology in the University of Dorpat, and, in this double capacity, he officiated till 1871—30 years. He wrote prolifically and in four languages—Latin, German, Russian, and Italian. Among his best known writings is one entitled *"Uber endemische Augenkrankheiten der Esten in Livland und verwandter Stämme im Russischen Reiche."*

Adelmann was a man of warm and generous disposition, and most courteous demeanor. His kindness to the younger men of his profession was extreme.—(T. H. S.)

Adelmann, Heinrich A. Son of a well-known German jurist and nephew of the surgeon Vincenz Adelmann, this oculist-to-be was born Aug. 17, 1807. He received his medical degree in 1830 at Würzburg, and, in 1837, was appointed docent, in 1840 extraordinary professor, at the same institution. He taught theoretic ophthalmology and gave ophthalmic operation courses on the phantom and

the cadaver. He invented, in 1852, a suction-instrument for hypopion. Being an excellent artist, he furnished the illustrations for Textor's *Elementary Principles for the Teaching of Surgical Operations* (1834-36), and, to this day, the eye-clinic at the University of Würzburg has preserved a collection of water-color pictures by Adelmann, showing the external diseases of the eye.

Adelmann was retired in 1879. He died Nov. 8, 1884.—(T. H. S.)

Adenemphraxis. That condition in which a duct or a gland is obstructed.

Adenite. (It.), n.f. Adenitis, i. e., the inflammation of a gland, especially of a lymphatic gland.

Adénite contagieuse des paupières. (F.) Purulent or contagious conjunctivitis.

Adenite contagiosa delle palpebre. (It.) Purulent conjunctivitis.

Adenitis. Inflammation of a gland, especially of a lymphatic gland.

Adenitis der Thränendrüse. (G.) Adenitis of the lachrymal gland.

Adenoid. adj. Resembling the structures of a gland.

Adénoide. (F.), adj. Resembling a gland in structure.

Adenoides Gewebe. (G.) Adenoid tissue.

Adenoids, Ocular symptons in. May names among these in children epiphora, blepharitis, dacryocystitis, congestion of the conjunctiva, phlyctenular conjunctivitis and keratitis, subacute and chronic conjunctivitis, certain forms of which resemble trachoma. He regards the adenoids as predisposing to these conditions or aggravating them, a connection explained by the congestion of the neighboring parts produced by the adenoids.—(*Ophthalmic Year-Book,* 1909, p. 75.) See **Cavities, Neighboring.**

Adenologaditis. Obsolete term for ophthalmia neonatorum.

Adenoma. (L.), n.n. A tumor with a glandular structure.

Adenom der Meibomschendrüsen. (G.) Adenoma of the Meibomian glands.

Adenomthränendrüse. (G.) Adenoma of the lachrymal gland.

Adeno-myxoma. An adenoma having its stroma invaded by myxoma.

Adenophthalmia. (L.), n.f. An inflammation of the lining of the Meibomian glands, or of their excretory ducts, or of both. Also called ophthalmia tarsi.

Adenophthalmitis. (L.), n.f. See **Adenophthalmia.**

Adeno-sarcoma. (L.), n.n. An adenoma infiltrated with sarcomatous elements; or a sarcoma which has developed in a gland.

Adeno-synchitonitis. (L.), n.f. A term used by von Graefe to designate inflammation of the Meibomian glands; formerly applied to ophthalmia neonatorum.

Adeps. See **Lard.**

Adeps benzoatus. See **Benzoated lard.**

Adepsin oil. A name given to one of the soft, or liquid, paraffins, used as a menstruum for various therapeutic agents employed in ophthalmic practice.

Adeps lanæ hydrosus. See **Lanolin.**

Adeps petrolei. See **Cosmoline.**

Adeps suillus. See **Lard.**

Ader. (G.) Vein, blood-vessel.

Aderbeschreibung. (G.) Angeiology.

Aderbruch. (G.) Rupture of a vein.

Aderentzündung. (G.) Phlebitis.

Adererweiterung. (G.) Phlebectasis.

Aderfalten. (G.) The valves of the veins.

Aderförmig. (G.) Veiny, veined, in the form of a vein.

Adergebäude. (G.) The vascular system.

Adergeflecht. (G.), n. A venous plexus; the chorioid plexus.

Adergeflechtschlagadern. (G.) The choroid arteries.

Adergeschwulst. (G.) A venous tumor, varix, thrombus, an aneurism.

Adergewächs. (G.) A vascular growth, polypus.

Adergewebe. (G.) Choroid plexus; plexus of veins.

Aderhaut. (G.) The chorion; the choroid.

Aderhautangiom. (G.) Angioma of the choroid.

Aderhautatrophie. (G.) Choroidal atrophy.

Aderhaut bei Myopie. (G.) Choroidal changes in myopia.

Aderhautbildungsfehler. (G.) Error or defect of development or malformation of the choroid.

Aderhautcarcinom. (G.) Choroidal carcinoma.

Aderhäutchen. (G.) The chorion.

Aderhauteinrisse. (G.) Choroidal fissure.

Aderhautentzündungen. (G.) Choroidal inflammation.

Aderhauterkrankungen. (G.) Diseases of the choroid.

Aderhautgefässe. (G.) Vascular choroid.

Aderhautgeschwülste. (G.) Choroidal tumors.

Aderhautgumma. (G.) Choroidal gumma.

Aderhautiridochorioiditis. (G.) Choroidal iridochoroiditis.

Aderhautkolobom. (G.) Choroid coloboma.

Aderhautmangel. (G.) Defect in the choroid.

Aderhautmuskel. (G.) The ciliary muscle.

Aderhautnerven. (G.) The choroid nerves.

Aderhautpigment. (G.) Choroidal pigment.

Aderhautruptur. (G.) Choroid rupture.
Aderhautsarkom. (G.) Choroidal sarcoma.
Aderhautschwinden. (G.) Choroidal atrophy.
Aderhautschwund. (G.) Choroidal atrophy.
Aderhautspalt. (G.) Coloboma of the choroid.
Aderhautspanner. (G.) The ciliary muscle.
Aderhautsyphilis. (G.) Choroidal syphilis.
Aderhauttuberkulose. (G.) Choroidal tuberculosis.
Aderhauttumoren. (G.) Choroid tumors.
Aderhöhle. (G.) A venous sinus.
Adericht. (G.) Resembling veins.
Aderig. (G.) Veiny, veined.
Aderknoten. (G.) A varix.
Aderkropf. (G.) A varix.
Aderlass. (G.) Venesection.
Aderlassbausch. (G.) A compress applied after venesection.
Aderlassbäuschen. (G.) Bloodletting compress.
Aderlassbinde. (G.) The bandage used in bloodletting.
Aderlasseisen. (G.) A lancet.
Aderlassen. (G.) To bleed.
Aderlasser. (G.) A bleeder.
Aderlasskunst. (G.) Phlebotomy.
Aderlasslanzette. (G.) A lancet for venesection.
Aderlasslehre. (G.) The science of bloodletting.
Aderlassschnäpper. (G.) A scarificator, a spring-lancet for phlebotomy.
Aderlassthrombose. (G.) Venous thrombus following venesection.
Aderlassverband. (G.) The dressing applied after venesection.
Aderlasswunde. (G.) A venesection wound.
Aderlasszeug. (G.) Instruments for bloodletting.
Aderlos. (G.) Veinless, non-vascular.
Adernetz. (G.) The choroid plexus.
Adernetzpulsadern. (G.) The choroid arteries.
Adernetzschlagadern. (G.) The choroid arteries.
Aderreich. (G.) Venous, full of veins, veiny.
Äderschen. (G.) Veinlet, venule.
Aderschlag. (G.) The pulse, a pulsation.
Adersystem. (G.) Vascular system.
Aderwasser. (G.) Serum.
Adhäsiv. (G.) Having the power of, or causing, adhesion.
Adherent leucoma. Union between the iris and the cornea, generally due to perforating ulcer (q. v.) operation on or deep injury to the

cornea. It is almost always associated with a white, opaque scar that causes disfigurement and greatly reduces vision. See **Cornea, Ulcer of.**

Adhesion of eyelids. This condition is sometimes congenital and sometimes due to burns, injuries and other lesions of the eyelids and conjunctival sac. See **Symblepharon** and **Ankyloblepharon.**

Adhib. An Arabic name for the plant Eye-bright.

Adiactinic. Impervious to the actinic or chemical rays of light.

Adipid. (G.) Fat.

Adipide. (G.) Fatty products of animal substances.

Adipidieren. (G.) To grease.

Adipinsäure. (G.) Adipinic acid.

Adipoma. (L.), n.n. A term for lipoma.

Adipose. adj. Fatty.

Adipose capsule of the eye. Also called, adipose body of the orbit. These expressions are employed to indicate the pad of connective tissue enclosing masses of fat that practically fills the orbit behind the eyeball.

Adjoining sinuses, Ocular relations of. See **Cavities, Accessory.**

Adjunct treatment of ametropia. See, also, **Eyestrain.** Chloretone is for this purpose used with cocain and other alkaloids, generally in the proportion of 2 per cent. It is a favorite remedy for the relief of the burning and smarting that so often accompany the lid hyperemias of eye-strain. The following makes an excellent mixture: chloretone, seven-tenths of a grain; borax, seven grains and a half, distilled water, one fluid ounce.

Theobold prefers the oleate of veratrine in 10 per cent. strength to any other preparation of the kind in asthenopia and frontal headache due to accommodative strain. He also employs it to lessen the irritability of the ciliary muscle preparatory to testing errors of refraction. A little is to be rubbed upon the forehead and temples once a day, preferably in the morning. None of it should be allowed to enter the eye, as it causes severe and persistent irritation.

For the hyperemia of the conjunctiva and the irritative symptoms that accompany refractive errors, and that occasionally persist after they have been properly corrected, Hanford McKee prescribes a collyrium containing one-sixteenth of a grain of zinc sulphate to the ounce of water. To the same end he often uses iodoform powder on a homatropin and cocain disc, or a little ointment of iodoform—ten per cent. strength.

As a ciliary tonic in asthenopic cases C. R. Gardner advises the following collyrium, a few drops to be put into the eye three times

daily: eserin sulphate, one forty-eighth of a grain, holocain, 20 drops of a one per cent solution, boric acid, six grains, rose water, half a fluid ounce.

For painful eyes in neurasthenic patients, where the irritation continues after the correction of the refractive error W. O. Moore advises the instillation of a few drops three times a day of a 1 per cent. solution of antipyrine.

Adjunctum cataractæ. (L.) An obsolete term for the whitish, viscid substance supposed to occupy the place of the crystalline lens after extraction of cataract.

Adler's test. In the optical forms of aphasia (q. v.) the patient may be regarded as color-blind, especially as he cannot give a name to a color, although he, as a matter of fact, recognizes it. Such a person should be asked to match colors, as in the Holmgren (q. v.) method, which he may be able to do quite readily though affected by aphasia.

Adnephrin. This is the trade (Stearns) name of a preparation that closely resembles adrenalin, suprarenalin and similar extracts of the suprarenal gland. It occurs in the market in the usual 1-1000 solution, as well as in the form of oil spray, emollient, suppositories, etc. From our experience of it, it appears to be a reliable vaso-constrictor and to be useful in all those ophthalmic operations and eye diseases for which suprarenin, etc., are advised.

Adnexa. (L.), n.n. Appendages, or accessory parts.

Adnexa bulbi. (L.) The appendages of the eyeball.

Adolescence, Cataract of. Although there is clinically almost always a decided difference between those opacities in the lens that form in early adult life and the genuine senile type, yet their physical characters may not differ greatly. The main (practical) difference lies in the fact that cataract forming before the age of fifty is likely to be due to more or less active changes in the uveal tract—especially in the choroid—to diabetes or to some other intercurrent affection, and should be dealt with accordingly. Early cataract undergoes more rapid secondary changes than does the translucent lens of old age. It is more difficult to deal with, as a rule, and its extraction should be conducted with especial care. See the major heading, **Cataract.**

Adonidin. In two to four per cent solution this glucoside of *Adonis vernalis* produces anesthesia of the lid, cornea and sclera, the pupil being unaffected. The anesthesia extends to the lower layers of the cornea, and to a slight extent affects the conjunctiva.

This local anesthetic was initially employed as a substitute for cocaine but there are too many disadvantages encountered during its

employment. At least one per cent. strength is required to anesthetize the anterior ocular segment. Two drops of this solution instilled during five minutes produces complete anesthesia after twenty-five minutes, but it also sets up almost at once a marked reaction, headaches, cloudy vision, conjunctival hyperemia and a bitter taste in the mouth. Tension and accommodation are not affected but it acts as a mild miotic and analgesic. Schiedlowsky demonstrated its therapeutic value before the St. Petersburg Ophthalmological Society in November, 1906, and showed that while adonidin has not much practical value as a local anesthetic it promptly relieves the pain in glaucoma, iritis and iridocyclitis. For this purpose one-quarter of one per cent. solution is sufficient and, like dionin, whose action it resembles, it may be used in conjunction with eserine, pilocarpine, atropine or any other of the miotic or mydriatic alkaloids.

Adorbital. n. The name employed by Geoffroy for the lachrymal bone of fishes.

Adorbital. adj. Pertaining to the orbit.

Adram. An Arabic alchemical name for sodium chloride.

Adrenal. $C_{10}H_{15}NO_3$. This is a crystalline base from the suprarenal capsule and belongs to the same category as suprarenine, (q. v.) suprarenaline, adrenaline and other hemostatics of that order. Although it is not readily soluble in water its salts are. It is used in $\frac{1}{10,000}$ to $\frac{1}{1000}$ solutions.

Adrenaline. EPINEPHRINE. $C_{10}H_{15}NO_3$. This compound, with its congeners, forms one of the most valuable remedial agents we have at our command. It is a crystalline substance isolated in 1901 by Takamine and Aldrich in the suprarenal body of the ox. It is a grayish-white, minutely crystalline substance, having a bitter taste and imparting a numb feeling to the tongue. It is very soluble in hot, but less so in cold water. Even the 1:1000 preparation of Parke, Davis & Co. turns pinkish on exposure to air and light, but this change does not affect its activity.

Although a number of preparations derived from the suprarenal capsules are on the market, this remedy, especially as adrenalin chloride (preserved by the addition of 0.05 per cent. of chloretone), in solutions of 1 to 1000-5000, seems still the favorite, its action being substantially that of other adrenal agents. Cocaine seems to reinforce its astringent or blanching action, thus making it a valuable adjunct in operating on the eyeball.

In a few minutes after the use of the solution the conjunctiva turns marble white, the tissues at the inner canthus shrink and the

palpebral conjunctiva becomes pallid. A few more instillations and the lid skin begins to whiten and in some patients this pallor extends quite to the cheeks, the nose and the eyebrow. Some surgeons claim that post-operative bleeding in such procedures as the advancement of an ocular tendon is more marked than when no suprarenal agent is employed, but as a clear field during the operation is the all-important consideration and the subsequent bleeding of small moment, the post-operative hemorrhage may be ignored.

Many suprarenal gland extracts are almost identical chemically, physiologically, and clinically with adrenalin. They are supplied to the profession by various manufacturing chemists in this country and abroad. Most of these hemostatics will be more or less fully described under separate headings. A few of the recent ones are hemisine, renaglandin, suprarenin, adnephrin, paranephrin and renostyptin.

Sydney Stephenson (*Ophthalmoscope,* Oct., 1908) believes that adrenalin is of no value in the treatment of superficial eye diseases, although it has been of service in glaucoma and spring catarrh. On the other hand it is most valuable as an adjuvant to atropine, eserine and fluorescine and as a local hemostatic in operations on the eye, especially on the eye muscles.

Darier (*Thérapeutique Oculaire,* p. 152) uses the following mixture with cocaine (which he calls coca-renaline): cocain hydrochlorate, one decigram; sol. of adrenalin, 1:1000, twenty drops; distilled water, 10 grams.

A single drop of this collyrium is sufficient to blanch the conjunctiva and dispel all scleral congestion. He has found it of great service to actors and others who feel obliged to appear with their eyes as brilliant as possible and the sclera as white as it can be made. With this mixture the desired result is obtained without dilating the pupil.

A. Duane believes that its use is indicated in engorgement of the conjunctival and scleral vessels and the feeling of irritation accompanying that condition, but does not think the remedy should be applied for any length of time and that this method of utilizing it is not justifiable except in cases of lachrymal diseases and in some examples of spring catarrh.

Under the name codrenin (q. v.) a mixture containing $4\frac{3}{5}$ grains of cocaine hydrochlorate, $\frac{1}{12}$ grain adrenaline chloride and $2\frac{1}{4}$ grains chloretone is for sale that seems well adapted for subconjunctival use.

Venable (*Ophthalmic Year-Book,* 1908, pp. 36, 37) has used ad-

renalin to modify the action of ether when employed in general anesthesia (q. v.). He sprays a 1/1000 to 4/1000 solution upon the towel or inhaler and depends upon its being carried into the air passages with the vaporized ether, sufficiently to produce the desired effect. The spraying is repeated once in six or eight minutes, and from one-half to one ounce of the solution is used for an ordinary operation. The adrenalin seems to contract the vessels of the respiratory tract, lessen the secretion of mucus, and thus secure better aëration in the bronchial and pulmonary vessels.

Theobald (*ibid.*) was led to use adrenalin with cocain, at first to lessen hemorrhage; but found it also increased the anesthetic effect of cocain. It also facilitates the passage of probes in the lachrymal canal, by diminishing the swelling; facilitates the removal of foreign bodies by diminished hemorrhage and swelling; and serves as an antidote to the toxic action of cocain.—(Ed.)

Adrenalinemia. An excessive amount of adrenaline in the blood.

Adreucaine. A preparation similar to eudrenine (q. v.). It is suitable for ordinary hypodermic use in inducing local anesthesia. Each cc. contains $\frac{1}{8}$ of a grain (0.01 gm.) of eucaine with adrenaline $\frac{1}{2000}$ grains (0.03) mgr.). The hypodermic dose is $\frac{1}{2}$ to 1 cc. When this mixture is diluted with four volumes of normal salt solution it forms an injection suitable for local infiltration-anesthesia.

Adrin. By this trade name is known epinephrine hydrate, one of the numerous suprarenal capsule extracts. It is probably identical with adrenalin chloride and is used in the same dose, as a hemostatic and astringent.

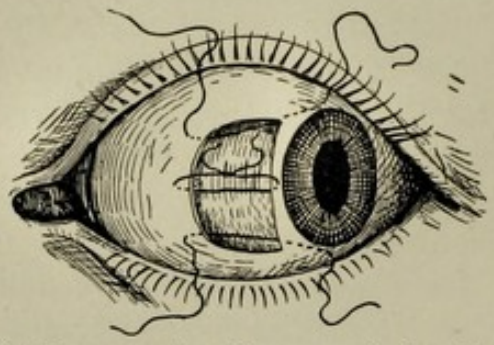
Adrovaine. This is a compound of a hemostatic with a local anesthetic and contains adrenalin 0.00025 gm. ($\frac{1}{250}$ grain) with stovaine (q. v.) 0.02 gm. ($\frac{1}{3}$ grain). It may be used with the hypodermic syringe or dissolved in sterile water as a local application in operations on the eye.

Adstringierend. (G.) Astringent.

Advancement. n. An operation whereby the tendon of an ocular muscle is separated from its insertion, and attached at a point farther removed from its original attachment. In this way the muscle acquires increased power over the excursions of the eye. There are numerous operating methods, but in all cases the tendon of the impaired muscle is loosened and, by means of sutures, is drawn forward to a point in advance of its original insertion. Section of the opposing muscle may precede or follow the operation.

Advancement operations differ from each other as to whether

the muscle is advanced upon the eyeball, along with the other tissues with which it is related (musculo-capsular advancement), or whether the attempt is made to partly separate the muscle from the related structures and bring it forward alone. They differ also as to whether the sutures used to secure reattachment are introduced simply into the episcleral tissue, or whether they are made to take hold of the firm tissues of the sclera, or the stump of the insertion of the advanced muscle. Then an indefinite variety



Critchett's Method of Advancement. Tissue excised and sutures introduced ready to tighten.

of operations is produced by the use of one, two, three, or more sutures; and by the different ways in which these sutures have been placed or tied by different operators. The attempt to designate by the proposer's name each slight variation in the mode of performing an advancement operation is a source of confusion. The more valuable the operation, the more widely it is used or modified, the less definite is the meaning conveyed by such names. This is illustrated by the questions that have arisen as to how Graefe did a tenotomy, or what is a de Wecker advancement. Operations for the shortening of a muscle by exsection of a part of its tendon, or folding the tendon, "tendon-tucking," are in effect to be classed with advancements.

It is of great practical importance whether an advancement operation is done without other disturbance of the muscular attachments of the eyeball, leaving the advanced muscle to contend with the unhampered activity of its opponents; or whether by over-stretching or tenotomy, its chief opponents have been temporarily weakened or rendered powerless in a combined operation. It influences especially the kind of anchorage that must be secured for the sutures and the probability of the first result remaining unchanged. But the general discussion of this matter is reserved for the section on the general indications for and effects of different muscle operations (q.v.).—[E. J.]

Advancement of the capsule. An operation by means of which a portion of the capsule of Tenon, generally with the overlying conjunctiva, is loosened from its bed, brought forward and attached nearer the corneal margin. See **Extrinsic ocular muscles, Operations on.**

Advancement operations on the extrinsic ocular muscles. See **Extrinsic ocular muscles, Operations on the.**

Advancement with anchor stitch. See **Extrinsic ocular muscles, Operations on.**

Adventitia oculi. (L.) The ocular appendages.

Adverse prism. This term is used by Maddox who defines it as meaning a prism with its apex set in the opposite direction from a "relieving" prism; for example, if the internal recti muscles are to be affected, the prism is placed base out; but base in, if the externi are to be exercised. See **Ocular muscles.**

Adversion. The turning of one or both eyeballs inward.

Adynamia. Loss of vital force or muscular power.

Adynamie. (G.) Weakness.

Adynamisch. (G.) Weak, adynamic.

Aegias. (L.), n.f. An ancient term for a spot or speck on the eye.

Aegidion. (L.), n.n. The name of an ancient collyrium or eye wash, said to have been so called on account of the prevalence of eye troubles in goats.

Aegilops. (L.), n.f. An obsolete term for a lachrymal fistula or an abscess that has opened externally.

Aegyptische Augenpest. (G.) Egyptian ophthalmia; trachoma.

Aegyptische Augenentzündung. (G.) Egyptian ophthalmia.

Aeolotrop. (G.) Doubly refracting.

Aelotropic. In *physics,* not having the same properties in all directions; non-isotropic; anisotropic: said of a body with reference to the action upon it of light. Iceland spar is an aelotropic biaxial crystal in consequence of its strong double refraction.—(C. F. P.)

Aelotropy. In *physics,* the state or quality of being aelotropic (q. v.).

Aequator des Auges. (G.) Equator of the eye.

Aequatorialebene. (G.) Equatorial plane.

Aequatorialplatte. (G.) Equatorial plate.

Aequator oculi. (L.), n.m. Equator oculi. The circumference of the eyeball that bounds its central transverse vertical plane, corresponding to that narrow zone which lies immediately behind the ciliary region.

Aequilibriemethode. (G.) Method of equilibration.

Aerämie. (G.) Air in the blood-vessels.

Aerhämoktonie. (G.) Death due to air entering the blood-vessels.

Aerial image. In *optics,* (1) the image formed in the air by a convex lens or concave mirror, and which is made visible when the eye is in line with the image and in accommodation for it. (2) An image of terrestrial objects that is formed through light being convergently reflected or refracted by strata of different atmospheric densities, the image appearing suspended in the air, as the different kinds of mirage.—(C. F. P.)

Aerial perspective. In *painting,* the art of giving due diminution to the strength of light, shade and colors of objects according to their distances, to quality of light falling on them, and to the atmosphere or medium through which they are seen.—(C. F. P.)

Aerial tints. In *painting,* the tints or modifications of color by which the expression of distance is attained.

Aeroben. (G.) Aërobic bacteria.

Aerobian. See **Aerobiotic.**

Aerobic. Aerobiotic (q. v.).

Aerobiontisch. (G.) Aërobic.

Aerobiotic. adj. Pertaining to the life of an aerobion, i. e. one requiring free oxygen or atmospheric air for the maintenance of life.

Aerobisch. (G.) Aërobic.

Aerostatisch. (G.) Aërostatic.

Aërotherapie. (G.) Air-treatment.

Aerotonometer. (G.) An instrument for measuring gas-tension in the blood.

Aerztekammer. (G.) Representative body of medical men.

Aerztetag. (G.) Meeting of medical men.

Aerztlich. (G.) Medical; relating to medical men or medical affairs.

Aeschinas. This classical patient deserves a place here as he presents for modern readers an especially interesting history. His record is preserved on a votive-tablet, more than twenty-two hundred years old, exhumed in 1883-85 from the ruins of the Asklepieion at Epidauros. It reads as follows: "Aeschinas climbed a tree, when those seeking help were already sleeping in the temple, and gazed across the sanctuary in the holy of holies. Then he fell from the tree, and wounded his eyes on a number of stakes. In this deplorable condition, and wholly blind, he supplicated the god, slept in the temple, and became healed."—(T. H. S.)

Aescorcin. See **Escorcin.**

Aesculus hippocastanum, Oculo-toxic symptoms from the. The fruit of the common horse chestnut, now and then eaten by children,

seems to produce poisoning which is followed by dilation of the pupil. It is very questionable whether aesculin is concerned in this symptom. It is more likely due to saponins. A boy ate the green rind of the fruit. He vomited a portion of it, the pupils became dilated, the face reddened, the pulse high, while nervous symptoms with sleepiness developed. Recovery resulted after administration of an emetic. Similar symptoms showed themselves in a girl, six years old, who had eaten the green fruit. She developed pains in the abdomen, nausea, thirst, delirium and fright. The pupils dilated and the eyes "looked" glassy.

Aestchen. (G.) A little branch.

Aesthesiometer. n. An instrument for measuring the acuteness of tactile sensation. It consists of two hair-like, movable points, which, placed upon the skin, are approximated until the two tactile sensations thus obtained blend into one. The distance between the two points, indicated by a scale attached to the instrument, is in inverse proportion to the degree of tactile sensibility. An esthesiometer.

Aesthesioneurosen. (G.) Affections of sensory nerves.

Aesthesodisch. (G.) Aesthesodic; conducting sensory impulses.

Aestig. (G.) Branched, racemose.

Aethehart. (G.) A kind or variety of ether.

Aetherauszug. (G.) Ethereal extract.

Aetherbesprühung. (G.) Spraying with ether.

Aetherbetäubung. (G.) Ether narcosis.

Aetherbildung. (G.) Etherification.

Aetherdampf. (G.) Ether vapor.

Aetherdarreichung. (G.) The administration of ether.

Aetherdouche. (G.) An ether spray apparatus.

Aetherdusche. (G.) An ether spray apparatus.

Aethereinatmung. (G.) The inhalation of ether.

Aethereinspritzung. (G.) The injection of ether.

Aethereinwirkung. (G.) The action or effect of ether.

Aether, Eye symptoms from the inhalation of. See **Ether.**

Aetherisch. (G.) Ethereal; essential.

Aetherisiren. (G.) To administer ether, to etherize.

Aetherisirung. (G.) The administration of ether.

Aetherismus. (G.) Etherism, after-effects of ether.

Aethermuskelstarre. (G.) Muscular rigidity under ether.

Aethernachwirkung. (G.) The after-effect of ether.

Aethernarkose. (G.) Narcosis by ether.

Aetheromanie. (G.) Etheromania.

Aetherscheintod. (G.) Collapse or asphyxia under ether.

Aetherschwefelsäure. (G.) Ethylsulphuric acid.
Aetherweingeist. (G.) The spirit of ether.
Aetherwirkung. (G.) The action or effect of ether.
Aetherzerstäuber. (G.) An ether spray apparatus.
Aetherzerstäubung. (G.) The act of spraying with ether.
Aethiops albus. (L.) A term applied originally by the Portuguese to albinotic negroes. Subsequently it was given to human albinoes in general, i. e., to anyone in whom the proper pigmentation of the skin, hair, iris and choroid is congenitally deficient. In them the eyes are pink and usually affected with photophobia; there is more or less blepharospasm, and often nystagmus. See **Albino.**
Aethomma. (Obs.) Ambrose Paré's term for pigment deposits in the humors and tunics of the eye. It has also been employed as a synonym for phosphenes, or flashes of light or sparks before the eye.
Aethyl. (G.) Ethyl.
Aethylaldehyd. (G.) Ethyl aldehyde.
Aethylalkohol. (G.) Ethyl alcohol.
Aethyläther. (G.) Ethyl ether.
Aethylchlorür. (G.) Ethyl chloride.
Aethylen. (G.) Ethylene.
Aethylenjodid. (G.) Ethylene iodide.
Aethyliden. (G.) Ethylidene.
Aethylidendimethyläther. (G.) Ethylidene dimethyl ether.
Aethyloxyd. (G.) Ethyl oxide.
Aethylschwefelsäure. (G.) Ethylsulphuric acid.
Aethylviolett. (G.) Ethyl violet.
Aetiologisch. (G.) Etiological.
Aetius of Amida (In Mesopotamia). This somewhat slavish, but most exhaustive, ophthalmologic compiler was born at Amida (now Diarbekir) A. D. 502 and died about 575. Educated at the University of Alexandria, he very soon settled in Byzantium, where he seems to have passed the remainder of his days. He was a devout Christian, became comes obsequii, or lord high chamberlain, to the great Justinian—compiler of the *Institutes, Code,* and *Digest*—and was also body-physician to the same potentate. His *Sixteen Books on Medicine* was a kind of Encyclopedia of the healing art as known and practised in his day. After Aëtius's time, his sixteen "books" were grouped into four Tetrabilia, each of four Sermones. A later name of the work was, in consequence of this arrangement, *Tetrabiblon.*

Though Aëtius was, in general, a scientific writer, sometimes he

abandoned the strictly scientific view-point; when he did so, he exhibited somewhat typically the spirit of his age. Thus, when making salves, he declared that one ought continually to repeat this incantation: "The God of Abraham, the God of Isaac, the God of Jacob, give virtue to this medicament." When a bone has stuck in the patient's throat, the physician should seize him by the neck, and cry in a voice of loud command: "As Jesus drew Lazarus from the grave, and Jonah out of the whale, thus Blasius, the martyr and servant of God, commands, 'Bone, go up or down.'"

Much of the Tetrabiblon is mere compilation from the earlier Greeks—Archigenes, Aspasia, Leonides, Philagrius, Soranus, *et al.* Yet there is also original matter, part of which, at least, is of high value. Moreover, Aëtius has preserved the doctrines of many an ancient ophthalmologue, who, but for this mediaeval writer would never have remained in view till the 20th century. Neuberger declares the ophthalmologic portion of the Tetrabiblon to be "the best and most exhaustive" of antiquity. This praise may be a little too high for a treatise which does not even mention the cataract operation (very commonly performed in Aëtius's time and for centuries earlier) and which lays but little stress on any ophthalmo-surgical procedure. Nevertheless, in the matter of the therapeutics of the eye, the work in question is undoubtedly important. It describes, in fact, with great detail the therapeutics of sixty-one distinct ocular affections.

An important and memorable passage of the work is the following: "On the treatment of the new-born. According to Severus. A terrible affection occurs in the eyes of the new-born. Commonly, the lids swell by reason of the abundance of pus. For moist and warm by nature are the newly born. [An allusion to the so-called "humoral theory" of disease.] The collyria for this disease must be cooling and drying, as well as astringent, in order to mitigate the flow of ocular secretion." Though an extremely early, this is not the very earliest, passage extant on the subject of ophthalmia neonatorum. For two much earlier passages, see **Soranus.** —(T. H. S.)

Aetius's operation for entropion. There can be no doubt but that this sixth-century surgeon advocated and performed an entropion operation quite similar to that of Burow (q. v.). At any rate, in addition to the removal of a longitudinal piece of palpebral skin the section went deeper and included the tarsus.

Aetz. (G.) Caustic, corrosive.

Aetzammoniak. (G.) Caustic ammonia.

Aetzammoniakflüssigkeit. (G.) Liquor ammoniae; a solution of caustic ammonia.
Aetzbar. (G.) Corrodible, irritable.
Aetzbaryt. (G.) Caustic baryta.
Aetzeinwirkung. (G.) The action or effect of caustics.
Aetzen. (G.) To cauterize, to corrode.
Aetzend. (G.) Caustic, corrosive.
Aetzgift. (G.) A caustic poison.
Aetzkali. (G.) Caustic potash.
Aetzkalilauge. (G.) A solution of caustic potash.
Aetzkalilösung. (G.) A solution of caustic potash.
Aetzlauge. (G.) A solution of caustic potash.
Aetzmittel. (G.) A caustic or escharotic remedy.
Aetzmittelträger. (G.) A caustic holder.
Aetzmittelzange. (G.) A caustic holder.
Aetznatron. (G.) Caustic soda.
Aetznatronlauge. (G.) A solution of caustic soda.
Aetznatronlösung. (G.) A solution of caustic soda.
Aetzpinsel. (G.) A caustic brush or pencil.
Aetzschorf. (G.) Eschar or slough from caustic.
Aetzsonde. (G.) A caustic sound.
Aetzstäbchen. (G.) A caustic point.
Aetzstein. (G.) Potassa fusa.
Aetzstift. (G.) A caustic point.
Aetzsublimat. (G.) Corrosive sublimate.
Aetzträger. (G.) A caustic holder.
Aetzung. (G.) Cauterization, corrosion.
Aetzvergiftung. (G.) Poisoning by caustics.
Aetzwunde. (G.) A wound produced by caustics or corrosives.
Aeusser. (G.) Outer, external, externus.
Aeusserlich. (G.) External, superficial, outer.
Aeussere Augenhaut. (G.) The cornea; a term mostly used by the older anatomists.
Aeusserer Augenmuskelnerv. (G.) The sixth cranial nerve.
Aeusserer Augenwinkel. (G.) The external angle of the orbit; the external canthus.
Aeusserer gerade Augenmuskel. (G.) The external rectus muscle.
Aeusseres Augenleistenloch. (G.) Infra-orbital foramen.
Aeusseres Augenwinkelband. (G.) External tarsal ligament.
Afachia. (It.) Aphakia or absence of the crystalline lens.
Affektion. (G.) Emotion, morbid change.
Affektionslosigkeit. (G.) Apathy.

Afferens. (G.) Afferent vessel.

Affizieren. (G.) To affect.

Affusio. (L.), n.f. (Obs.) A cataract.

Affusio oculi. (L.) Obsolete name for cataract.

Afterbildung. (G.) Pseudoplasm, neoplasm, secondary growth, malformation, deterioration.

After-cataract. The importance of a definite understanding of this subject, not only from the operative form but from the non-operative standpoint, cannot be overestimated by the ophthalmologist, although it is generally considered from the viewpoint of the operating surgeon.

An after-cataract is any membrane stretched across the area of the pupil after a cataract extraction, which obscures vision.

These opacities vary from a loose, clear capsule which, hanging in folds, disperses light and obscures vision, to a dense, inflammatory membrane on which is superimposed the iris, the lower pupillary border of which may be drawn up into, or into the neighborhood of the cicatrix resulting from the incision in the cornea made for the extraction of the cataractous lens.

Much has been written about the dangers of operation on after-cataract, and even at the present time many surgeons never operate unless it is absolutely necessary to secure useful vision. Much of this dread has come down to us from pre-aseptic times. Iritis was then a much more common complication during convalescence from cataract extraction, and the resulting cyclitis produced a condition which was easily aggravated by any subsequent operation. The preceding iridocyclitis also produced a matting together of the tissues at the root of the iris which increased the predisposition of such eyes to a glaucomatous cyclitis. Septic infection at the point of incision in the operation for after-cataract was also a much more common accident. At the present time these dangers are much less than formerly and some operators, notably Knapp, have advocated the use of the method in every case in which vision could be distinctly increased. But that there is real danger is evidenced by Marshall's report during the five years from 1889 to 1893. During this period there were 404 operations for after-cataract in which number there were five cases of suppuration and ten cases of glaucoma giving 1.02 per cent. cases of suppuration and 2.08 per cent. of glaucoma. His explanation of the method of infection is that when the needle is withdrawn a tag of capsule, or vitreous, may follow it up to the corneal puncture and even be drawn through it and project exteriorly, which affords a very ready means of infection of

the interior of the globe. When a percentage as high as this is reported by so eminent an authority, it is obvious that aseptic precautions should be as thoroughly observed in every case of after-cataract as in the original operation.

The simplest form of after-cataract is that in which the loose posterior capsule throws itself into folds or ridges upon which are minute dots. This membrane will often produce an amount of obstruction to the vision entirely out of proportion to its apparent opacity, as seen when looking into the eye with the ophthalmoscope. The reduction of vision is due to the dispersal of the rays of light by the corrugations of the membrane.

The next and more serious condition is that in which the obstruction is due to opaque masses or bands of tissue lying upon the anterior surface of the capsule. These arise from a variety of causes, being largely due to the fact that the epithelial lining of the posterior capsule which produces the lenticular fibres continues under the new conditions to produce abortive lenticular cells. This is especially true where the anterior capsule overlies the posterior, these cells subsequently becoming sclerosed and opaque.

Another frequent source of after-cataract is small masses of cortical lens-matter that remain behind when the lens is extracted. These subsequently undergo absorption but at their seat there is found a dense connective-tissue-like material. Bates, from experimental work upon rabbits, drew the conclusion that the fluid which replaced the normal aqueous humor not only contained albumin, but would clot, and that such clots when stained and examined by the microscope showed the structure to be of fibrin. He deduced from these experiments that probably a fibrinous connective tissue process followed on the capsule from loss of the aqueous humor during cataract extraction. It is well known that when the wound of a cataract extraction does not close promptly, so that there is a considerable leakage of aqueous for a number of days, these opacities on the posterior capsule are much more likely to occur, which would seem to confirm Bates' deductions. These opacities very often take the form of bands stretching across the pupil in a direction approaching vertical. The capsule itself is elastic, and these bands tend to contract and draw the elastic membrane tensely across the area of the pupil.

Another variety of simple after-cataract is due to former disease of the capsule itself, in cases of old and complicated cataract.

When, following cataract extraction, we have an iritis or an iridocyclitis, the result complicates the simple after-cataract by

pouring out upon the surface of the capsule an exudate from the iris. This exudate forms dense opaque masses at the border of the pupil, attaching it to the capsule at such places, and if the iritis has been profound the whole margin of the iris may in this manner be agglutinated to the capsule. The pupillary area becomes much diminished, and if the iritis is complicated with ciliary inflammation in the neighborhood of the original wound, the iris may be drawn up and attached by inflammatory material in such a manner that the lower border of the pupil is dragged to the upper margin of the anterior chamber. The consequent stretching of the iris tissue approximates it to the capsule to which it becomes firmly adherent, with the result that a dense, inflammatory membrane of iris tissue, connective tissue and posterior capsule is stretched across the anterior chamber.

The intent of the operation is to obtain a clear opening in the pupil for the purpose of giving distinct vision. In a simple after-cataract the size of the opening is of less importance than its position. A very small opening in a fairly transparent capsule often gives us good, or better, vision than a large one, provided this opening is centrally placed. Most operators have laid stress on the statement that the important factor is a wide horizontal slit. It is probable that too much stress has been laid upon this point and that a vertical slit giving a clear area through which the lower part of the field of vision is clear is even more useful than a wider opening whose main dimension is horizontal.

The principal difficulty encountered in this operation is often the inability of the operator to see exactly what he is doing. This is chiefly due to alterations in the illumination and the refraction of the light. First, after the needle is introduced into the anterior chamber a slight amount of traction on the cornea is produced by the movements of the needle, which alters the curvature of the cornea. Second, while the membrane may be perfectly distinct as it is stretched across the posterior portion of the anterior chamber, the moment the point and cutting edge of the needle depresses the center of the membrane, the reflection of the light from its surface is thrown in such a manner as to make it quite, or almost, invisible. Jackson urges that every operator should use a binocular magnifier, and while his advice has not been generally followed, it serves to emphasize this particular difficulty in the operation. A good Nernst or electric light, employed as the oblique illumination, set on a standard, or used as a head-lamp, acts excellently in outlining with vivid distinctness even the smallest strand or filament in the anterior chamber. The advantage of an oblique or sideways illumination is that it rids one of the annoying corneal reflexes.

Most operators have agreed that it is necessary in these operations to avoid traction upon the ciliary body through the attachment of the posterior capsule. The chief difficulty that this presents is because it is only with the greatest care that the small knife-needles used in the operation can be made and kept sufficiently sharp to do their work without dragging on the capsule during a discission.

Infection of the corneal wound is often due to the fact that insufficient precautions have been taken before the operation. But many operators believe that the point of incision is of importance in this respect, and if the needle be entered well back at the limbus, or even subconjunctivally, and then through the limbus into the anterior chamber, the vascular blood supply of this region is a safeguard against infection.

The second danger is that the *traction on the after-cataract* may be sufficient to produce a recurrence of an iridocyclitis, and that this inflammation may pursue a very slow, inactive course with the loss of the physiological function of the ciliary body weeks or months afterwards, with consequent loss of vision.

The third danger is that if there has been much inflammatory exudate poured out upon the capsule, this may send out proliferations which may subsequently close the opening made by operation.

Most of the early operations for after-cataract were designed for use in those cases in which the pupil had become occluded by inflammatory products, but in recent years operations are also done for after-cataracts which are much less formidable, and now the great bulk of operations for after-cataract are upon the posterior capsule on which opaque masses have appeared. These vary widely in their translucency, from the simplest form, in which the posterior capsule of the lens is hanging loosely in folds upon which are deposited minute points of opacity, through the various grades in which these opacities occur in larger areas, and not infrequently in the form of opaque striæ, or bands approximately vertical, to those cases still more troublesome in which in addition to areas and bands of opacity on the capsule, there are points of attachment to the iris, opposite which masses of opaque material have extended onto the capsule.

When it is expedient and proper to operate for simple after-cataract has been much discussed. Knapp, who stated, "I perform extractions with a view towards the necessity of a subsequent discission," naturally operated earlier than others who fear the results of secondary operations. It is his custom to operate within a few weeks after the extraction in cases of simple after-cataract. Surgeons who have never performed the operations, except in cases

where the vision is greatly obscured, operate, as a rule, upon more complicated after-cataracts that have been the subject of an iridocyclitis, and have naturally maintained that early operations are inadvisable. Success under these circumstances is absolutely dependent upon the entire subsidence of the original inflammation, and even then sufficient time must be allowed for the circulatory apparatus of the eye to recover its normal function so completely that even the slight traumatism produced by the operation is not sufficient to cause a recurrence of the inflammatory process. Obviously, in these cases, a considerable period of time must elapse before the secondary operation is undertaken. Careful operators often wait three or four months before again exposing the eye to the traumatism of an operation.

When an operation for after-cataract is performed soon after the extraction of the lens, there is danger that the tension caused by pressure of the needle in one direction, and the pulling caused by the fixation forceps in the opposite direction, may be sufficient to reopen the original wound, therefore the prompt healing of the wound with a flat and firm cicatrix is a condition precedent to an early secondary operation for after-cataract.

Before operation study the area of the capsule when the pupil is undilated. This is necessary to make sure that the opening in the capsule resulting from the operation shall be exactly in the center of the pupil. The danger in operating upon a membrane with a dilated pupil is that, owing to some inelasticity of the iris on one side, or because it is adherent to the capsule, the operator may select the center of the capsule as exposed, and when the mydriatic is omitted he finds to his chagrin that the opening is at one side of the pupil, or, in extreme cases, even behind the iris. Another reason for this preliminary study is that the elasticity of the capsule often allows it to be pushed before the blade of the knife and the opening is then made a considerable distance from the true center of the pupil in which the operator thinks he is operating.

In this preliminary study it is necessary to do two things. First, locate the center of the pupil by means of the relationship of such opacities as appear upon the capsule, so that it is easily recognized after the pupil is dilated. Second, observe whether the capsule is stretched more tautly in one direction than in others, so that advantage of this tension may be taken in making the incision and the opening remain widely extended.

Cutting instruments used in these operations are knife-needles, knives, scissors, spear-pointed needles and punches. The operation

for simple after-cataract at the present time is more often done with some form of knife than by any other instrument.

The first requisite of a *knife-needle* for after-cataract discission is that *it should be very sharp.* This is a condition of the instrument not easily obtained and maintained, owing to the mechanical difficulties of sharpening the instrument, and the care necessary to keep it sharp during the aseptic preparation and the subsequent

Cheselden's Knife-Needle. (After Sharp.)

manipulations. If such a blade is drawn only once or twice across a piece of the finest linen the cutting edge is practically destroyed.

Secondly, the blade should make an opening in the cornea no larger than is entirely filled by the shank of the instrument. This is necessary to prevent the evacuation of the aqueous early in the operation and to avoid an advance of the vitreous and its inevitable wide laceration during the maneuvers to cut the after-cataract.

The third requisite of a proper knife-needle is that the cutting edge shall be so placed that it will incise the membrane when it is drawn back and forth upon its surface, or, if entered more obliquely, that the edge shall cut without wide excursions into the vitreous, in the sawing movement which is necessary to do these operations, and

Hays' Knife-Needle.

without undue tension upon the ciliary attachment of the capsule.

The fourth requisite is that if the point is to be used in puncturing the membrane, it shall be sufficiently sharp and thin to puncture it easily, without pushing the capsule before the blade.

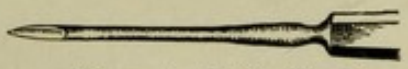
The first knife for secondary cataract was described by William Cheselden. It consisted of a long narrow shank with a knife blade at the end 11 mm. in length, and was used by making a puncture through the anterior portion of the sclera and approaching the membrane of the after-cataract from the posterior chamber. Ziegler draws attention to the fact that it was very similar to Hays' knife-needle, which was used by Isaac Hays in his surgical work at the Wills' Eye Hospital in Philadelphia, Pa., and has been in constant use by the staff of that institution for half a century. It was described by the inventor as follows: "This instrument from the point to the head near the handle is six-tenths of an inch, its cutting

edge nearly four-tenths of an inch. The back is straight to near the point where it is truncated so as to make the point stronger, but at the same time leave it very acute. The edge of this truncated portion is made to cut. The remainder of the back is simply rounded off. The cutting edge is perfectly straight and is made to cup up

Ziegler's Knife-Needle.

to the part where the instrument becomes round. This portion requires to be carefully constructed so that as the instrument enters the eye, it shall fill up the incision and thus prevent the escape of aqueous humor."

Ziegler has described a knife-needle as follows: "The form of this needle is the falciform knife and the bistoury and possesses the advantages of both. It has a delicate point which punctures easily and an excellent cutting edge of sufficient length (7 mm.) and if

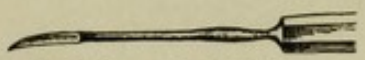


Knapp's Knife-Needle.

the shank is properly rounded it can be used with a sawing motion, sliding backwards and forwards through the corneal puncture without injuring the cornea and without allowing the escape of aqueous."

Knapp designed a knife-needle which has been much used and consists of a narrow shank with the point opposite to the center of the shaft and the cutting edge somewhat bellied. The blade is 5 mm. long.

Sichel's iridotome is very similar to Knapp's knife-needle with the exception that the rounded back of the blade is straight and the blade is 11 mm. in length.

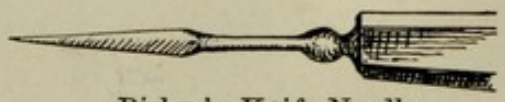


Falciform Knife-Needle.

The falciform knife which Graefe recommends and Galezowski employs has a straight blade with a slight falciform point.

Risley described a knife which he designed, and drew attention to the fact that a cross section through most knife-needles presents too often an almost equilateral triangle which he avoids by having a spear-shaped knife, sharp at both edges, beaten out on the end of the shank. The midrib of the spear is very thin and tapers grad-

ually to the point and to either edge. The amount of metal in the spear or blade of the knife is the same as contained in the shank, less the lost sustained in grinding and polishing. He thought the ad-



Risley's Knife-Needle.

vantage of such an instrument was that it could be readily and satisfactorily sharpened from the fact that a cross section through the blade is not a triangle, but a very flat ellipse.

Post described a knife-needle which he designed, as follows: "The blade is 6 mm. long and 1¼ mm. wide at its widest part. It has a back straight and dull and a rounded cutting edge extending its entire length. The shank is cylindrical and of a diameter suffi-

Post's Knife-Needle.

cient to prevent the escape of aqueous during the operation. The width of the blade is sufficient to admit of its cutting edge being ground very sharp."

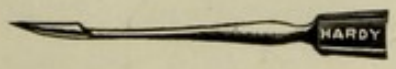
Weeks devised a curved knife-needle shaped something like a sickle, the length of the blade varying from 5 to 3½ mm. A hooked extremity is formed by a curve which extends from the middle of the blade to its point. The curve of the blade brings the extreme point 2.5 mm. away from a line projected from the axis of the shaft. The blade is about 2/3 mm. wide and the shaft is just large enough to fill the opening made by the blade. The concave edge and point of the blade are made as sharp as possible, and the convex edge, to a point 1 mm. up, is also sharpened.

Levinsohn described a similar curved knife-needle.

There has been much controversy for over 100 years as to the proper place to pierce the globe on making an incision in an after-cataract. Cheselden, whose knife has been described, made his puncture back of the sclero-corneal junction on the temporal side behind the iris, carried the knife across the posterior chamber, and cut through the iris from behind forward. In recent years Da Gama Pinto entered his knife still farther back, from 6 to 8 mm. from the sclero-corneal junction. The point was then carried back toward the center of the globe, but after it was entered he brought it gradually forward so as to transfix the after-cataract near the pupil-

lary margin of the same side from behind forward. He then pushed the knife forward across the anterior surface of the membrane to the opposite side of the pupil and subsequently withdrew the knife by the reversal of the procedure from entering the globe.

Da Gama Pinto at the Luzerne Congress in 1904, stated that he had abandoned the operation because he had observed two cases of detachment of the retina after the procedure. With these exceptions all operators have entered the knife either anterior to, or at the sclero-corneal margin. That the point of entrance should be at or near the limbus of the cornea has been insisted upon by many opera-



Weeks' Knife-Needle.

tors. One of the principal advantages of the peripheric puncture lies in the fact that with the blade of the knife introduced parallel to the plane of the iris, the curve of the cornea forms a valve-like opening which is closed, upon the withdrawal of the knife, by intra-ocular pressure. Many operators believe that, owing to the great vascularity of the limbus, there is much less danger of infection in making the wound at that point, and others have thought that they obtained still greater safety from infection by drawing forward the conjunctiva and entering the knife through that, thence passing it through the limbus into the anterior chamber. These advantages of a peripheric incision have been strongly urged by many operators, and Jackson emphasizes the necessity of this method of entrance to the anterior chamber and unqualifiedly condemns all other methods. He gives as one of the reasons that one can obtain with a peripheral puncture a sweep of 8 mm., while with a corneal puncture he can get only a sweep of 4 mm.

As all incisions in the after-cataract must be made with a sawing motion, the length of the portion of the blade which is cutting at a given time must be greater with a very oblique position of the knife, and the penetration of the vitreous is apt to be less than if the knife approaches the after-cataract more perpendicularly.

The loss of the aqueous from the anterior chamber previous to the incision in the after-cataract greatly increases the extent of laceration of the vitreous and the difficulties of the operation. The dangers of infection from a puncture of the cornea anterior to the limbus, under proper aseptic precautions, have been greatly exaggerated, and it may often happen in a given case that the position of

the opacities in the capsule may make the probabilities of success much greater when the knife is entered more anteriorly.

When the incision is made in the clear cornea, the knife should still be entered in such a manner as to make a valve-like incision in order to prevent the loss of the aqueous upon the withdrawal of the knife, which always happens if the knife is thrust perpendicularly through the cornea directly towards the after-cataract. These essentials in the entrance of the knife are equally valuable whatever form of instrument is used.

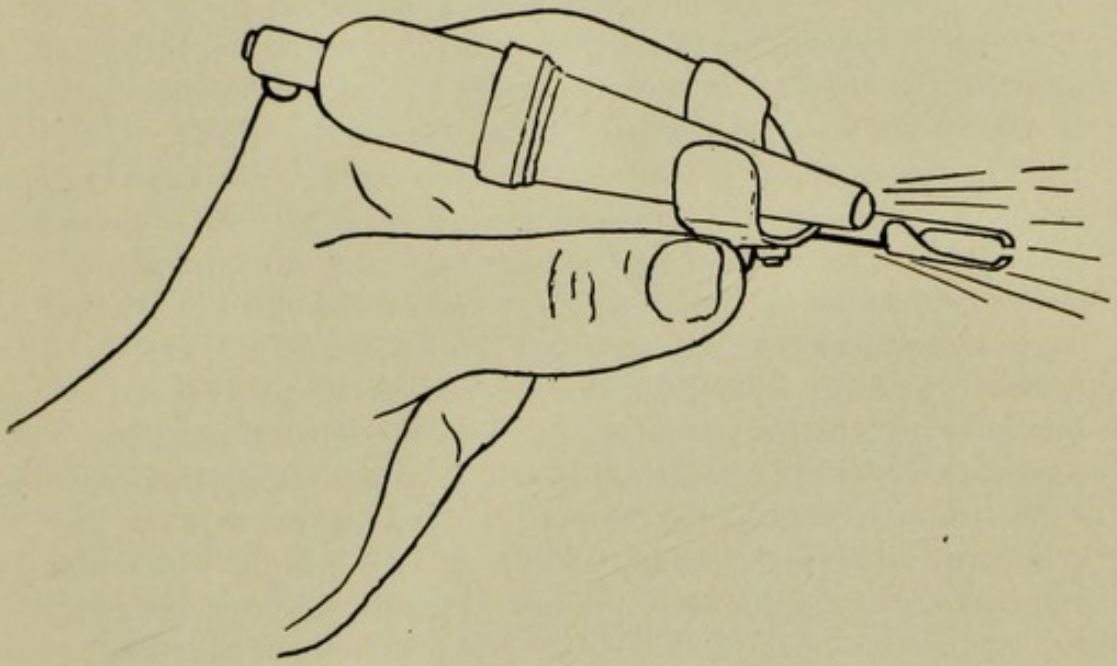
The dangers of non-success from a single incision in simple after-cataract are two: First, that the wound may not open widely enough to give good vision, and, second, that the opening may subsequently close as the result of a low, inflammatory process. The precautions necessary to avoid failure are, first, to make the incision transverse to the principal line of tension in order that the opening may be broadened by the release of this tension; and, second, not to do an early operation in a case in which there has been a considerable inflammatory process following the extraction.

The direction of the incision should be carefully selected. McGillivray, who used a knife not unlike that described by Post, stated that the preferable incision in the capsule was one running diagonally across the whole extent of the dilated pupillary area, from above downwards and inwards, and, other things being equal, such an incision undoubtedly has great practical advantages, nevertheless, a small vertical incision centrally placed in the pupil in a not very opaque capsule, will often give the highest possible vision, even when its length is not more than 2 or 3 mm.

The horizontal incision has undoubtedly been used by more operators than any other in operations for after-cataract. Its principal advantage is ease of technique.

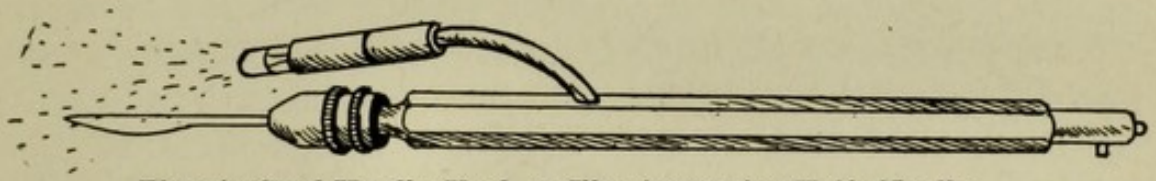
A brilliant illumination of the after-cataract is absolutely necessary for successful operation. This can never be obtained while operating in diffused daylight. The dispersal of the rays of light by a slight change in the curvature of the cornea, due to pressure of the knife, will often make an after-cataract, which is entirely visible before the operation is begun, quite invisible at the moment of the incision. Often again, the after-cataract is depressed by the point of the knife in such a manner that its visibility is entirely lost. This condition will be obviated by focal illumination, and for many years operators have had light focalized upon the after-cataract by means of a hand lens held by an assistant. This method, although pursued in a dark room with a single light is often unsatisfactory because

the operator may have very annoying reflections between himself and the point of operation, when the field is perfectly illuminated from the point of view of the assistant holding the focalizing lens. A much better method is to illuminate the anterior chamber by a



Chandler's Electric Illuminator Attached to Fixation Forceps.

small, shaded electric light, but when this is held by an assistant not infrequently the operator does not have the best point of view. To obviate this annoyance Chandler devised a small electric light enclosed in a shield with a focalizing lens in front. This instrument



Electric Spud-Handle Used as Illuminator for Knife-Needle.

was attached to the forceps with which the eye was held, thus placing the control of the illumination entirely within the hands of the operating surgeon. He suggested that it could also be used upon the knife-needle, and recently I have had my knife-needle constructed without handles and use them in the electrically illuminated spud handle. This can be so arranged that the condensation of the light through the small lens in front of it can be brought exactly to bear upon the cutting portion of the needle, and therefore the illumination is always perfect. Small lights have also been devised

which can be attached to the handle of any knife-needle, which would seem to be a desirable arrangement.

In preparing for the operation on after-cataract, first, see that aseptic precautions are as thoroughly followed out as for an extraction of the lens. Second, study the after-cataract with undilated pupil. Locate by landmarks the portion of the after-cataract which is central. Determine, if possible, lines of tension, and whether the elasticity or tension of the membrane is such as to make probable a successful opening after a single incision. Third, determine whether in a given case it is desirable to use a straight-pointed knife, a sickle-shaped knife or a curved knife; or a full-bellied knife which cuts without preliminary puncture with the point. This choice will be largely governed by the amount and direction of the dense opacities in the capsule, and the tension of the globe. Alternate areas of thin capsule and dense bands are perhaps more easily incised with a knife which has some form of falciform point and a considerable length of cutting blade. Less dense capsules, especially when present in rather soft eyes, or eyes known to have fluid, or semi-fluid vitreous, are more easily cut with a knife which has considerable belly to the cutting edge. Fourth, measure the length of the cutting blade of the needle over the area to be operated on and be sure that its edge is of sufficient length, and see that the knife is sharp. Fifth, dilate the pupil with atropine before the operation. Sixth, darken the room and see that the electric illumination is in good working order and trustworthy.

The technique of operation upon simple after-cataract by single incision is as follows:

The eye having been cocainized, a speculum is introduced which opens the lids without great pressure. The conjunctival and episcleral tissues are seized by fixation forceps opposite to the point of puncture. This point should be selected so that the cut in the after-cataract can be easily made along the line decided upon. The knife blade, being held parallel to the plane of the iris, is thrust through the cornea at the point selected, preferably at the limbus, thence it is carried directly across the anterior chamber to a point a millimeter or two beyond that where it is necessary to make the counter-puncture. The edge of the blade is then turned toward the membrane, and thrust through the after-cataract within a previously determined, thin area. Then the knife should be drawn back and forth across the line of incision, making as little pressure as possible to achieve the object and absolutely avoiding any prying motion which

uses the cornea as a fulcrum as this procedure tends to evacuate the anterior chamber and produce strain upon the ciliary attachment of the capsule. It often happens that after the counter puncture has been made with the point of the knife the elastic capsule recedes before the knife, which does not cut. In this event, the sawing motion must be persisted in until it is obvious that the method will not succeed. Under these circumstances it is wise to depress the point of the knife so as to produce the maximum of cutting across the thickness of the capsule without tearing or dragging its way through the membrane. Upon the conclusion of the incision the knife blade is turned to its original position, the handle is carefully placed in the plane of the iris and the knife is withdrawn. If this is done skillfully there ought to be a minimum loss of the aqueous, intraocular pressure promptly closing the wound.

Post describes the method of using his knife-needle as follows: "The point is entered near the periphery of the cornea with the flat of the blade parallel to the plane of the iris and is carried well across the pupil to the place where it is proposed to pass it through the membrane. The blade now cuts its way to an extent equal to its own width. Having passed it still farther it is pressed in the direction of the cutting edge so that in withdrawing it, the sharp heel of the blade divides the membrane as far as may be necessary."

Many operators have used an exceedingly narrow, but stiff cataract knife to make the incision above described. The disadvantage of this instrument is that in making the sawing motion necessary to cut the capsule, the operator has his attention drawn away from the corneal incision and is apt to enlarge the corneal incision during the operation with consequent loss of aqueous. This loss of aqueous is followed by the pushing forward of the vitreous, and makes the second incision, if such is necessary, exceedingly difficult, while considerable laceration of the vitreous is inevitable. Some surgeons dull the edge of the cataract knife from the heel almost to the point for the purpose of avoiding this enlargement of the incision, but a capsulotomy with a Graefe knife by any method is rarely done without losing practically all the aqueous.

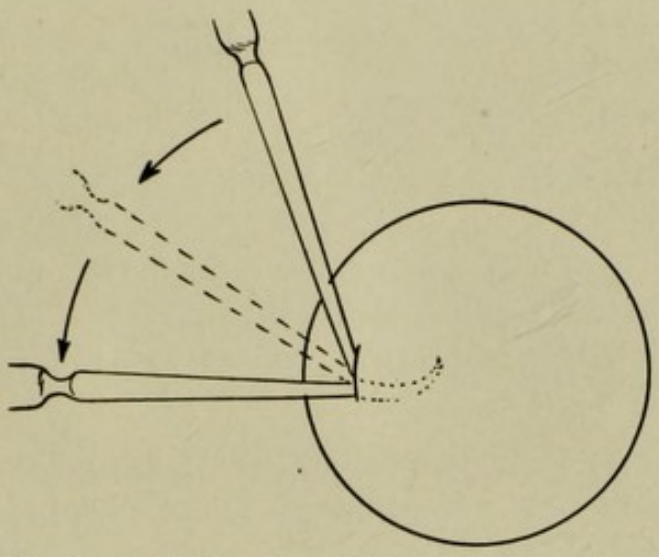
In the secondary operation with Weeks' knife-needle, the passage of the knife into the anterior chamber is not so easily effected as with the Knapp knife-needle. The operator should stand behind the patient, using the right hand to operate on the right eye, and the left hand to operate on the left eye. The puncture is made in the cornea at a point in its horizontal meridian midway between

the center and the periphery of the cornea on its temporal side. The curve of the knife must be followed in the passage through the cornea to avoid making an incision too large to be filled by the shaft. The knife is entered on the flat, the sharp edge toward the upper margin of the cornea. After entering the anterior chamber the point of the knife is passed to the opposite margin of the iris; it is then turned so that the cutting edge presents toward the capsule, and the point is made to pierce the capsule. The knife is so held during the time of making the incision that only the thickness of the capsule presents against its edge. The resistance is thus reduced to the lowest possible degree and the danger of destroying the membrane and of making too much traction on the ciliary body is avoided. It is seldom that this knife will divide successfully a tough capsule or firm bands without undue traction on the ciliary attachment of the membrane; it must be exceedingly sharp to divide even a thin membrane satisfactorily, and is difficult to remove from the eye if the patient becomes unruly. On withdrawing the knife it should be turned on the flat as when entered and the curve of the blade followed. Weeks thinks that on account of the dull convex edge of its curved extremity, the knife is much more easily manipulated, and that the vitreous is less liable to injury by this method.

Of operations upon simple after-cataract by more than one incision there are three principal methods, which have in common a dependence upon the elasticity of the capsule to curl back the tongues of the tissue which are included between the incisions.

The first method consists of two incisions which meet at their proximal ends and form a V. The point of entrance is selected in the lower margin of the cornea at a point which is determined by the position of the opacities and the line of tension in the capsule. The knife, with the flat of the blade in the plane of the iris, is thrust through the cornea near or at the limbus, and carried across the pupillary area obliquely to its inner (or outer) upper margin. The cutting edge of the blade is then turned toward the capsule, the point thrust through the membrane and the incision extended to the inferior edge of the pupil by a sawing motion. The knife is then turned so that the blade is in the plane of the iris, and is carried forward to the upper margin of the pupil and swept across to the opposite side. Thence a second incision is made across the pupillary area to meet the first incision below, the two incisions forming the letter V. The difficulty in this operation consists in cutting the last portion of the second incision, because when the tissue between

the two incisions becomes narrow its elasticity is greatly exaggerated and it is with considerable difficulty that the second incision is carried into the line of the first. This operation can also be done by entering the knife above the resulting incisions making an in-



Sweep of Needle to Follow Curve When Piercing Cornea. (Weeks.)

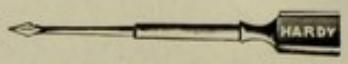
verted letter V. Some operators, however, prefer not to have the puncture at the site of the cicatrix resulting from the incision made in the operation for the extraction of the lens.

The second method is by a T-shaped incision. The puncture is the same as in the operation just described. An incision is made across the upper portion of the pupillary space, after which the blade is carried back to the center of the first incision and the second incision is made from that point to the lower margin of the pupil perpendicular to the line of the first incision. The difficulty with this method is that after the tension of the membrane has been relaxed by the first incision, the second is made with so much difficulty that the pressure required to make the incision will depress the membrane and is apt to cause considerable laceration of the vitreous.

The third method of double discission is by a cross incision. In this operation the knife, having been entered as before, is carried to the center of the upper portion of the pupillary space, thence vertically down and an incision is then made from the margin of the pupil on either side to the incision already made.

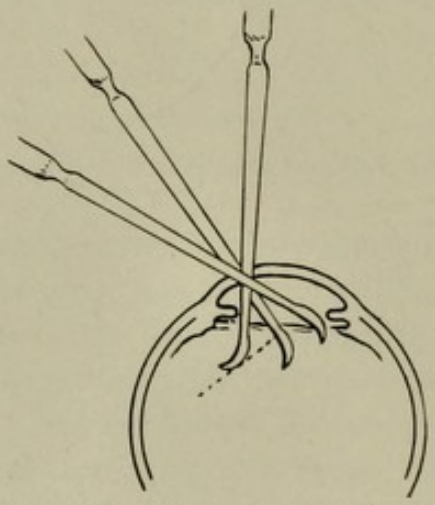
The amount of traction made upon the ciliary body at the insertion of the capsule has been much dreaded by operators and in order

to avoid it *Bowman devised an operation* which was formerly much practised. He used two spear-pointed stop-needles with sharp cutting edges. The eye being fixed with forceps, one of the needles is thrust through the tissues of the limbus at one end of the transverse



Bowman's Stop-Needle.

diameter, the breadth of the spear-head point being parallel to the plane of the iris. Then, putting down the fixation forceps and steadying the eye with the needle already introduced, a second needle is introduced in the same manner through the limbus directly opposite the point of the incision of the first needle. Both points



Contact with Capsule When Curved Needle is Employed. (Weeks.)

are then carried on until they reach the middle of the pupillary area. Both needles are then plunged through one opening in the capsule, being careful that no tissue intervenes between the blades of the needles. The needles are then turned so that their cutting edges lie in the transverse diameter and the handles of the needles are approximated. By this movement the membrane will be divided by the two needles. If this is insufficient, the needles are carried back to the first position, and second slits made at right angles to the first. The needles are then rotated so that their blades are in the same plane as when first introduced and withdrawn. If skillfully done, there need be no loss of aqueous.

Panas recommended extraction of the after-cataract. He considered it necessary to wait a considerable number of months after

the primary operation before attempting this procedure. He examined the eye very carefully to determine the presence or absence of adhesions between the membrane and the iris. If found, he divided the synechiæ by means of a narrow, curved knife. He made an incision 8 or 10 mm. long in the upper corneal margin and then, using special forceps, with the sharp blade backward, he passed them down into the anterior chamber, perforated the after-cataract with the sharp blade until the upper blade was in the lowest part of the anterior chamber. He then closed the forceps, grasping the tissues between the blades. In the withdrawal traction was made at first vertical, followed by slight lateral movements which broke down the small adhesions. The membrane generally came out whole, but occasionally it was held by a sort of pedicle at the upper part of the coloboma. This pedicle was cut off with the scissors and the prolapse reduced.

Major Smith states that in his hands the removal of the posterior capsule has been eminently satisfactory. He does an iridectomy above, if it has not already been done, reaches in, somewhat beyond the center of the pupil, with a rather stout pair of iridectomy forceps, allows the blades to separate, drives them through the after-cataract wide apart, closes the forceps firmly and withdraws the after-cataract. He adds that there may be an escape of a bead of vitreous, but this he considers of no importance.

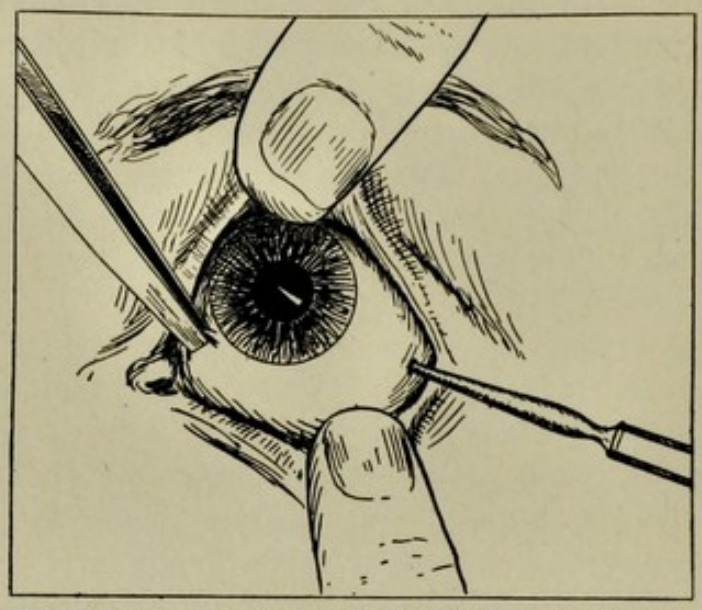
Partial avulsion has also been done by various surgeons in which the membrane was drawn out of the anterior chamber with a Tyrell's hook and cut off.

In cases of a thick membrane with firm adhesions, Agnew performed an operation which is described by Noyes. At the upper edge of the cornea a broad needle pierces the capsule and is held steady. At the opposite side, on the margin, a wound is made for the introduction into the anterior chamber of a small, sharp hook whose point is engaged in the wound in the capsule made by the broad needle. Securing a good hold the hook tears down the membrane and is resisted by the needle in the operator's other hand, which also defends the ciliary region from traction. As much of the tissue is drawn out of the wound as possible. It is then cut off with scissors by an assistant.

Complicated after-cataracts are always due to an iritis or an iridocyclitis following the extraction of the lens. This complication may be due either to traumatism at time of operation, or to irritation resulting from small fragments of the lens left after the extraction; to prolapse of the iris following an extraction either with or

without iridectomy; to infection at time of operation, or it may have its origin in some constitutional condition, as syphilis, rheumatism, diabetes, or tuberculosis. Whatever the etiology the result is a small pupil firmly tied down along the greater part of its margin, and a firm, dense membrane occupying the pupillary area.

A second condition is an incomplete prolapse of the iris, so that it, or the pillars of the coloboma (when an iridectomy has been



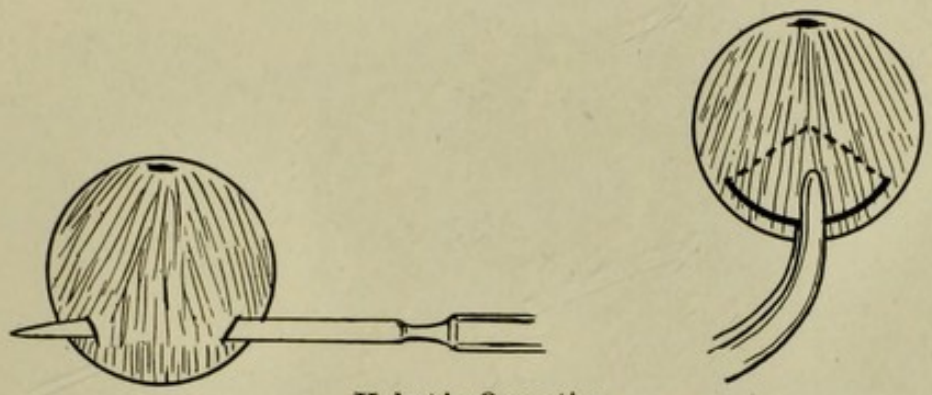
Entrance Through the Sclera for Division of After-Cataract. (Meller.)

done), become attached to the cicatrix of the incision made for the purpose of extracting the lens. In these cases the tendency is for the iris to become more and more firmly attached above, and as this progresses the iris tissue below the pupil is dragged up to the seat of the wound. Occasionally the lower margin of the pupil is attached directly to the corneal cicatrix. Then the whole area visible through the cornea is occupied by the tightly stretched iris. Practically in all recent cases the slightest traumatism may produce a violent return of the cyclitis and nullify the operation. Consequently it is wise to postpone operation for a considerable period—three or four months—until all ciliary tenderness has disappeared and the eye has become white and quiet.

Iridotomy operations with single incisions were among the early operations for complicated after-cataract. They consisted in making an incision horizontally through the membrane. Cheselden's original procedure was of that character. He entered his knife-needle through the sclera back of the sclero-corneal junction on the temporal side. He then passed his knife across the posterior chamber, made his counter-puncture in the iridic membrane near the nasal

margin. He then cut through the iris from behind forward for two-thirds of its extent. This made a horizontal slit which resulted in a more or less oval opening, according to the elasticity of the membrane. The after result with this operation was apt to be much modified by traumatic iritis with consequent obliteration of the pupil, or by the formation of a membrane in the new pupil.

Adams modified Cheselden's operation by using a small iris scalpel of his own design, which had a straight, dull back, a long, straight cutting edge and a rounded point. With this he made his puncture back of the limbus on the temporal side, passed it directly through the iris from behind into the anterior chamber, across to the nasal



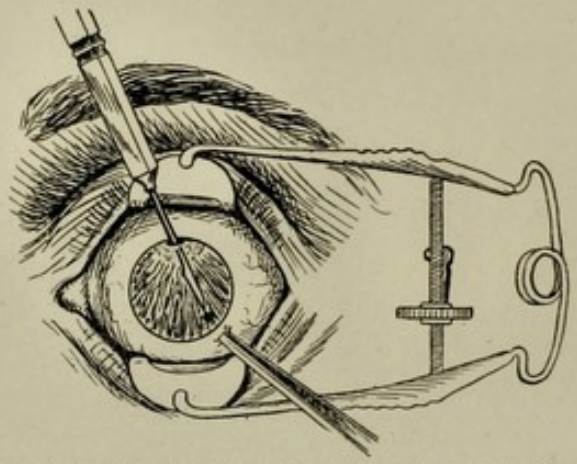
Kuhnt's Operation.

side, keeping the edge of the knife turned back against the iris throughout the whole maneuver. He was thus able by the most delicate pressure to make a horizontal incision. If the incision was too short he again carried the knife forward and again partially withdrew it, always cutting in the same plane.

Kuhnt, in order to make the opening more permanent, devised an operation in which a piece of the iridic membrane is removed. He uses a narrow-bladed, stiff linear cataract knife for his incision. This knife he plunges through the cornea and underlying membrane at a point about midway between the horizontal diameter and the inferior end of the vertical diameter of the cornea. As soon as the point perforates the after-cataract, he depresses the handle and passes the knife across the posterior chamber until the point has reached a corresponding position on the opposite inferior quadrant of the cornea. He then depresses the handle of the knife still more and makes a counter-puncture through the membrane and the cornea. He continues his incision, emerging in the clear cornea just above the limbus. The upper lip of the wound in the after-cataract is then seized, drawn forward and a piece excised with scissors by means of two incisions meeting above, so that a triangular piece of

the membrane is freed and removed from the eye. He advises protecting the wound by means of a large conjunctival flap which is brought forward and stitched in such a manner as to cover the lower half of the cornea.

Knapp's iridocystectomy in closed pupil is performed and described by him as follows: "Under cocaine anesthesia a Beers' cataract knife pierces the cornea about 3 or 4 mm. above the lower corneal margin, opposite the scar from the extraction, and transfixes the iris or pupillary pseudo-membrane by an opening 3 or 4 mm.

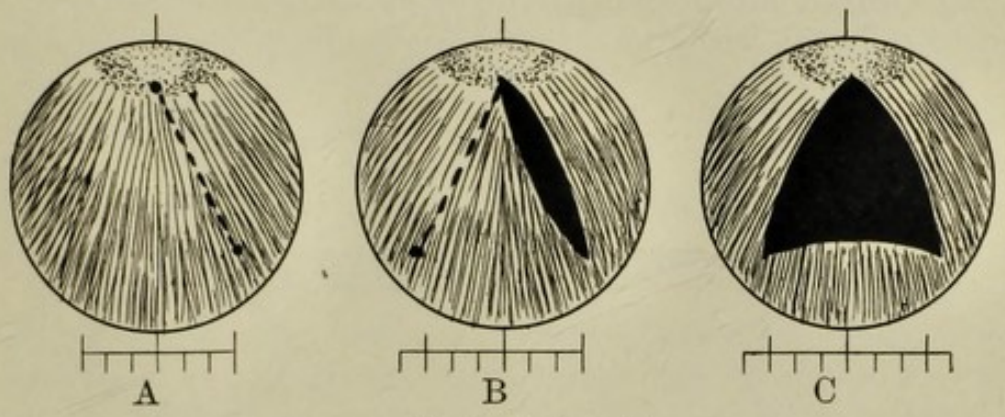


Ziegler's Iridotomy for After-Cataract. The Knife-Needle is in the Anterior Chamber.

long. The knife is withdrawn. With a blunt hook the lower lip of the iris wound is seized, drawn out of the eye and abscised close to the cornea. There are scarcely any accidents. The healing is usually prompt and yields most surprisingly good visual results. Prolapse of the vitreous is not infrequent during this operation."

Ziegler's operation is a V-shaped iridotomy with his modification of Hays' knife-needle. His own description of the procedure is as follows: "First Stage. With the blade turned on the flat, the knife-needle is entered at the corneo-scleral junction, or through the upper part of the cornea, and passed completely across the anterior chamber to within 3 mm. of the apparent iris periphery. The knife is then turned edge downward, and carried 3 mm. to the left of the vertical plane. Second Stage. The point is now allowed to rest on the iris-membrane, and with a dart-like thrust the membrane is pierced. Then without making pressure on the tissue to be cut, the knife is drawn gently up and down with a saw-like motion until the incision has been carried through the iris tissue from the point of the membrane puncture to just beneath the point of the corneal puncture. This movement is made wholly in a line with the axis of the knife, the shank passing to and fro through the corneal punc-

ture, and the loss of any aqueous being carefully avoided. Third Stage. The pressure of the vitreous will now cause the edges of the incision to immediately bulge open into a long oval through which the knife blade is raised upward, until above the iris-membrane, and then swung across the anterior chamber to a corresponding point on the right of the vertical plane, which, owing to the disturbance in the relation of the parts made by the first cut, is now somewhat displaced and the second puncture must be made at least 1 mm. farther over, i. e., 4 mm. to the right of the vertical plane. Fourth Stage. With the knife point again resting on the membrane, a second puncture is made by the same quick thrust, and the incision rapidly car-



Ziegler's Operation.
a. Plan of First Incision.
b. First Incision Completed. Plan of Second Incision.
c. Pupil Resulting from V-Shaped Iridotomy.

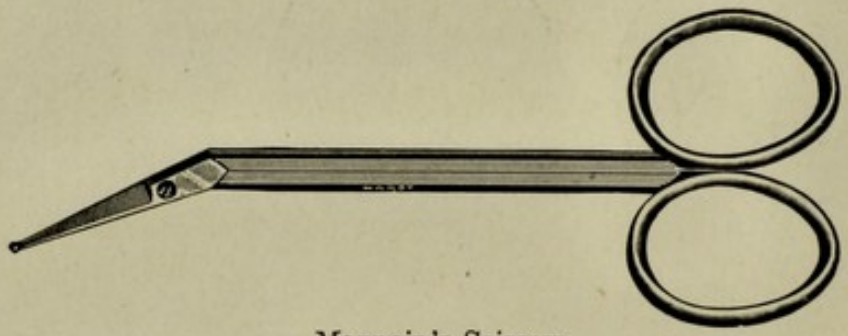
ried forward by the sawing movement to meet the extremity of the first incision, at the apex of the triangle, thus making a converging V-shaped cut. Care must be taken at this point that the pressure of the knife blade on the tissue shall be most gentle, and that the second incision shall terminate a trifle inside the extremity of the first, in order that the last fibre may be severed and thus allow the apex of the flap to fall down behind the lower part of the iris membrane. If the flap does not roll back of its own accord it may be pushed downward with the point of the knife. When the operation is completed, the knife is again turned on the flat and quickly withdrawn."

It sometimes happens, as in cases where there has been a long continued irido-cyclitis, that the retraction of the triangular piece of the after-cataract included between the V-shaped incisions is insufficient to leave a central opening. Ziegler then advises that the V-shaped flap be pushed downward with the point of the knife and if this maneuver is not successful the knife is turned so that the blade is parallel to the surface of the iris and by a quick thrust is

pushed through the base of the triangular flap and then by means of a sawing motion cut across its fibres in which case it will fall back upon the pedicle that remains. If by this procedure the desired result is not obtained, he withdraws the knife-needle and re-introduces it far enough away from the apex to secure proper leverage, and again makes an incision across the base of the triangular flap. The technique of this operation is difficult, but in the hands of skilled operators has been very satisfactory.

Ziegler sometimes modifies his operations by making two punctures and a cross incision in the after-cataract.

Operations for complicated after-cataract by the use of scissors, arose from the difficulty experienced by many operators in attempting to split the iris with a knife in complicated after-cataract. It

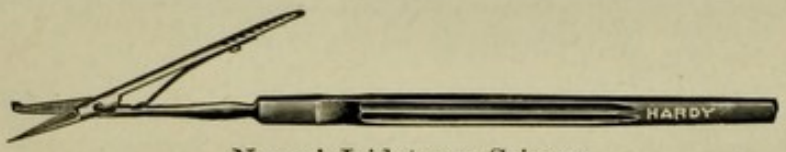


Maunoir's Scissors.

caused them to turn to some form of operation in which the incisions in the after-cataract are made with scissors. Owing to the fact that the opening of the blades in ordinary iridotomy demands too large an incision in the cornea a special form of scissors is needed. The essential requirements in scissors for this purpose are that the blades shall be thin and narrow, so that when closed they can pass through a comparatively small opening in the cornea, and that the blades shall be able to separate within the globe without materially widening the diameter of the instrument at the point where it passes through the cornea. The first instrument of this sort was described by Maunoir of Genoa, in 1802. He used a pair of scissors with very thin, narrow blades which when closed were not thicker than a common probe. The blades were seven-tenths of an inch long and bent so as to form at the joint an angle of 140°. The extremity of the superior blade was blunt or round-pointed for use in the anterior chamber, and the inferior blade sharp at the point for the distance of one line on the back as well as on the cutting edge. The scissors were intended to be introduced flat, and then turned so that the sharp point should pass through the membrane.

deWecker's scissors have been much used. They differ from Maunoir's in that the handles resemble in shape those of an ordinary pair of iridectomy forceps which have been hinged at the side and end, to open laterally. When the handles are in this position the blades are open. At the point at which the blades cross they are bent anteriorly to an obtuse angle. The original instrument had both blades rounded on the ends, but in recent models one blade is pointed. A spring holds the handles apart on the side opposite the hinge. These scissors are an admirable instrument, but are often clumsily made.

Ferguson's scissors resemble deWecker's in general shape but the blades are turned in the opposite direction and lie closed instead of open when the scissors are at rest. The blades are sharp on the



Noyes' Iridotomy Scissors.

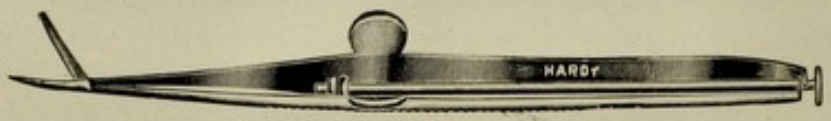
outer as well as inner edges so that they cut when the blades are opening, and in the usual manner when the spring is allowed to close them. They are separated by the same action that closes deWecker's scissors to an amount that, before operating, can be regulated by a screw.

Noyes' iridotomy scissors are perhaps the easiest to use of any which have been devised. The handle is in every respect similar to that of an ordinary cataract knife and the scissors consist of a fixed blade (with a rounded point) that is inserted into the end of the handle. This blade is crossed 12 mm. from its point by another which has a sharp point. The proximal end of the movable blade extends to the handle of the instrument and is broadened, thickened and corrugated in order that the finger shall not slip when it is pressed down to close the blade. The blades are very delicate and narrow, only 1 mm. broad, and are held apart by a spring. Its advantages are that with the thumb placed on the end of the lever, the instrument is grasped precisely as the operator is accustomed to hold his Graefe cataract knife. The bulk of the blades is so small and their length so short that the incision can be made in the after-cataract with the pivot practically in the corneal wound. This enables them to be used easily through the smallest possible incision.

deWecker, in his scissors operation, made his corneal incision 4 mm. in length and with a stop-keratome. He then partially with-

drew the knife, allowed the aqueous to escape slowly and when the iris came forward thrust the knife forward again, and made an opening in the iris 2 mm. in length. Withdrawing the knife he introduced the scissors, with the sharp point through the opening in the membrane, and cut obliquely from either extremity of the incision toward the apex of a triangle. He then grasped the triangular flap with forceps and removed it.

Instead of the above operation deWecker sometimes used the following procedure: He made the corneal incision and opening in the iris membrane as above described, then introducing his scissors as before he cut from the center of his opening in the iris at an



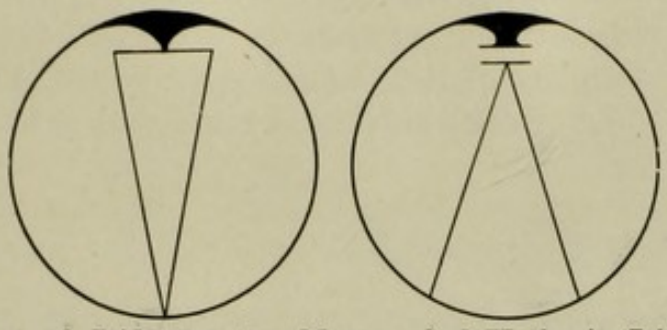
deWecker's Iridotomy Scissors.

oblique angle; then swinging the scissors about he made an incision in the opposite direction, thus forming an inverted V. If the flap thus formed did not retract sufficiently, he grasped it with forceps and tore it across.

A small incision is made in the cornea with a lance-shaped knife through which Ferguson introduces his scissors closed and pierces the capsule at the center of the desired opening. The blades are then separated and their sharp outer edges cut the capsule to the required extent without dragging on the ciliary processes or on any adhesions that may be present. If it is desirable to make other incisions to get a good opening, one blade can be placed behind the membrane and the other in front and the scissors used in the same manner as deWecker's instrument.

The operation with Noyes' scissors has often been performed by the writer, and is done in the following manner: The corneal incision is made just anterior to the limbus, above, with a Graefe iridotomy knife. The blade of this knife is bent upon the shank at the end of its cutting edges. It has a sharp point and the cutting edges are long and parallel to each other. The width of the blade is 1 mm. The point of the knife is inserted parallel to the plane of the iris and after it has entered the anterior chamber to the width of the blade, the point is depressed and thrust through the after-cataract until the full width of the blade is engaged in the membrane. It is then withdrawn, the blade returned to the plane of entrance and gently withdrawn from the cornea. If this is done carefully the anterior chamber need not be evacuated. Noyes' scis-

sors, with the blades closed and the thumb or forefinger upon the movable handle, is introduced through the wound, the pressure relaxed so that the spring separates the blades, the sharp point of the movable blade is carried through the opening in the capsule, the rounded point of the fixed blade passed anteriorly to the after-cataract downward and inward to the distance necessary, and the blades closed by pressure upon the movable blade. Pressure is again relaxed, which opens the blades of the scissors, and the instrument



The Two Forms of Iridotomy by Means of deWecker's Iridotomy Scissors. (deWecker.)

swung to a similar position downward and outward, and the incision repeated in this direction. If the triangular flap freed by this V-shaped incision does not retract sufficiently the scissors can be turned so that the blades are in the plane of the iris and an incision made entirely or partially across the flap which will produce a large, free opening. The instrument is then closed and withdrawn. The advantage of this operation with the Noyes instead of the deWecker scissors is that the blades are so narrow they can be opened to a

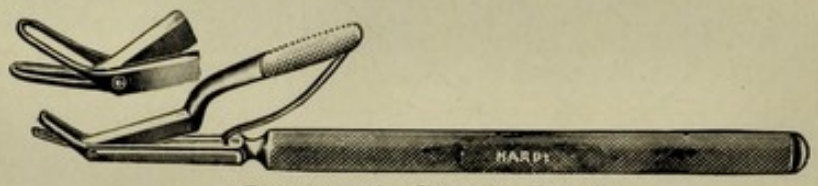
Graefe Iridotomy Knife or Bent Broad Needle.

width sufficient to make the required incision in the capsule through a corneal opening of 2 mm. or less, thus avoiding the danger of prolapse of vitreous into the wound and insuring prompt closure of the corneal incision.

When the secondary membrane is very thick and inelastic the writer has often successfully operated with Noyes' scissors as follows: The incision is made with a Graefe iridotomy knife (broad needle) as before described and is extended by use of the cutting edge of the instrument to 4 mm. The opening in the after-cataract is made approximately of the same width. The Noyes' scissors are then introduced, as above described, at one end of the incision and a vertical cut in the membrane made of the desired length. The scis-

sors are then withdrawn and reintroduced at the other end of the incision in the cornea and after-cataract and a parallel, vertical incision is made. The scissors are then turned and an oblique incision made across the tongue of capsule, the free portion of the membrane is removed either by gently grasping it between the blades of the scissors or by the introduction of a pair of iridectomy forceps. The triangular, free flap remaining eventually contracts. A good opening, which does not readily close, is obtained by this procedure. The operation is best performed under general anesthesia.

A number of instruments have been devised for the purpose of punching out a piece of the after-cataract and withdrawing it from the wound. The corneal incision is made with a broad keratome at



Stevenson's Capsule Punch.

the limbus and the point of the keratome is carried through the membrane in the same manner as has been described in operations with scissors. The punch is then introduced through the wound, the lower blade carried behind the after-cataract and the upper blade passed in front of it, as in an operation with scissors. The punch is then closed and withdrawn. The objection to most of these instruments is that they require a large opening in the cornea and, unless they are very sharp, are apt not to make a clean cut through the membrane, so that when they are withdrawn considerable traction has been made on the ciliary body by dragging on an uncut tag of the after-cataract.

Hemorrhage following operations for after-cataract is not infrequent. The absorption of the blood in the anterior chamber containing an after-cataract is much slower than in a normal eye. Hemorrhage is said to be much more profuse when the iris is cut transversely than when it is split in the direction of its radial fibers. This fact should be borne in mind when planning an operation involving the iridic tissues.

After-care in operations for secondary cataract is important. Atropin should be instilled after the operation, and if there has been much hemorrhage a pressure bandage ought to be applied. The patient should be placed in bed and kept quiet for 24 hours, after which the bandage can be removed and the patient allowed to sit

up in a shaded room. After the wound is closed if the effused blood does not absorb promptly, the process can be hastened by instillation twice a day of a 10 per cent. solution of dionin. The atropin should be continued for two weeks at least.—(M. S.)

Aftergebilde. (G.) Formation, development, structure, organization, training, culture, cultivation, texture, growth.

Afterhaut. (G.) Pseudo-membrane.

After-image. A retinal impression that remains after the light or object visualized has been removed. It is called a positive after-image when the sensation is prolonged. A negative, colored or positive-complementary after-image occurs when the image appears tinged or outlined in complementary colors.

Cattell, in the *System of Diseases of the Eye,* gives a most interesting account of these retinal impressions, from which the following is quoted. In order to observe a positive after-image, a bright object, as the sun or the globe of a lamp, should be looked at for a short time, say one-half second. This can be done conveniently by holding a black screen (pierced in order to secure a point of fixation) before the eyes and uncovering the object for a moment. The eyes should be rested (closed and covered) for from one to five minutes previously, so that traces of previous after-images may disappear and nothing be left in the field of vision excepting the light chaos or "own light" of the eye. Care should be taken to avoid movements of the eye or body.

The *positive after-image* maintains the same relations of light and shade as the original objects, and the colors may be the same at first, but these quickly change. When the eyes are covered after exposure to a bright object, nothing is seen at first by most observers, but after a couple of seconds the after-image appears in the light chaos of the field of vision. v. Helmholtz holds that the delay in the appearance of the after-image is due to movements of the eyes and body; but this can scarcely be the case, as the after-image does not appear at once, even when no appreciable movements are made, and does not appear in due time, although movements be purposely made.

In the after-image details can often be noticed which, owing to lack of time or to intense brightness, were not seen in the original object. Thus, the twigs of a tree may be imperceptible when they are between the eyes and the sun, but may become apparent in the after-image. As the image fades, the relations of light and shade change, the brighter parts lasting the longer. The further course of the positive after-image become complicated with the results of fatigue or exhaustion.

When an object is not very bright and is looked at for several seconds or longer, the positive after-image can be perceived with difficulty or not at all, but the stimulation leaves effects which are called *negative after-images.* In these, as in the negative plate of a photograph, the relations of light and shade are reversed, so that a bright object on a dark background becomes a dark object on a bright background. They can be seen in the field of vision when the eyes are closed, or can be projected on any surface.

The color of the negative after-image is in normal cases complementary to the color of the original object. It is a curious and important fact that in the case of red the *after-image may be positive and complementary.* Fechner has made the most careful study of the color of negative after-images, considering the background on which the object is exhibited and the color of the field on which it is projected.

While the color of the *negative afer-image* may be said to be complementary to the color of the original light, it is not established that the relation is exact, and cases have been recorded in which it does not hold at all. Hilbert has recently described his own case, in which the color of the after-image is entirely altered when he is fatigued. It is possible that the nature and course of after-images may prove unexpectedly useful in the diagnosis of certain diseases of the eye and of the nervous system.

The complementary color of negative after-images is accounted for in a general way by fatigue; the eye has become exhausted for the color at which it has been looking, and the complementary components of white light produce relatively greater effects. When the after-image is projected on a colored field complementary to the original light, the color (even of the sun's spectrum) appears brighter and more saturated than otherwise. Colors more intense and beautiful than can be imagined may be seen by looking for one-fourth second at a part of the spectrum early in the morning after the night's rest, the eyes having previously been exposed for one minute to the complementary color.

The longer the time of fixation the longer does the negative after-image last; indeed, Purkinje goes so far as to state that there is an exact proportion, each additional second of fixation (of a candle) increasing the duration of the after-image twenty seconds. Aubert found that when the sun was regarded for three seconds the after-image lasted two-thirds of a minute; when the time of regard was five seconds the image lasted about five minutes; when eight seconds, it was about ten minutes. The after-image also lasts longer the

brighter the light of the original object. In the writer's laboratory exact measurements are being made of the duration of after-images regarded as a function of the time, intensity, and area of stimulation. The average duration of the after-image increased from eight to fourteen seconds as the time of exposure was increased from three to twenty seconds, and from eight to sixty seconds as the intensity of the light was increased three-hundred-and-twenty-fold.

The course of the after-image is not so simple and regular as might be supposed from reading the accounts usually given in the text-books of psychology and physiology. If a bright white light be looked at for a moment, according to v. Helmholtz, there will be a white after-image which passes quickly through a green-blue to a brilliant indigo-blue and then into violet or rose. Then follows a gray-orange, the after-image usually disappearing or becoming negative. In the latter case the orange may be followed by a dim yellow-green. The order and nature of the colors vary according to the time of exposure and the intensity of the light. Admitting light or projecting the image on a brighter field advances the course of the image, and, conversely, decreasing the light brings it back to an earlier stage. If the sun be viewed for an instant, similar results follow, but there are concentric rings of color which proceed from the outside towards the centre.

The descriptions of Fechner and v. Helmholtz seem largely to ignore oscillations of the after-image, ascribing such as occur to accidental movements, pressure, and changes of illumination. The oscillations have, however, been properly described by Purkinje, Plateau, and Aubert, and are to the writer the most striking of all the phenomena. These authors have noted four or five oscillations from positive to negative, the after-image lasting in all about five minutes. The writer has made the unexpected observation that an after-image may last indefinitely, the oscillations from positive to negative being innumerable. The writer obtained (after resting the eyes five minutes and exposing them for one minute) an after-image of the clear sky and the bars of a window, which can be seen at the present writing, after an interval of eight months. During the first hour the oscillations occurred continually, at first at intervals of about ten seconds, the panes and bars displaying brilliant and beautiful colors, mostly greens and purples. In the course of the first month the after-image became gradually less distinct. On closing the eyes it always appeared positive, becoming negative after a few seconds, and passing through a series of oscillations which could be continued indefinitely by altering the illumination. Since that time the after-

image has become continually less distinct. On closing the eyes it always appears positive, becoming negative only so far as lines of light appear along the dark bars. The colors of the panes are dim yellow and violet. When projected on a bright surface, as the sky, the after-image is negative.

Aftermasse. (G.) Pseudoplasm, neoplasm, secondary growth.

After-treatment of ametropia. Too little attention is paid by ophthalmologists to this important subject, many practitioners believing that when refractive errors and muscular anomalies are corrected their whole duty is done. Because of this neglect the work of the refractionist is often in vain and the effects of otherwise well-directed efforts are partially or entirely nullified. It is the concern of an educated ophthalmologist to see that the general condition of his patient is carefully scrutinized, that systemic dyscrasias are treated and that all vicious moral and physical habits are abandoned. It should not be necessary to add that the treatment of eye congestions and inflammations (the result perhaps of the eye-strain for which glasses, etc., were ordered) should be continued until cured, that needed ocular rest should be insisted upon and that all the other axioms of ophthalmic hygiene should be heeded by the patient. Last, but not least, the ametrope should report to the oculist a week or two after the correction of his errors for further advice and to make sure that earlier directions have been carried out.

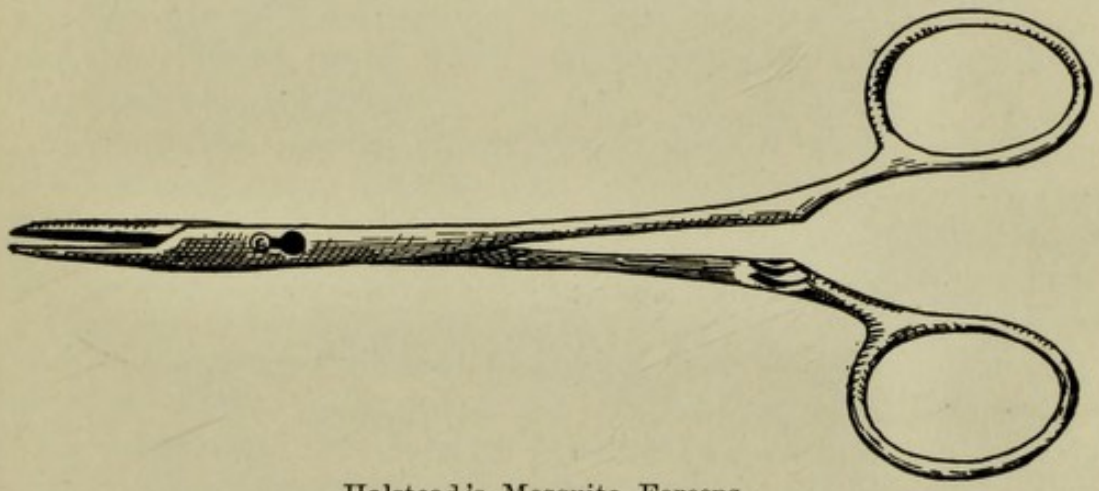
After-treatment of ophthalmic operations and of their complications.

In many particulars the after treatment of ophthalmic operations differs in no important detail from that of other surgical operations, and with these the ophthalmic surgeon is presumably familiar. There are, however, some points of difference, largely dependent on the anatomical and physiological peculiarities of the tissues involved, and also on the extreme delicacy and great functional importance of these tissues, which make a section on the particular after-treatment of ophthalmic operations not only desirable but indispensable.

Upon the completion of any operation on the eye or its appendages, the necessary steps preceding the application of a dressing are the arrest of hemorrhage, and the cleansing of the wound. The procedures differ somewhat according as the operation has to do with the lids, or the lachrymal sac, as after a blepharoplasty, or with the tissues of the orbit, as after a tenotomy, advancement, enucleation, exenteration of the orbital contents, etc., or with the eyeball itself, as after an iridectomy or cataract extraction.

In general the arrest of hemorrhage during or after ophthalmic

operations does not present a problem of any moment. The looseness of the tissues permits the retraction and contraction of the blood vessels, and hemorrhage usually ceases spontaneously. Proper preparation of the patient and field of operation will also contribute to lessening the tendency to bleed. The administration of a laxative sufficiently long before the operation to secure an evacuation of the bowels, contributes, among other things, to the patient's comfort, lowered blood pressure and quiet. A good night's rest, the prone position in bed, the avoidance of excitement or stimulating drinks, with the administration, if it seems advisable, of a sedative,



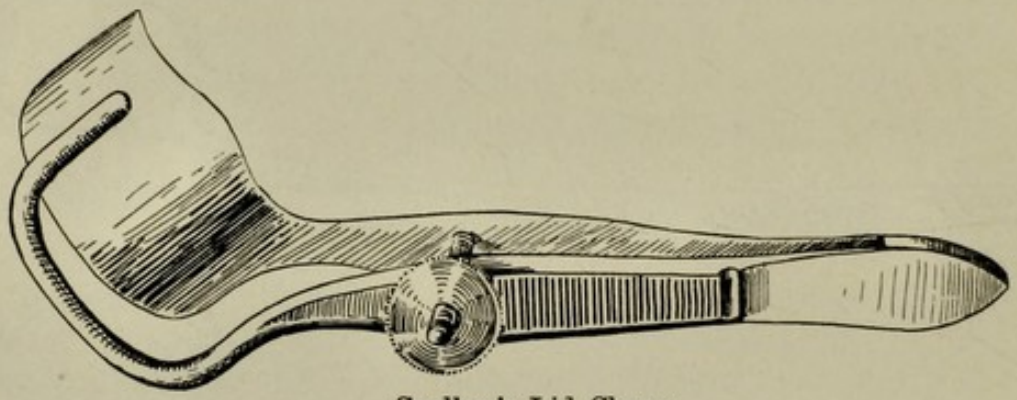
Halstead's Mosquito Forceps.

all contribute to the composed mental and circulatory condition, which bears directly on the question of post-operative bleeding. If the operation is done in a hospital, all these things are more conveniently arranged if the patient appears at least a day before the operation.

In the presence of vascular disease or nephritis additional precautions as to rest, condition of the bowels, sedatives, and the administration of certain drugs, such as the calcium salts, will tend to lessen bleeding. In certain operations, as on the conjunctiva, muscles, and iris, bleeding can be further prevented by the local use of one of the preparations of the suprarenal gland. The instillation of this substance into the conjunctival sac suffices for operations on the conjunctiva, such as for pterygium, but for operation on the muscles and iris the action is much more certainly obtained, together with infinitely better anesthesia, by injecting sub-conjunctivally or along the muscles, a solution of cocain and adrenalin, as advised by Robin and Bruns. (The solution consists of one part of 4 per cent. solution of cocain, one part of 1-1000 solution of adrenalin chloride, and two parts of normal salt solution.)

It should be remembered that hemorrhage is apt to be more free from an operation performed on a woman during menstruation, or on a patient suffering from sepsis.

In operations on the lids and lachrymal sac bleeding can usually be controlled by pressure, best made with little pads of gauze, which may be wet in a hot antiseptic solution, and pressed directly into or on the wound, and held for a minute or two. Should this fail to control the bleeding, the point whence it comes should be sought for and grasped with suitable hemostatic forceps. Since the wounds are usually small, delicate forceps are advisable, such as Halstead's mosquito forceps or serrefines. If after the application of such



Snellen's Lid Clamp

means of compression for a minute or two the bleeding continues when the forceps are removed, a ligature of silk or catgut should be applied, or a suture, employed in closing the wound, should be so passed as to include and occlude the bleeding point. In general it is not well to close a wound that is still bleeding, as the blood clot that collects between the wounded surfaces interferes with their proper approximation, and also furnishes a medium for bacterial growth which plainly increases the risks of wound infection.

In many operations on the lids the field can be rendered bloodless, or nearly so, by the application of a lid clamp before beginning the operation. After the completion of the operation and removal of the clamp it may be necessary to resort to some of the measures just mentioned to control bleeding.

In bleeding after *enucleation of the eye-ball* or *exenteration of the orbit*, the conditions are not always so simple. As a rule pressure with gauze sponges, wet in a hot antiseptic solution, and the application of a firm compress and bandage will control the hemorrhage, but after these operations the bleeding may be free and prolonged. If this is apparent at the time of operation, ligatures should be applied to the bleeding vessels, or the bleeding may be checked

by use of the actual cautery. If, however, the tendency is only manifested after the patient has recovered from the anesthetic, removal of the saturated dressings will reveal tissues so swollen and infiltrated with blood that the location of the bleeding point, situated deep within the orbit, is very difficult. Packing with gauze, pressure, and the internal administration of sedatives should be resorted to. These failing, the patient should again be anesthetized and the bleeding point located and tied.

In operations where excessive hemorrhage is anticipated, as in the removal of large malignant growths of the orbit, it might become necessary to expose the internal carotid artery, and pass a loop of ligature around it preparatory to tightening it if necessary to control the bleeding, or it might even be advisable to ligate it before beginning the operation.

In operations on the eye-ball the principal sources of bleeding are the conjunctiva and the iris. Unless the conjunctiva is much inflamed, the instillation of some preparation of the suprarenal gland will prevent bleeding from that membrane. The iris, when wounded, nearly always bleeds, and sometimes bleeds very freely. This is objectionable in so far as it obscures the contents of the anterior chamber and embarrasses manipulation on the lens and other structures. The anterior chamber may fill quite full of blood, when the pressure of the blood on the cut iris will arrest the bleeding. Allowing a little time for this to occur, the blood may be expelled from the anterior chamber by the same manipulation that is employed in freeing the chamber of cortical debris after cataract extraction (q. v.). It is rarely that such measures will not insure at least a sufficiently clear anterior chamber to permit the completion of the operation, though it is conceivable that the inability to secure it might necessitate postponement of further steps. At the completion of the operation it is a mistake to submit the eye and patient to much manipulation or disturbance in an effort to free the anterior chamber of blood. In case the dressings are applied to an eye whose anterior chamber is completely filled with blood, it will usually be found in twenty-four hours to be entirely clear, so rapidly is the blood absorbed.

Before dismissing the question of hemorrhage some mention should be made of the hemorrhagic diathesis and secondary hemorrhage.

The *hemorrhagic diathesis* (hemophilia) is fortunately seldom encountered. A patient subject to this disease may have an uncontrollable hemorrhage as an oozing from an insignificant ocular wound. Inquiry into the family history may put one on his guard,

and in the presence of this diathesis nothing but a question of life, or possibly that of vision, would justify a surgical operation. Pressure is perhaps the best local means to combat such a hemorrhage, while as far as general treatment is concerned, the injection of normal blood serum, of man, rabbit or horse, is the best measure to increase the coagulability of the blood. Twenty to thirty cubic centimeters should be given subcutaneously or intravenously. If normal blood serum is not to be had, ordinary diphtheria antitoxin can be given instead. A detailed description of this condition may be found in most works on general medicine and surgery.

Secondary hemorrhage arises from the dislodgment of the clots by which nature has arrested the hemorrhage primarily. It is usually due to sloughing, following infection. Here too, pressure is the most efficient single means of controlling the bleeding.

Price's Suture Plate, actual size

Hemorrhage having been arrested, the wound and surrounding parts should be carefully cleansed of blood. Such clots as cannot be readily removed by irrigation and gentle wiping with gauze or cotton sponges, should be picked out with fine forceps, such as iridectomy forceps. This is generally the best way to remove clots from the conjunctival sac, since it can be done with least disturbance to the patient. Sponging or wiping in this situation may excite "squeezing" on the part of the patient, with disastrous results, a circumstance which would be particularly deplorable after the completion of the operation.

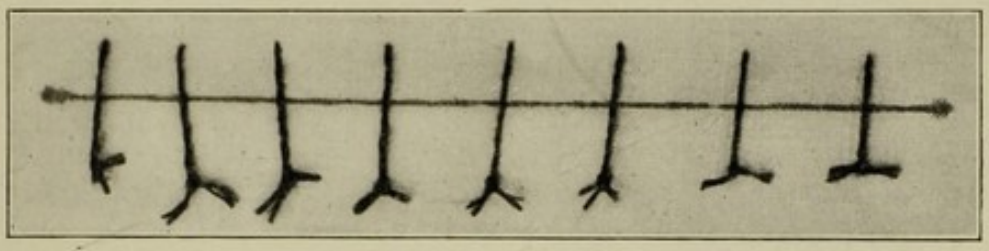
A word should be said here in regard to sutures, since their presence and their removal constitute one of the important problems in the after-treatment of ophthalmic operations.

Of the *material for sutures* and its preparation suffice it to say that silk and cat-gut are the materials most used, and both should be black (iron-dyed) or otherwise colored to facilitate easy recognition for removal. This is assisted in the case of conjunctival sutures, by the use of the suture plate devised by Geo. Price, of Nashville. It consists of a small silver plate, oval in shape, and about 9x5 m.m. in size, with two holes in it, through which the ends of the suture

are passed and the knot tied on the plate, which in turn lies smoothly on the ball. In certain muscle operations, where a bunching up of the tissues included in the suture is not desirable, the suture plate serves to hold them flat.

After operations involving incision in the skin in the region of the eye, accurate apposition of the edges of the wound should be secured, as early healing is thereby promoted and the subsequent scars are rendered much less conspicuous. In case the sutures are used to secure apposition only, and little if any tension is put on them, they should be removed in twenty-four hours, as they have by that time served their purpose and their further retention can only lead to irritation.

It should be remembered that the use of sutures is to secure apposition, while bandages give support. Sutures are foreign bodies, and should be dispensed with at the earliest possible moment. Where



The Interrupted Suture

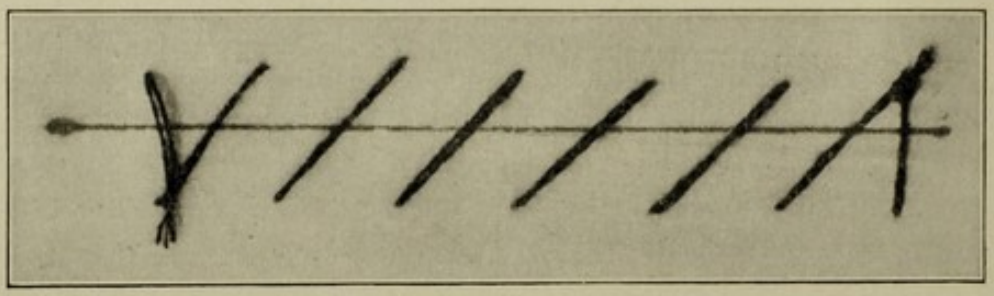
they are intrusted with the holding of parts in place that would otherwise tend to be displaced, as after blepharoplasty, pterygium operations and advancement of muscles, they must be left in position longer. Under these circumstances three days for the conjunctiva and six to ten for muscle and skin will be found to be the proper time. Gifford believes that if skin sutures are touched daily with a 4 per cent. solution of nitrate of silver they can be left in place longer without exciting suppuration.

Of the various kinds of sutures generally used, three common forms might be briefly mentioned here.

The interrupted suture is, as its name implies, composed of a series of single loops of suture material passed across the wound from side to side. The number and distance between these sutures is determined by what is found necessary to produce accurate apposition of the edges of the wound. In tying the units of this suture the ends are crossed to make a single or double knot, which is drawn down to the surface of the tissue by pulling on the two ends. Both ends are then drawn rather forcibly to one side, and the second knot tied. This maneuver places the knot just at the

point of entrance of the suture into the skin, and not in the line of incision.

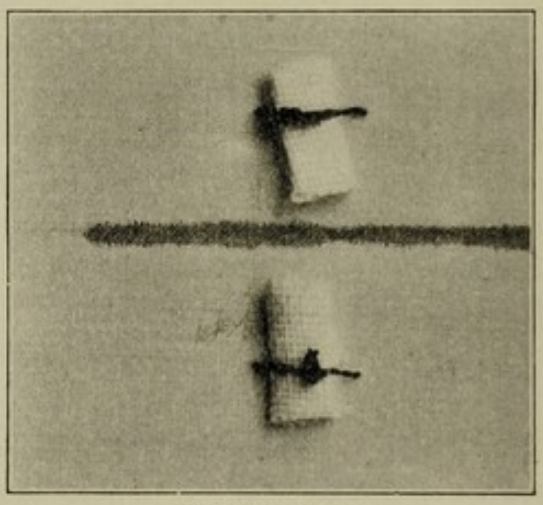
The continuous suture, as shown in the cut, is less often used, and consists in first passing a loop across the line of incision. This may be tied or not. Subsequent loops are similarly passed, the suture being carried from one to the other without being cut to form single units. This suture is more difficult to remove than the



The Continuous Suture

interrupted suture, as no part of it can be removed or loosened without interfering with the whole.

Tension sutures are used for support, as in holding flaps in place after certain plastic operations. They are generally deeply-placed



Tension Suture

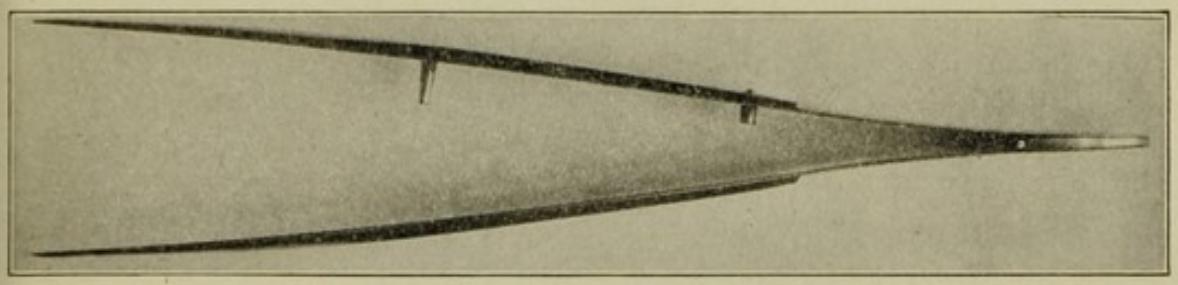
sutures of heavy material, introduced well back from the wound edges, in pairs, the adjoining ends on the same side of the wound being tied over a piece of gauze or glass bead to prevent their cutting into the tissues. In addition to these, one of the other forms of suture is used to secure apposition of the wound.

In removing sutures the thread should be grasped with the points of small smooth-pointed forceps at one side of the knot and drawn

out a little from its bed. It is then cut with scissors as close to the point of its emergence from the tissue as possible, and then entirely removed. In this way one avoids drawing through the tissues any portion of the thread that has been exposed, and possibly contaminated, so that the risks of wound infection are materially lessened.

The materials used for dressing the eye after operation are principally gauze and cotton, held in place by bandages, adhesive plaster, shields, masks, patches and shades.

Surgical gauze is usually plain, not impregnated with any medi-



Smooth Pointed Forceps for Removing Sutures

cament, but sterilized by heat. A piece of suitable size and shape and two or three layers thick is applied next to the wound. If wet with a non-irritating antiseptic solution, such as boric acid, it will adapt itself more perfectly to the irregularity of the part, and thus be less apt to shift its position, though this renders it less absorbent than if applied without wetting. Some surgeons tease out absorbent cotton into a thin layer, with the fibers all running one way, and apply this, wet, next to the skin. Whether gauze or cotton be used in this way, over it is placed a pad of absorbent cotton. The size of the pad must vary with the object to be attained, varying according to whether we do or do not wish to make any pressure on the parts. In case there are cavities left in the tissues after operation, as after removal of the lachrymal sac, additional pads of gauze are so disposed as to close, by pressure, these cavities so far as possible.

It was formerly the custom with many surgeons, and is still the practice with some, to use, instead of plain gauze, that which is impregnated with some antiseptic. The ones most commonly used were the bichloride of mercury, the cyanide of mercury, carbolic acid, boric acid and iodoform. It is probably unnecessary to use any of these, in other words the dressing should be aseptic and not antiseptic, in the event of clean wounds. In the case of sloughing wounds, or surfaces, and particularly cavities, which are healing by granulation, an antiseptic gauze for dressing may have some

advantages. Iodoform gauze is objectionable on account of its odor, but is thought by many to be of special value in sloughing wounds or to stimulate the granulation of bone wounds.

The variety known as absorbent cotton is used exclusively for dressings, and should be tested as to its absorbability by placing a loose piece of it on the surface of the water in a glass or bowl. If properly prepared the piece will almost at once absorb water and sink; if not, it will resist the solution and float for some time on

Monocular Eye Bandage

the surface. While the lack of absorbent qualities is not so important in the making of dressings, its usefulness as sponges and for the purpose of protection while irrigating is seriously interfered with if it is not properly prepared, and such a sample should be discarded.

Cotton in the packages in which it comes has been repeatedly shown not to be sterile. It can be sterilized by heat (baking) if desired, but as it is often applied outside of the gauze, it is not more necessary to have it sterile than it is to have the bandage sterile.

The best bandages for use in ophthalmic surgery are flannel and gauze. Flannel bandages possess a degree of elasticity which makes them very serviceable for pressure bandages, but the difference between flannel and gauze in this respect is not very great. On the whole, gauze bandages which can be obtained ready made in any width, are perhaps the best. Consideration of economy may prompt the use of muslin, or even calico, in hospital wards and dispensary work. Mosquito-netting of the cheapest variety and containing much starch is recommended by H. D. Bruns. This is

applied wet, and when dry forms a stiff but very light cast. Ocular bandages should be one-and-a-half inches wide.

An eye bandage is commonly applied in the form of a figure 8, and is made to cover one or both eyes according to circumstances. The monocular bandage is applied as follows: The end is fixed at the center of the forehead and the first turn encircles the head passing just above the eye-brows in front and just below the occipital protuberance behind. For the right eye the first turn

Binocular Eye Bandage

crosses the forehead from the patient's right to left and for the left eye, from the left to right. The second turn follows the first as far as the occipital protuberance when it drops lower, passes below the ear and comes up across the pad of gauze and cotton with which the eye is covered, crosses the first turn obliquely and rests on the parietal eminence of the opposite side. Subsequent turns may be made in the same manner, and by each over-lapping its predecessor, cover the whole dressing, or turns may be made alternately around the head like the first turn, and then oblique like the second.

A binocular bandage is started like a monocular. The first turn encircles the head, the second passes below the occipital protuberance and ear and up across one eye. The third turn, after passing the occipital protuberance, goes upward, crosses the parietal eminence and then comes down obliquely across the first turn, across the second eye and below the ear on the same side. Succeeding

turns may be oblique, alternating from one eye to the other, or one may vary these with a horizontal turn.

A single turn bandage that is secure and quickly applied is made by taking a piece of bandage about three feet long and placing the center of it over the dressing which lies on the eye. The ends are

A Simple Single Turn Bandage

passed around the head in opposite directions and looped around each other at the occiput, each end then going forward by the same route it followed in going backward. The two ends are then tied on the forehead.

For greater security, especially in children, the finished bandage may be covered with a single strip of adhesive plaster, half an inch wide. This is very effective in preventing slipping, a tendency which is extremely great on certain shapes of heads.

Before applying a head bandage to a woman, the hair should be plaited in one or two braids behind.

While bandages have a certain sphere of usefulness, especially where it is desired to make pressure, more and more is adhesive plaster being used instead of the roller bandage. A good quality of fresh plaster holds admirably and is much more comfortable to the patient than a bandage. Adhesive plaster, into the adhesive layer of which a certain amount of zinc oxide is incorporated, can be used with much less irritation of the skin than the plain variety,

Monocular Dressing with Adhesive Plaster

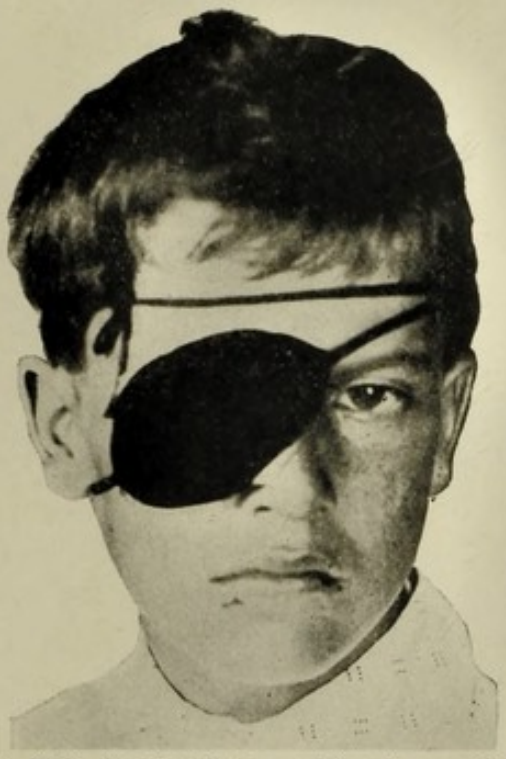
and is in other respects more satisfactory. To secure a dressing on one eye, two parallel strips may cross the dressing obliquely, being fixed on the cheek and brow, or a strip can be run along each edge of a triangular pad as advised by Casey Wood. The latter is supposed to give better protection than the former, as the eye is

Monocular Dressing with Adhesive Plaster

Binocular Dressing with Adhesive Plaster

Fixation of the Lids with a Vertical Strip of Isinglass Plaster

less apt to be disturbed by the fingers of the patient and others. For applying a dressing to both eyes, a long strip is passed across both ocular regions from temple to temple. Two additional shorter strips cross each dressing obliquely from cheek to brow. The plaster strips should be ½ inch wide. Fixation of the dressing with adhesive plaster has the advantage, among others, over the roller bandage, of being applied and removed with much less disturbance of the patient, especially when the latter is lying in bed.



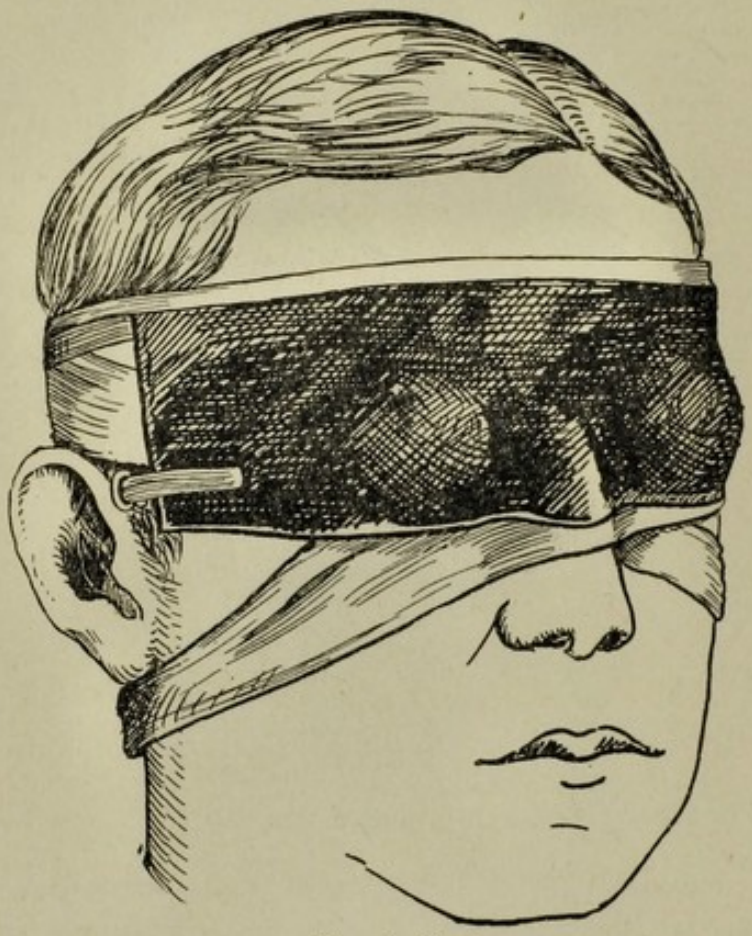
A Patch of Black Felt for Retaining a Dressing and Protecting the Eye

In place of zinc oxide plaster, isinglass plaster (''court plaster'') is sometimes used in the same way. Some surgeons apply a strip of this directly to the lids after cataract extraction, either passing the strip across the palpebral fissure to fix both lids, or horizontally on the upper lid, to fix it, as by a splint. If one will close the lids and grasp the eye-ball as firmly as possible with the finger tips and attempt to restrain its movements, he will be convinced of the futility of attempting to fix the eye and render it immovable by any dressing applied to the closed lids. The belief in the efficiency of a bandage, then, to fix the eye, is a fallacy, and the best we can do is to secure quiet and immobility by closing both eyes and removing the incentive to movement. This will be reverted to presently.

Besides bandages and plaster strips a variety of patches, binders

and shields are used to retain eye dressings. A very convenient one is made of black felt, with tapes attached to each end. This is also adaptable to both eyes and answers the purpose of the old Liebreich bandage, of which it may be said to be an imitation.

A little point that should be mentioned in the application of patches, shields and masks to the eyes, especially when the patient is in bed, is to tie the ends of the tapes so that the knot will be on



Ring's Mask

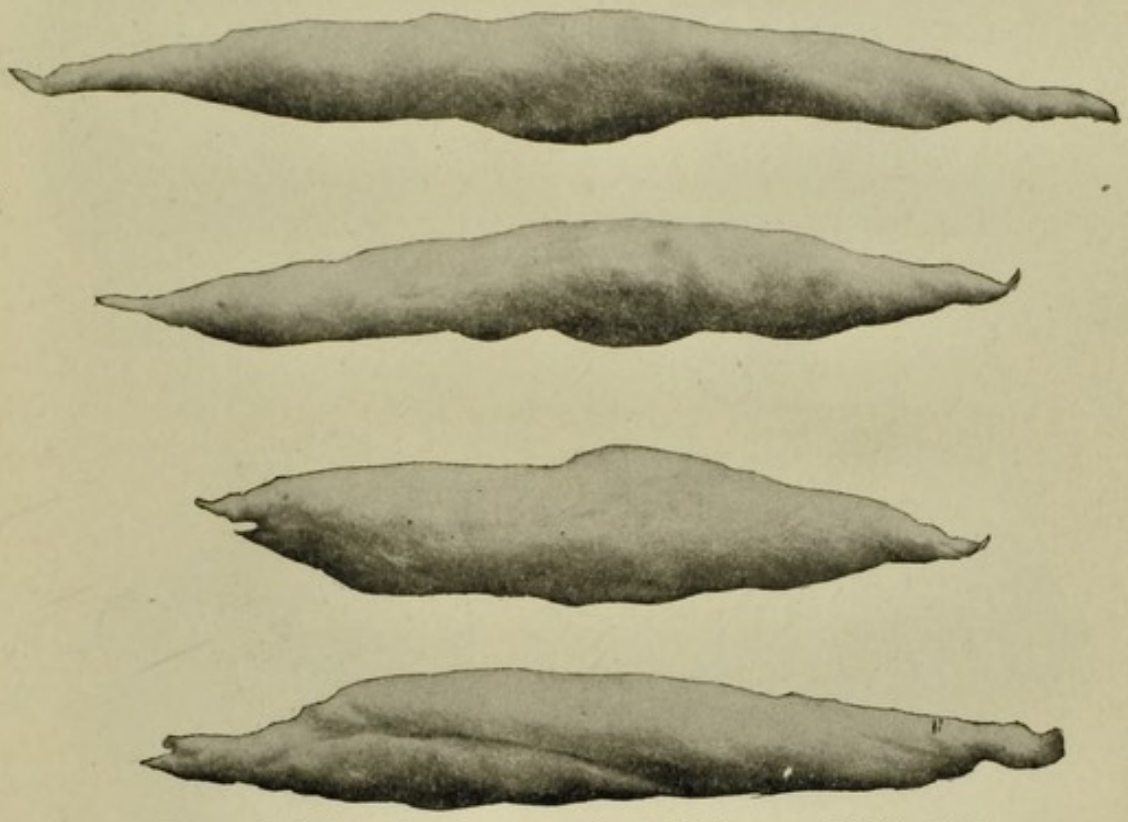
the side of the patient's head, and not at the back. In the latter position it is a discomfort to the patient lying on his back, and is also inaccessible. As a hint to the nurse it might be well when first adjusting the dressing to cut one tape fairly close to the patch. The two then can be tied only at one side.

Patches of celluloid and covered pasteboard are better adapted for shading the eyes from light than for retaining a dressing.

Shields and masks are used for the double purpose of retaining dressings and protecting the eye from injury, or for the latter purpose alone. They are made of pasteboard or similar material, like Ring's mask, or of wire, and may be used with or without any eye

dressing, and cover one or both eyes. Metal plates are at times incorporated in the dressings for the same purposes.

The sponges which are used for this and other purposes are made by wetting a pledget of absorbent cotton, somewhat smaller than an egg, in a boric or other antiseptic solution, and rolling it be-



Cotton Spindles for Sponges, about 2″ long and ½″ thick

tween the palms into a little spindle with two pointed ends, and squeezing it almost dry. In this form and shape it proves most useful, and when freshly made and well squeezed is sufficiently dry to be absorbent. As Beard so aptly expresses it, the tip will "drink up" secretions and excess of solution in a most satisfactory manner.

Sponges may also be made of gauze, the edges being turned in so as to leave no raw edge exposed to fray out and deposit threads on the wound.

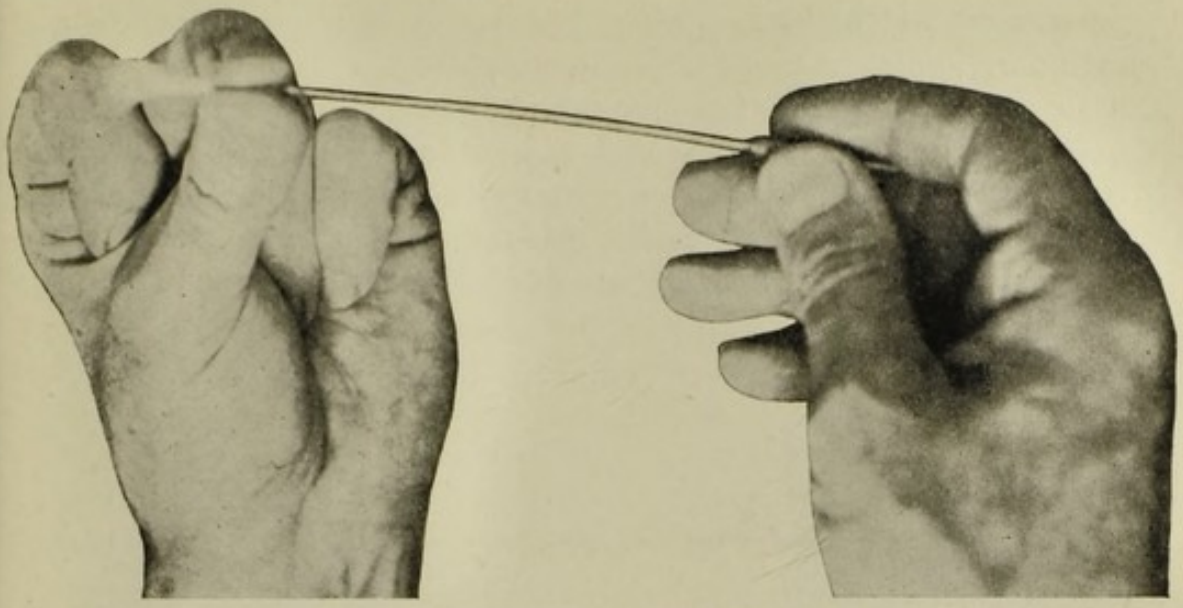
Applicators wound with cotton are used for making applications to the lids and eye. For making an application to the conjunctival aspect of the lids or to other similar surface, the applicator should be wound as shown in the figure. The grasp of the tuft of cotton is made at its proximal end only, and the result is a tufted applicator, which, when wet, spreads out like a little brush. It is sometimes desired to apply a stronger solution, such as carbolic acid, tincture

of iodine or other substance of this character, to a limited area of the eye or lid. For this purpose the applicator is wound in such a manner that the whole of the cotton pledget is applied tightly to

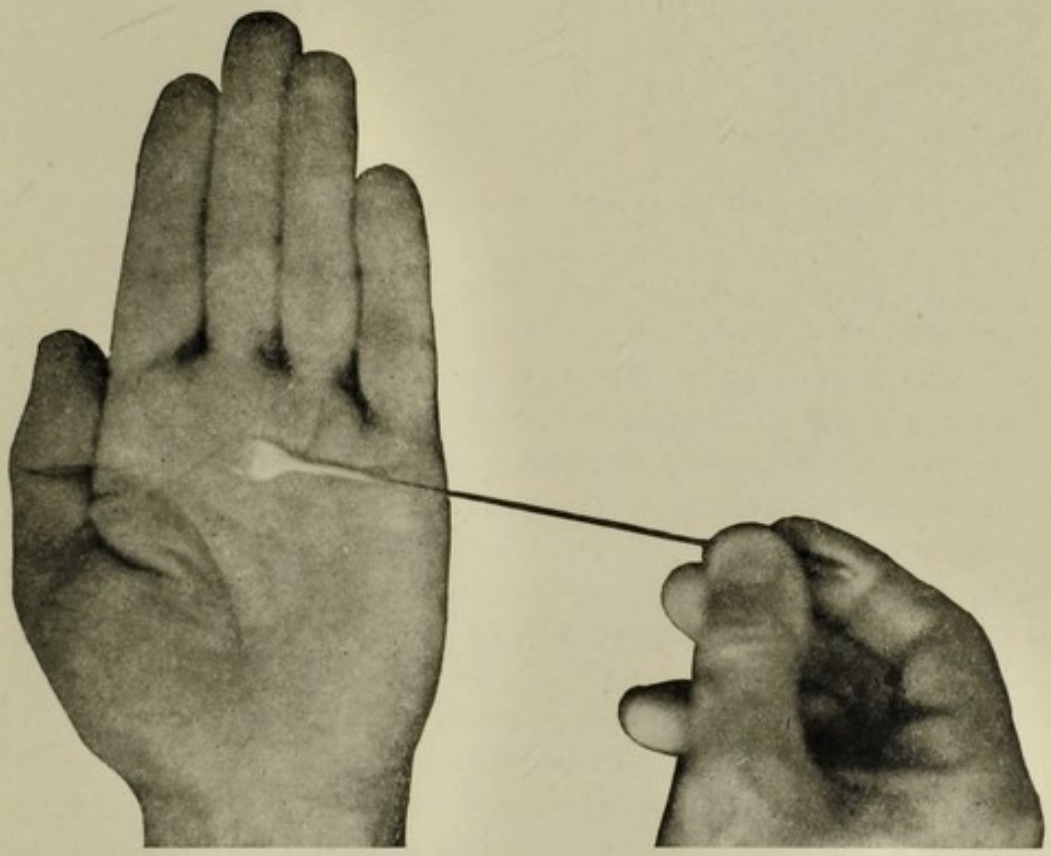
Gauze "Bird Nest" Sponges. No Edge is Exposed. These are 1 to 1½ inches in Diameter

the shaft of the applicator. The finger grasps the cotton for this purpose throughout the entire extent. With the applicator prepared in this manner a small quantity of a very active solution can be applied exactly where it is desired, as for instance to the surface of an infected wound.

Colored glasses are used in the after-treatment of ophthalmic operations to protect the eyes from light, especially during convalescence after operation on the globe. A variety of colors is to be had, notably green, blue, amber and amethyst, but the most useful are "smoked" glasses in varying shades. If well-fitted as to pupillary distance and relation to the lashes, they offer considerable protection. The flat instead of the coquille-shaped lens should be used, as the latter, unless carefully ground, are found to possess refractive



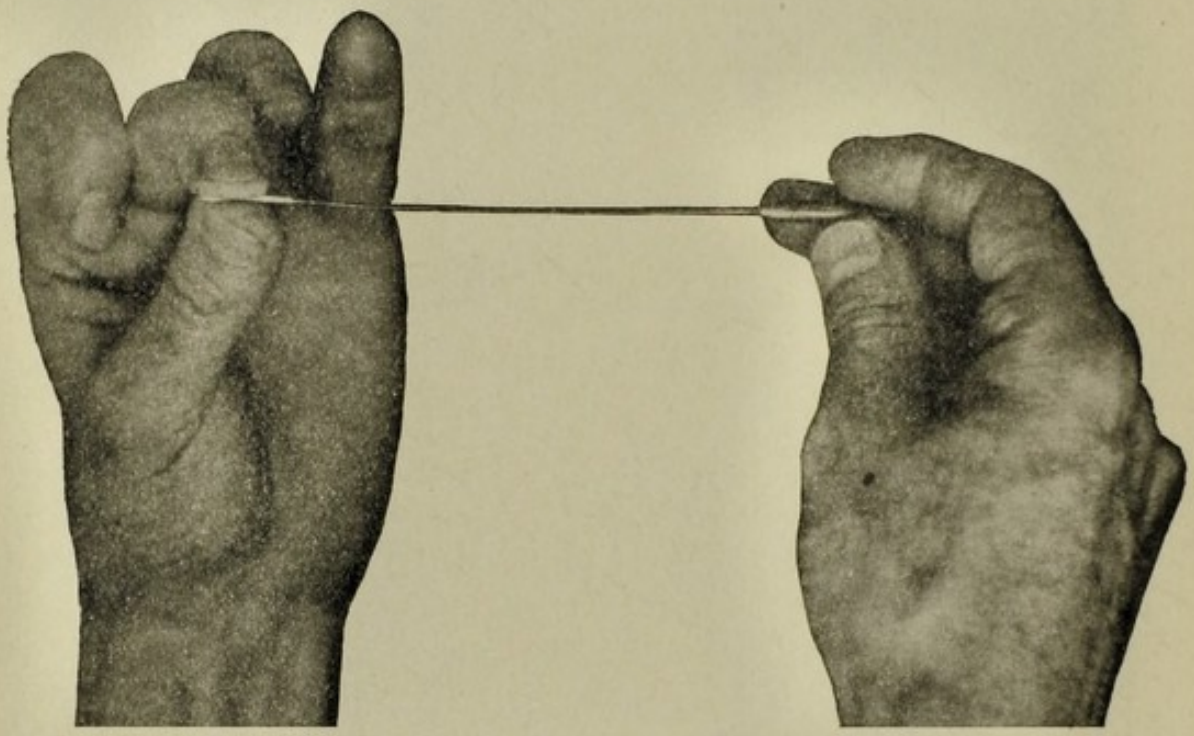
Method of Wrapping Cotton to Make an Applicator



The Way in which the Cotton Wrapped as Shown in the Previous Figure Spreads Out to Form a Brush When Wet

powers equivalent to varying combinations of concave spheres and cylinders, which may be objectionable.

In considering the after-treatment of operations on the eye, the question whether to occlude one or both eyes must be decided in at least two instances, namely, squint operations and cataract extraction. In all these operations the occlusion of both eyes is advocated to secure immobility and, by a period of rest, to favor the proper



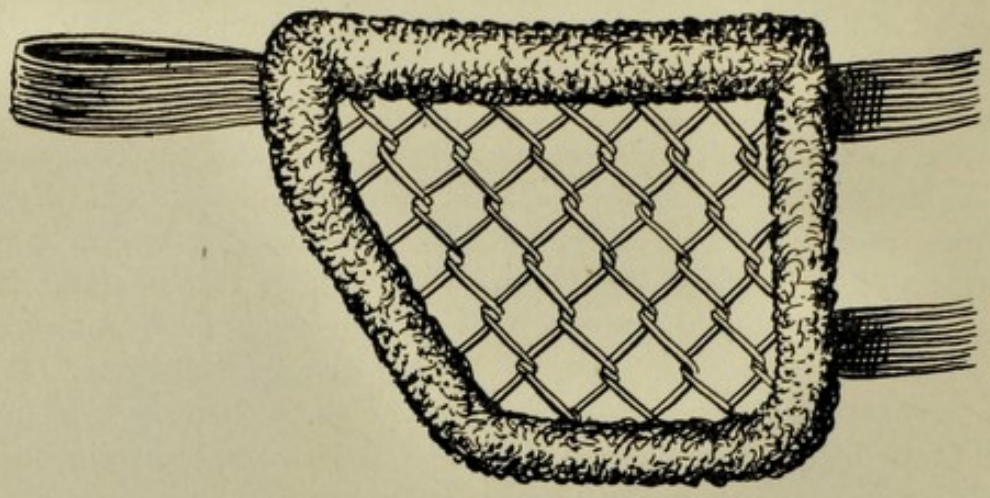
Method of Wrapping Cotton to Make Applications of Acids and Caustic Solutions

initiation, at least, of the healing processes. It has already been stated that no dressings applied to the closed lids can prevent movement of the ball, but there is no doubt that with the lids of both eyes closed, one will keep the eyes more quiet than with one or both eyes open. This is the argument for including both eyes in the dressing. In opposition to this practice it is argued that inflammation of the conjunctiva and secretion from that membrane are certainly increased, if not caused, by an occluding dressing, and the risks of infection of the wounds are increased. Furthermore, the covering of both eyes is said to exert at times a very disturbing effect on both the mental and physical condition of the patient, and for that reason should not be practised. In the case of an operation for squint, an additional reason for omitting all dressings is that we expect, by practice, to secure the co-operation of the two eyes in the visual act, and the sooner this is begun the better, since the

union of the muscles may to some extent be induced in the manner most suitable for these conditions.

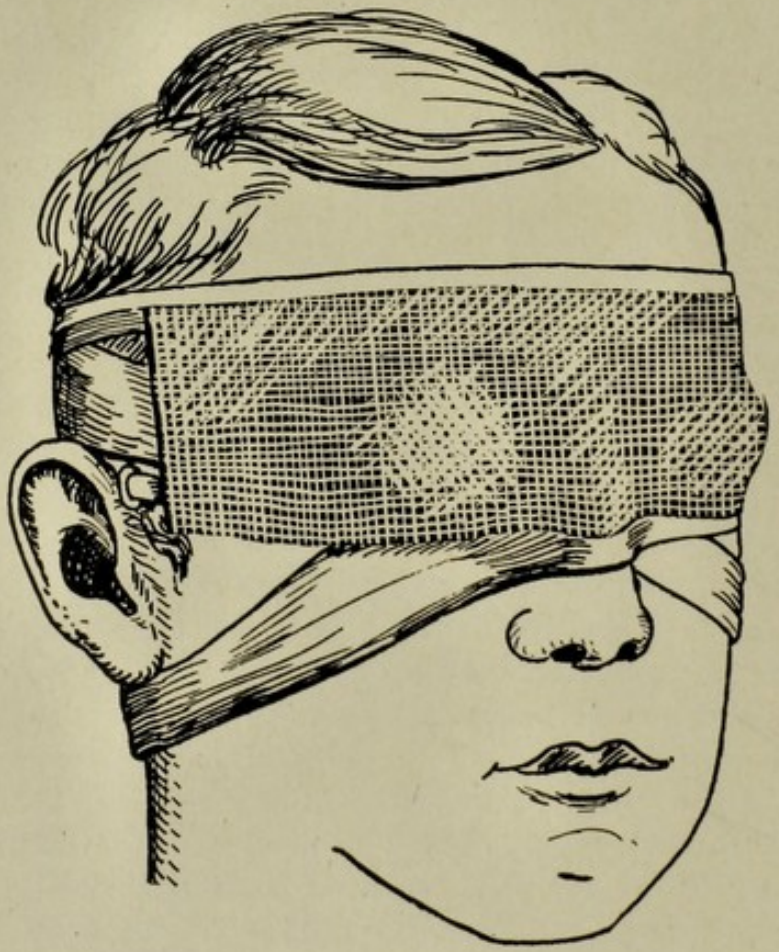
In reply to these arguments it may be said that many patients who are operated on for cataract are blind in both eyes, and whether one or both eyes are covered cannot concern them much. Even in the case of a blind eye, covering it with a dressing is apt to make it more quiet. Mental disturbance that follows this practice is not very common. Should it occur it is usually relieved by uncovering the sound eye, or both eyes, or by the use of sedatives. It can usually be prevented by not leaving the patient alone, and a bell cord or bell, placed in easy reach, so that he can summon some one at will, is often as quieting in its influence as the presence of an attendant. In squint, if a tenotomy only has been performed, it is probably never advisable that both eyes be covered, and many surgeons advise that no dressing at all be applied after this operation (Jackson), but that the eyes be left open to assume the best possible position for binocular vision. If an advancement has been done the case is different. Here some writers advise closing both eyes for five or six days, while others, Bruns, for instance, advise that no dressing or bandage be applied. The practice of most surgeons lies between these two. Closing both eyes for twenty-four hours, and the one operated on for a longer time (usually till the stitches are removed, if any are to be removed) has proven a satisfactory practice, and the operative failures that have occurred could not fairly be attributed to the manner of dressing. In passing, it might be said that many squint operations are undertaken, and properly, for the correction of a deformity, when little in the way of improvement of visual acuity and attainment of binocular vision can be expected.

Something remains to be said of the practice, which has many advocates, of applying no dressing at all after cataract extraction. This "open" treatment has been advocated by a number of surgeons recently, and is the extreme position among advocates of freedom from restraint for cataract patients. It is usually advised that the eye be protected only by means of a shield or wire mask, or hollow bandage. Heimann argues that this practice is less irritating to the patient, less apt to cause psychic disturbance, and that inspection of the eye is easier. The hollow bandage referred to is made of parchment paper, dipped in glycerine and molded closely to the border of the temples, forehead, nose and cheeks, glycerine jelly being used as an adhesive. Glycerine jelly is composed of five parts of tragacanth, two of glycerine and 100 of water. J. W.



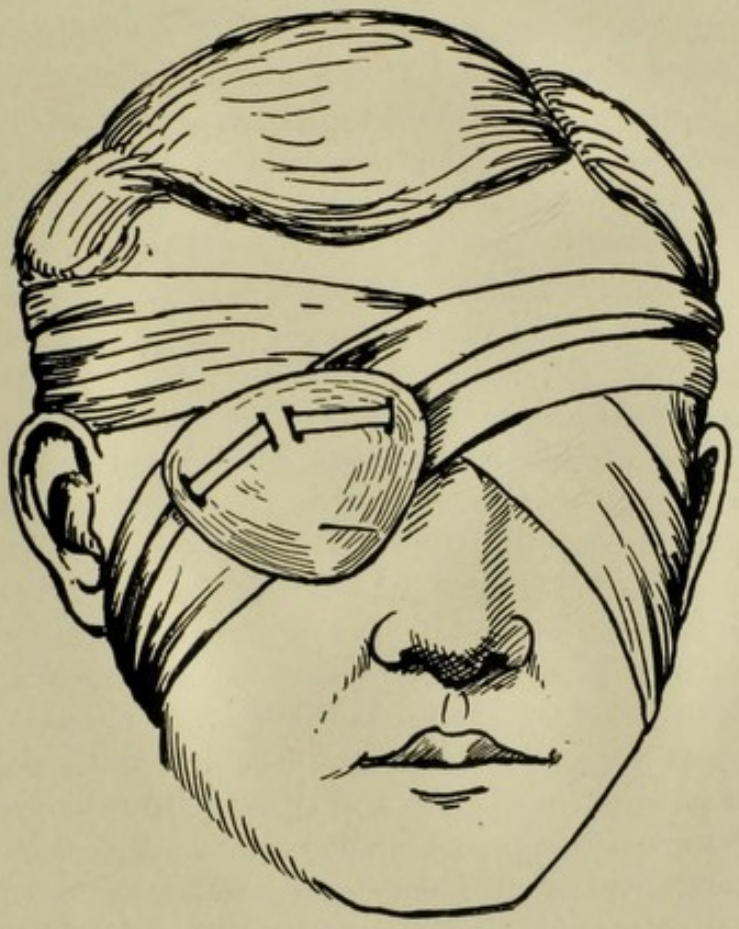
Single Wire Mask

Scales does not approve of the bandage because (1) it interferes with the natural drainage of the eye and brings about a retention of secretion; (2) it interferes with uniform pressure, which the lid would exert; (3) it creates a feeling of discomfort; (4) it tends to



Double Wire Mask

cause entropion and (5) it causes conjunctivitis. His practice, which is adapted from Sattler, of Leipsic, is to close the eye after operation and lay on it a double layer of moist bichloride gauze. Over this a wire mask is placed. In six hours the gauze is removed, and not replaced. C. Hess reports "about a thousand cases treated with the open method, and the results were at least as good as, or better than, with the bandage." He has attempted to secure fixation of



Metal Plate Incorporated in an Eye Dressing

the eye by putting over it a capsule with an aperture in the center. The patient must look through this to see. On the whole it would seem that the following quotation from Hotz pretty well expresses the views of most ophthalmic surgeons, at least in America, today on this subject.

"While we fully indorse the laudable desire to cater to the patient's comfort, we are not prepared to go in this direction as far as Hjork, of Christiania, who, in a recent issue of the *Centralblatt für Augenheilkunde,* very strongly pleads for the omission of all bandages after operations upon the eye-ball. His reasons are that winking serves to cleanse the eye and carry all the micro-organisms

with the tears through the normal tear passages; bandages, therefore, stopping the movements of the eye-lids, favor rather than prevent the contamination of the wound. From October, 1895, to 1896, he used a bandage, but during the first 24 hours only, and since October, 1896, he has discarded bandages altogether. During this period 112 operations by which the globe was opened were done (extractions, iridectomies, sclerotomies, needle operations), and in all cases the healing was favorable."

"We do not doubt that the puncture of a needle and the linear incisions of a keratome heal kindly under the open treatment, and even that a sclerotomy wound, unless unusually extensive, will do well without bandages, for these wounds have no disposition to gape, but close up tightly as soon as the instrument is withdrawn. But when it comes to the large curved incision of cataract extraction, we hold that kind healing requires something more than the aseptic condition of the wound; it requires in addition that the accurate apposition of the wound-edges shall be protected against disturbance by winking. The edges of these flap-wounds are easily separated by the slightest pressure of the winking lids, hence, if no bandage is used, the sealing up of the wound is retarded and the chances for prolapse are considerably increased. Hjork proves this by his own cases; for in 24 simple extractions performed during this period of the open wound treatment iris prolapse occurred four times, or in 16 per cent. of the cases. In other words, the accident is likely to occur twice as frequently under the open wound treatment as under protective bandages. This is not a favorable showing for open wound treatment, and surely cannot induce ophthalmic surgeons to abandon protective bandages. We would advise the bandage as the safest treatment until somebody invents a cement by which a fresh wound can be firmly sealed up directly after the extraction. Then the movements of the lids could not disturb the edges of the wound, and of course, bandages could be safely omitted."

It must not be forgotten, however, that pressure on the eye ball after corneal section should be avoided, as it cannot produce fixation of the eye and may cause a disturbance of the lips of the corneal wound. Fixation of the eye is favored by closing the fellow eye, and guarding against startling the patient by sudden noises, etc. A dressing which closes the lids and keeps them gently closed is desirable. A bandage which maintains its position only when it exerts pressure, should be avoided.

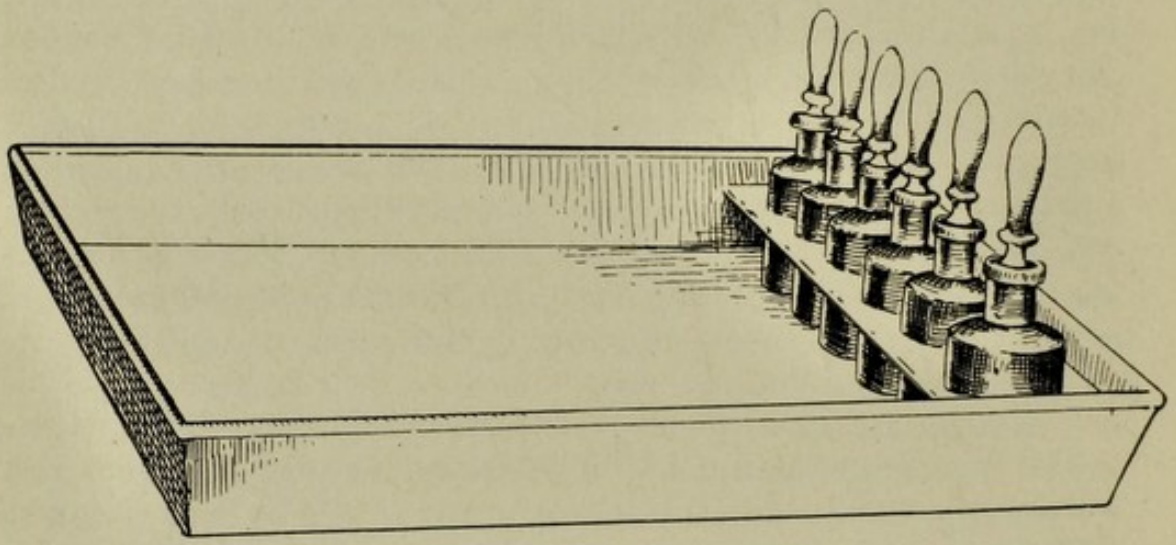
The practice in regard to the restraints placed upon a patient after

cataract extraction has changed materially in recent years. The deleterious effects, both mental and physical, of confinement on old people is well known. The most conservative methods in practice are set forth by Lawson. He bandages both eyes for two or three days, the eye operated on for a week or ten days, and is careful not to let the patient walk to his bed or elsewhere after the operation. The hand on the side of the operation should be hobbled with a piece of bandage to prevent its reaching the eye, and the patient is kept in bed for a few days. The diet should be one that needs little or no chewing. At the other extreme, Lopez thinks these patients need not be confined to bed at all, and that recovery is not impeded if they walk about, eat and smoke in their ordinary way. Only the eye operated on is covered by the dressing. Bruns bandages but one eye unless both are entirely blind, or some serious accident renders their immobilization highly desirable. He is also more and more inclined to allow patients to return to their homes after operation and report to the clinic daily, and is well satisfied with the results. The majority of American ophthalmic surgeons follow about the practice indicated by Casey Wood. A light dressing of gauze and cotton is applied to the eye (usually to both eyes), and held in place by a triangle of adhesive strips. The patient is transported to his bed with the least possible disturbance and effort, or if possible, he should be operated on the bed on which he is to lie. Complete rest for the next 24 hours is now in order. He should be warned not to talk more than is absolutely necessary, not to make any sudden movement of his body, and to refrain absolutely from blowing his nose, squeezing his eye-lids together, turning over or getting up suddenly, and above all to abstain from sneezing and coughing. If both eyes are closed it is customary to remove the dressing from the non-operated eye and to allow the patient to sit up when the lips of the corneal wound have adhered and the anterior chamber has reformed. This time can be definitely determined, while to say when the corneal wound is "healed" is not easy. In another twenty-four hours the dressings can be left off the eye operated on and dark glasses or a shade worn by day; at night a dressing with a mask or other protection is to be applied.

While this will be decided in each case on its own merits, most ophthalmic operations require daily dressing. Since it is usual for the conjunctiva to become congested and secrete freely under an occlusive dressing, the patient's comfort, as well as the safety of the wound, is promoted by daily cleansing and airing, and this is true of all operations on the ball or adnexa when the eye is covered by

the dressing. While many surgeons do not advise this plan, and allow some cases to go three or four days or a week before changing the first dressing, the more common practice is for earlier dressing, and the almost universal custom includes daily dressing after the first one is changed.

It must be remembered that we have to do with a sensitive and conspicuous field of operation, so that not only are an excess of secretion and a dry and stiff dressing sources of particular discomfort, but the head is not easily kept still and dressings about it are readily disarranged. The surgeon's aesthetic regard for the appearance of his own work prompts him to keep the dressing clean and



Allport's Treatment and Dressing Tray for Bedside Use

in order—a state of affairs no less satisfactory to the patient and others concerned.

The hands of the surgeon should for the *removal of dressings* be prepared exactly as for operation, and the patient's hair and face and the pillow be covered with sterile towels. It may not be necessary for the surgeon to put on a sterilized gown, but if he has several patients to dress, as in a hospital round, it is best to adopt this precaution.

A convenient tray for holding the necessary solutions and dressings at the bedside is shown in the figure.

If bandages have been used they should be cut through, and gently removed. Let it be said, once for all, that no disturbing sight, sound, touch, application (especially of hot, cold or painful substances) or sudden movement should be permitted, lest the patient be excited to some act, such as "squeezing," that might work to his detriment. As at the operation, one person should do all the talking and give

directions to the patient. If adhesive plaster has been used to secure the dressing, cotton sponges (wet in alcohol for plain plaster, in ether or benzine for zinc oxide plaster) should be applied, first to wet the plaster where it adheres to the skin, and then with these same cotton sponges to wipe off the plaster, working towards the eye. The pulling off of the plaster, if done forcibly, is especially apt to excite "squeezing."

If patches or shields have been applied, the retaining cords should be untied and the patch gently removed.

The dressing itself should then be liberally wet with a warm solution of boric acid, till it is thoroughly softened, and can be easily taken away in successive layers. The excess of solution which may run from the dressing should be caught in a pus basin or similar dish, or by means of a pad of dry absorbent cotton. Basins and dishes are with difficulty held so that they will thoroughly protect the patient and bedding from a wetting, and for this reason a pad of absorbent cotton seems preferable. What was said about the absorbent qualities of the cotton applies especially to that used for this purpose; unless it is of good quality water will flow over it and not be absorbed by it.

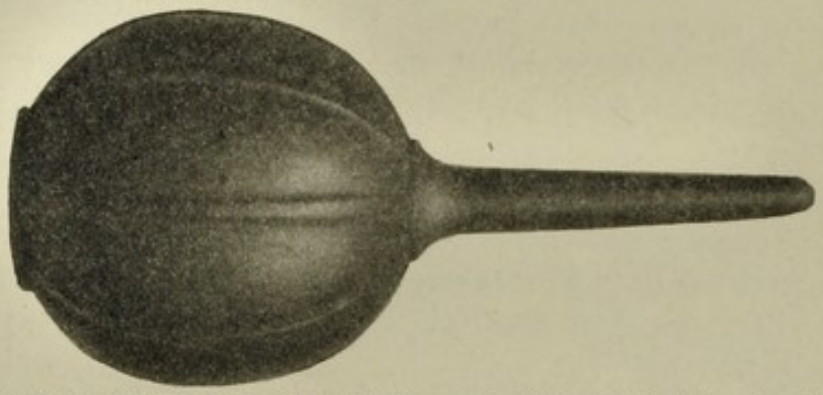
The dressings having been removed, the margins of all skin incisions should be wiped with wet cotton sponges to remove secretions or blood clots from the edges of the wound. Pledgets of gauze may be used, but the cotton sponges, just described, will be found to be more satisfactory.

Attention is next directed to the palpebral fissure, the eyes being kept closed in the meantime. A stream of warm boric solution is directed over the lids to soften any secretion that may be on them, and the patient allowed to open the eye without assistance, if possible. Any secretion clinging to the lashes may be removed by gentle stroking with the pointed end of a cotton sponge. The patient should then be directed to look up while the surgeon draws down the lower lid and flushes the cul-de-sac with warm boric acid solution.

It is well to say here that in patients who tend to "squeeze" the eye, this tendency can be controlled by drawing down the lower lid with the thumb or finger as the first step in attempting to get the eye open, and hold it till the patient voluntarily and quietly closes the eyes. The force of the orbicularis muscle can be so broken by pulling the lower lid strongly down, that it is not likely that any harmful contraction of it could take place. As the lid is apt at this time to be moist and slippery, it may be necessary to protect

the end of the finger with a layer of gauze or cotton to prevent slipping.

The solution used in this way should be warm and non-irritating to avoid shock in its application, which might otherwise cause the patient to start or "squeeze." A boric acid solution fulfills these conditions and is the one most used, although some surgeons prefer a one per cent salt solution, a half per cent sodium bicarbonate solution, etc. A convenient plan is to keep a "stock solution" in a large bottle, containing such an excess of boric acid that a layer of the undissolved acid covers the bottom of the vessel to the depth of



"Ear and Ulcer Syringe," Convenient for Irrigating the Eye

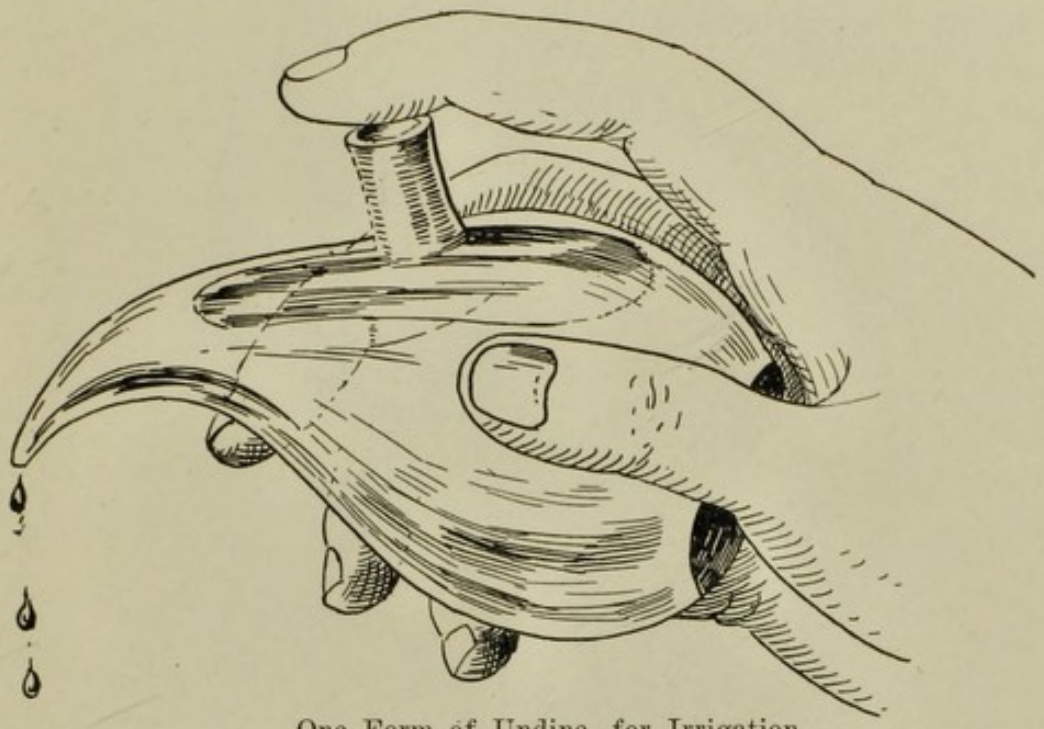
half an inch or an inch. A sufficient quantity of this solution diluted with an equal quantity of hot sterile water gives a warm solution which answers all the requirements.

Ordinary glass finger bowls make convenient vessels for holding the solutions for dressings, being sufficiently large and easily sterilized.

The solution is applied to the eye in one of several ways. Pledgets of cotton or gauze may be thoroughly wet with it and squeezed onto the eye. This is a convenient and gentle method, though minute particles of cotton fiber may thus be forced into the eye and act as foreign bodies. A dropper of glass and rubber, a rubber syringe, undine or other form of irrigator, may be used. A favorite method with many surgeons is to use a bottle for the solution with a large rubber dropper fitted to it as a stopper. Whatever method is employed it is important to remember that it must be used gently. The solution should flow on the lids or into the eye, and should not be squirted into it with any force. At the conclusion of the irrigation any excess of the solution should be taken up with a cotton sponge.

Inspection of the eye should be made, as with all other manipulations, as gently as possible. It will usually be necessary, at least at

the first few dressings, to open the eye with the assistance of the fingers. Great care must be taken not to make any pressure on the eye-ball, and to direct the patient's actions so that he co-operates with, rather than opposes, the surgeon. A most important matter

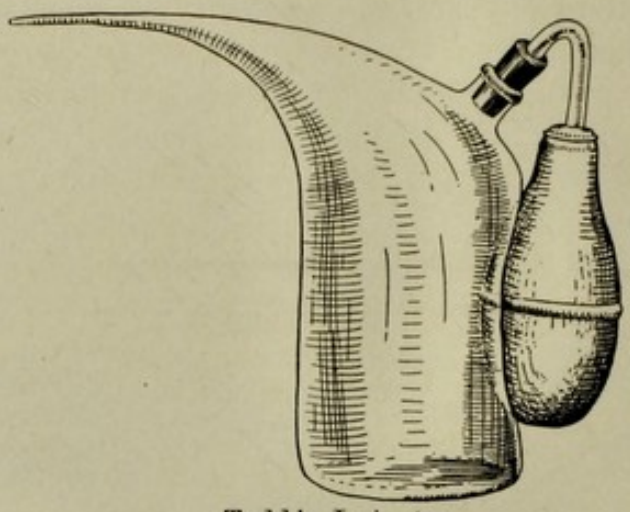


One Form of Undine, for Irrigation

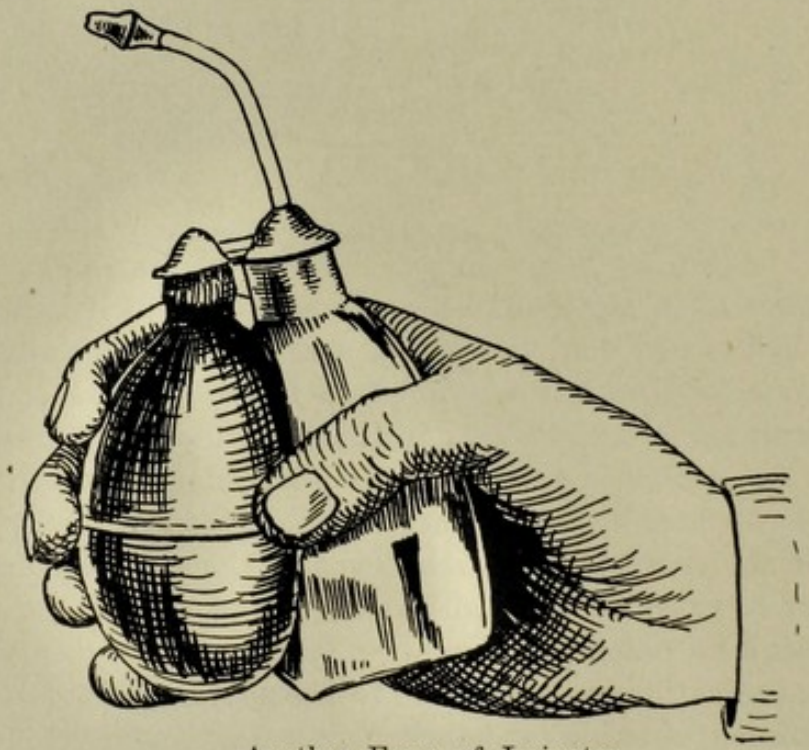
in this connection pertains to the opposite eye. If it is first cleansed and the patient be told to keep it open and look this way or that, the eye operated on will be found to follow the movements, and a helpful relaxation of the lids is the result. This simple means of securing the patient's co-operation is often neglected. Its value can readily be demonstrated to patients and to students by comparing the associated movements of the eyes to those of the fingers. It is very easy to extend or flex all the fingers of one hand together, but it is difficult to extend one and flex the others, or vice versa.

If an application is to be made to the eye, especially if it be painful, the patient should first be warned, lest an unexpected unpleasant sensation make him jump or squeeze the eye, with the possibility of disastrous results. Most solutions are distinctly less irritating if applied warm, and this applies to "drops." A very good way to warm these is to first fill the dropper with hot water, or better with a hot antiseptic solution, expel this, and then draw up with the dropper the desired quantity of "drops." By this means they are sufficiently warmed and are distinctly more grateful to the patient's eye than are cool or cold solutions.

In the after-treatment of ophthalmic operations wet or dry forms of hot applications may be used, the former being preferable, as a greater degree of heat can thus be obtained.



Todd's Irrigator

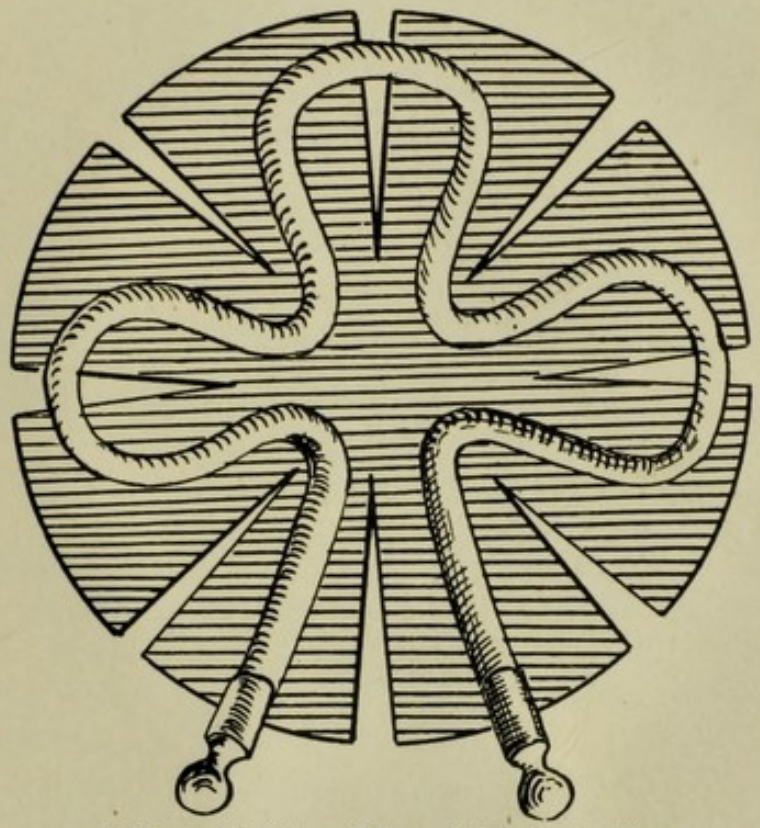


Another Form of Irrigator

Dry heat is applied with a hot water bag or bottle, Leiter's coil, with a Japanese hand warmer (hot-box), with a bag of sand or salt heated in an oven, or with an electric pad or electric lamp. The latter is apt to get too hot if an ordinary 10 or 16 C. P. lamp is used, but a lamp of smaller candle power, or one with a regulating attachment, like night lamps, and "Hylo" lamps, can be so regulated as not to get too hot. In applying dry heat with a hot water bag it is

well, on account of the weight, to have the patient lie with his face on the bag, rather than to lay the bag on his eye. Dry heat may be applied continuously.

Moist heat is applied by wringing a towel, pad of gauze or other cloth, out of hot water and applying it to the eye and surrounding parts. A cloth or pad only large enough to cover the eye would not



Leiter's Coil for Hot or Cold Applications

be so easily handled nor retain heat so well as a larger one. In the presence of a wound an antiseptic or sterile solution should be used instead of plain water, and the whole application made with due regard to surgical cleanliness. The pad should be renewed often enough to keep it hot, and it should be as hot as the patient can bear. Various devices have been arranged to keep the water hot at the bedside, particularly by means of a Bunsen burner or alcohol lamp and tripod, but hot water in a kettle will usually keep hot as long as needed, especially if it be placed on a fire in the room, or in a room nearby. Hot applications should be retained in place on the eye for ten or fifteen minutes at a time, or even longer if the effect is pleasant to the patient. They should be repeated every three to six hours. This all sounds somewhat empirical, but the desired effect is usually obtained when the applications are made in this manner.

Just as hot applications may be either wet or dry, so may cold.

Dry cold applications are made by means of an ice bag or Leiter's coil. The ordinary form of ice cap as used for applying cold to the head may be used, and has in its favor the fact that being of large size the ice does not melt quickly and the bag will remain cold a relatively long time. Smaller ice bags fit the ocular region more accurately, but the small amount of ice they hold quickly melts and

Dropper Fitting into the Mouth of the Bottle

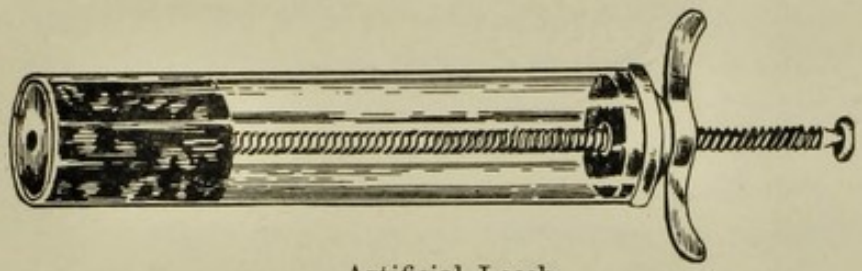
must be frequently replenished. Dry cold is generally applied continuously.

Moist cold applications are made by preparing half a dozen pads of gauze, two inches square and six layers thick, and by placing these on a block of ice. The block of ice should rest on a towel or cloth so arranged in a basin as to keep the ice free of the water which collects beneath it, and which would hasten the melting of the ice. The pad applied to the patient's eye is replaced by a fresh one as soon as it becomes the least warm. The number provided will insure a cold one being ready. These applications are usually kept up for 24 or 36 hours at a time, or longer.

Leeches are often used for the abstraction of blood from the temple in certain post-operative inflammatory conditions and the value of

the procedure is very great. Leeches are either natural or artificial.

Natural leeches, when they can be procured, are very efficient. The leech is removed from the water in which it is kept, and placed in a test tube or roll of paper, by which means the head is directed just where the surgeon wishes to apply it, the skin being previously cleansed. The application is usually made to the temple. If the leech does not readily take hold, it can be made to do so by putting a drop of milk on the skin, or by pricking the skin and drawing a drop of blood. From four to six leeches are applied and allowed to remain till they drop off, usually in half an hour. The little wound



Artificial Leech

may be permitted to bleed awhile, or the bleeding, which is sometimes quite free, can be stopped with pressure. Occasionally it is necessary to insert a suture to stop the bleeding. Leeches should not be used a second time, but fresh ones applied if the blood-letting is to be repeated.

Artificial leeches consist of two parts, a spring lancet or other device for making an incision, and a glass cylinder and a screw piston for making suction. Under antiseptic precautions the skin is incised and the cylinder applied over the wound. It is often difficult to secure sufficient blood with the artificial leech, and this, together with the fact that the glass cylinders are easily broken and the plunger of the piston apt to dry up and become useless, makes the artificial leech rather a troublesome instrument.

In addition to the remedies already mentioned, the principal drugs used in the after-treatment of ophthalmic operations are sedatives, laxatives and antiseptics.

The drugs used as sedatives vary with the absence or presence of pain. In the latter case it is generally better to give at once a full dose of morphine hypodermically, or codein, or some liquid preparation of opium internally. In case of restlessness, nervousness, or sleeplessness from other causes than pain, potassium or sodium bromide in 20-grain doses, with or without chloral; or trional, or veronal, should be given. If the psychic disturbance is of an hys-

terical nature, valerian is a most effective remedy. The patient's idiosyncrasies should always be inquired into, and if there is some favorite remedy on which he is accustomed to rely, it had better be given unless contraindicated. The sedative value of alcohol and tobacco under some circumstances should not be lost sight of.

In the case of laxatives it is well to consult the habits of the patient, especially if he be an adult. Most people need laxatives when confined to the house, and from the large number of salines, when it is decided to use this form of cartharsis, it is easy to select one. Epsom salts, Rochelle salts, Seidlitz powder, citrate of magnesia or any of the various aperient mineral waters may be employed, besides castor oil, compound carthartic pills, etc. Particularly agreeable to the taste, as well as efficient in action, are compound licorice powder and citrate of magnesia. Calomel should only be given for particular reasons, not merely as a laxative.

Antiseptic (q.v.) *and cleansing solutions* best adapted for use in the after-treatment of ophthalmic operations include:

Normal saline solution, .6 per cent.
Boric acid, 2 per cent.
Sodium biborate, 2 per cent.
Sodium bicarbonate, ½ per cent.
Bichloride of mercury, 1-1,000 to 1-10,000.
Formalin, 1-1,000 to 1-50,000.
Argyrol, 10-50 per cent.
Permanganate of potash, 3 per cent.
Carbolic acid, ½ per cent.
Thiersch's solution (salicylic acid, gr. xv,
boric acid, gr. lix to a pint).

All solutions should be made with hot sterile water, and filtered. They should be kept in closed sterile containers, preferably glass bottles or flasks.

Solutions used as drops should be dissolved in a sterile 2 per cent solution of boric acid, or, better, dissolved in the boric acid solution by boiling. This would not apply to any drug that would be injured by boiling, or to any drug not compatible with boric acid.

Powders, usually antiseptic in character, are sometimes used. Iodoform is not popular on account of its disagreeable and clinging odor, and less objectionable substances are preferable. Xeroform, aristol and acetanilid are satisfactory in their therapeutic properties and unobjectionable otherwise.

In speaking of the **treatment of complications after ophthalmic operations in general** it may be said that the signs of unfavorable

progress after operations are subjective or objective. We usually mean by "unfavorable progress in a wound," infection.

The subjective signs of operative complications are chiefly the presence or absence of pain. While more or less discomfort will follow any cutting operation on the eye, it is not usual, after the operations most commonly performed, for the patient to complain, or to require any special means for the relief of pain. Patients differ very much in their ability and willingness to stand pain, and equally as much in their conception of what constitutes pain, so that it is only exceptionally that any value can be attached to subjective signs as indicative of the unfavorable progress of a wound.

The objective signs, however, are definite and easily determined. In the case of incision of the skin and in operations requiring skin flaps, redness and swelling of the edges of the wound are the principal indications of unfavorable progress. It may be said here that owing to the rich blood supply of the region of the eye, wounds of the skin in its neighborhood heal quickly as a rule, and with little reaction.

The signs first seen, then, to indicate that the wound is not doing well, are redness and swelling of the edges of the wound. Unless checked, these processes will go on to suppuration, which more or less interferes with the objects sought by the operation. In the case of flaps and grafts, the implanted tissue may not live. This is indicated by the flap or graft assuming a dark or yellowish-gray hue, with subsequent loss of a part of it by sloughing, or by a drying or shrivelling process, usually the former. The general symptoms that accompany infection of a wound of the skin and soft parts vary very much. Usually they are moderate or absent, but if the infection is severe, or if erysipelas should develop, the general disturbance may be great. A peculiar danger that attends infected wounds of this locality is that of the infection traveling by way of the ophthalmic vein and its branches to the cavernous sinus.

The treatment of infected post-operative wounds of the skin and soft parts near the eye consists in the removal of sutures, the evacuation of pus and the application of a wet dressing consisting of gauze soaked in one-half of one per cent solution of carbolic acid. This should be covered with a layer of oiled silk to keep it moist, and changed daily or oftener. At each dressing pus and sloughs should be removed. When these have ceased to form, the wet dressing should be discontinued, and a dry one, composed of sterile gauze and cotton, used instead. The local treatment alone is usually all that is needed, but if there is any constitutional disturbance a

calomel purge, followed by supporting treatment of tonic drugs (iron and quinine) and nourishing diet, should be carried out.

Much is promised in the treatment of local infections from the use of injections of dead micro-organisms, the vaccines and bacterines. The subject is too extensive for discussion in detail here, especially as it is, at this time, scarcely beyond the experimental stage. The vaccine should be made of the same organism that is the cause of the infection, and is said to be most effective when made from cultures derived from the infected area itself. For further information on this subject the reader is referred to the admirable articles of Jno. E. Weeks, and under the heading **Seropathy** in this *Encyclopedia.*

If infection should follow an operation on the conjunctiva or muscles it should be treated on the same principles. After these operations, however, infection is extremely rare.

The occurrence of infection following an operation involving the opening of the ball is the most depressing and disastrous calamity that can befall patient or surgeon. The necessity for the early detection of this unfortunate complication, that measures to combat it may be instituted, constitutes a potent reason for early removal of the dressing and inspection of the wound after cataract extraction and other operations involving opening of the globe. The subjective symptoms are so variable as not to be reliable, and when to this is added the personal equation of the patient, who may complain bitterly of a little discomfort or not at all of a great deal, it will be seen how little we can depend on subjective symptoms to warn us of even serious trouble. This statement is to a certain extent true of the appearance of the lids; the degree of swelling in them is no positive index of trouble within the ball. The safest plan therefore is to remove the dressing and inspect the eye twenty-four hours after operation on the globe.

The lids, when exposed by removal of the dressing, will usually appear swollen and there will be some discharge from between them. It is thought that swelling of the lids near the inner canthus is particularly significant of intra-ocular infection or intense reaction, but it is seen quite often with only a moderate amount of reaction. On separating the lids a considerable quantity of thin, turbid secretion will usually escape. There is a moderate amount of conjunctival secretion as a rule, and abundant lachrymal secretion, which gives the discharge a thin consistency. The conjunctiva is found to be intensely injected and swollen. As a rule it projects around the edge of the cornea to a greater or less degree. The edges of the

incision, if in the cornea, show a grayish or yellowish infiltration, the whole cornea has a cloudy look, the aqueous is turbid and the iris discolored. The infection is usually derived from the lachrymal and conjunctival secretions, or from other extraneous sources, but if from within (an infected instrument or foreign body) the signs may at first consist in a deep-seated, yellowish discoloration in the vitreous, with intense injection of the conjunctiva. Later the iris becomes discolored, the aqueous turbid, and, finally, the cornea is infiltrated. As the infective process advances the cornea becomes more and more opaque and finally melts away or separates in a more or less consistent mass, as a slough.

The involvement of all the tissues within the eye in a purulent inflammation (panophthalmitis) is a most serious complication of operations. If the infection starts within the ball the cornea may resist and remain to the last, or it may become infiltrated and softened, starting from the wound and spreading across the cornea; or the infiltration may spread around the circumference rather than toward the center.

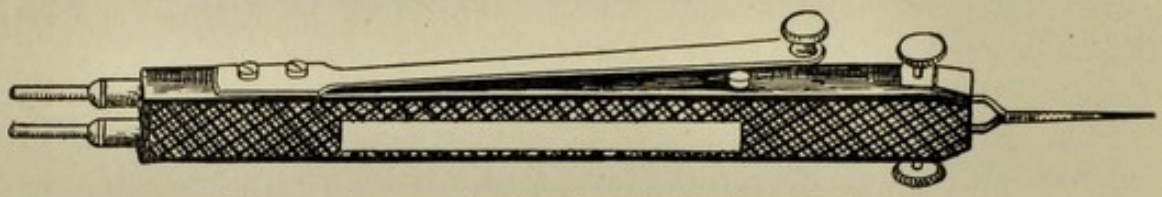
Since the treatment of such a condition is not encouraging, it might be well to dwell for a moment on the measures used to prevent it. First among these is careful inspection of the conjunctiva and the lachrymal apparatus, especially the latter, before undertaking any operation necessitating opening of the ball. Any disease of either should be cured if possible. If incurable lachrymal disease exists, the lachrymal sac should be removed, or the canaliculi may be tied off by passing a suture through each lid so as to include the canaliculus, as advised by Knapp, Buller and Casey Wood. In the presence of incurable conjunctival disease, with secretion, the conjunctiva may be incised all around the cornea, dissected loose from the ball, and after the completion of the operation proper, the cut edge can be caught up with a purse-string or other suture and brought up to cover completely the cornea. In four or five days the sutures can be cut, when the conjunctiva will resume its normal position. In the meantime the corneal wound will have firmly closed.

Redness and roughness of the conjunctiva are of much less import in this connection than the presence of secretion, whose bacterial contents should be carefully scrutinized. Besides attention to these points, the usual antiseptic precautions as to instruments, operator and field of operation should be minutely observed.

In order to guard against infection after cataract extraction J. A. White advises a careful routine, which is indorsed by others who have followed it. The most important feature of this preliminary

treatment is the use of a bichloride vaseline, 1-3000 (See **White's ointment**), with which the conjunctival sac is filled for twelve hours before the operation and the eye is dressed with the same preparation each time the bandage is removed.

Following the cataract extraction, *iritis* is not uncommon, as evidenced by pericorneal injection or more general redness, and by adhesion of the iris to the capsular remains. To combat this form of inflammation the pupil should be dilated with atropine as soon as the anterior chamber is reformed, and the atropine continued



Galvano-Cautery Handle for Use in Ophthalmic Surgery

at such intervals as may be necessary to maintain maximum dilation of the pupil. Dionin, with or without general remedies, is also of signal value. Post-operative iritis varies much in severity.

Irido-cyclitis, indicated by the severity and long duration of the inflammation, sometimes occurs, usually due to roughness in handling the eye at the time of operation. A healthy condition of the cornea and wound and the absence of pus in the anterior chamber should enable one to differentiate plastic inflammation from that due to infection, although some observers regard every post-operative uveitis as infective in character. The treatment is much the same as that employed for iritis, although in this connection one should bear in mind full doses of aspirin or the salicylates, given in the manner described by Gifford.

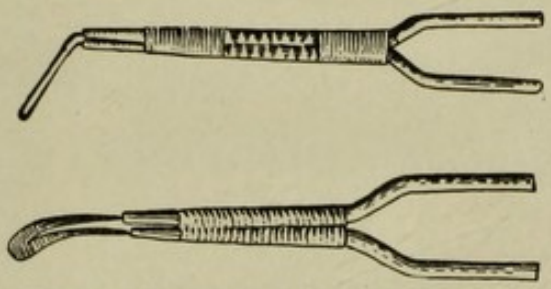
Another condition that is especially apt to disconcert an inexperienced operator is what is known as "striped" keratitis. This is a deep-seated corneal infiltration, manifesting itself as parallel gray lines and running from the wound towards or even beyond the center of the cornea. It is caused by traumatism to the cornea, and is probably always due to the operator making too small a corneal wound, and bruising its edges in the delivery of the lens.

When infection of the wound of operation develops, the question of treatment is important and urgent. The dressings should be permanently removed from the eye. It is a well-known fact that an occlusive dressing applied to an eye will increase or cause conjunctival secretion, and this is the reason for dispensing with the dressing.

Ice compresses should be applied continuously for at least 36

hours. This will require the entire time of one person and should be carried out as already described in this section. If at the end of 36 hours some arrest of the infectious process seems to have occurred, the cold applications may be continued, but this is a matter for the surgeon to decide. Cold applications are preferable to hot, in that the lowered temperature exerts an inhibiting influence on bacterial growth, though hot applications are preferred by some. The latter should be applied, as described elsewhere, for ten minutes at a time, every three hours.

The eye should be irrigated with an antiseptic solution at least every hour. Boric acid is probably the best, but bichloride and other salts of mercury, 1-5,000 to 1-10,000; permanganate of potash



Galvano-Cautery Points for Use in Ophthalmic Surgery

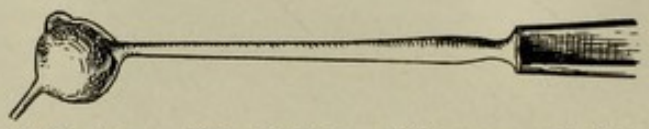
1-10,000; carbolic acid ½ of 1 per cent; formalin 1-1,000; have all been recommended. The last named is apt to prove too irritating.

The wound should be cauterized throughout its entire extent. The actual cautery is best, using the galvano-cautery or a simpler device, such as the Wordsworth-Todd cautery. A strabismus hook or probe heated in the flame of an alcohol lamp can be made to answer the same purpose.

In addition to these measures some antiseptic should be frequently instilled as "drops" into the eye. Argyrol, as a freshly prepared fifty per cent solution, is probably the best for this purpose. It is not irritating, and while laboratory tests do not give it high rank as an antiseptic, it is clinically one of the most efficient. It should be dropped into the eye after each irrigation.

The introduction of iodoform into the anterior chamber of vitreous is a measure advocated by Haab, Ostwalt and others. Experimental study carried out by the writer has not been very convincing in its testimony, but it seems worthy of trial. The iodoform is incorporated with gelatin, and made into little rods to facilitate its introduction into the eye. This is accomplished by means of forceps, either through the operative wound, or other opening, and should be repeated when the first rod is seen to be absorbed.

The injection of antiseptic solutions into the eye-ball, into the orbit, and under the conjunctiva, has been advised. The solutions are generally of some salt of mercury—preferably the cyanide [always associated with one per cent acoin (q. v.)] in the proportion of 1-3,000 to 1-1,000. This procedure is to be recommended, since it does not interfere with other treatment and some good results have been reported from its use. E. L. Jones injects under the conjunctiva 2 c.c. of 1-1500 cyanide of mercury in which is dissolved .03 of a powder composed of one part acoin, one part boric acid and four parts sodium chloride. This solution is said not to be painful, and its therapeutic virtues are highly praised. Bourgeois prefers the oxycyanate, 1-1,000.



Wordsworth-Todd Cautery. The Ball is of Copper and Retains the Heat. By Means of the Two Projecting Points the Application Can Be Accurately Made

It is unfortunately true that when infection involves an eye after the extraction of cataract, an iridectomy, or removal of a foreign body from the vitreous, the eye is nearly always destroyed in spite of all our efforts to prevent it. Therefore when the infective process has advanced to a point where, in the judgment of the surgeon, the destruction of the eye is certain, much time and suffering can be saved by evisceration or enucleation. It requires no small degree of moral courage to advise the enucleation of an eye on which one undertook a cataract extraction but a few days before, with every prospect of restoring the function to the eye, and possibly for this reason the operation is frequently not done under these circumstances. It is a question too, as to how much risk there is under these circumstances of enucleation being followed by meningitis from infection of the sheath of the optic nerve, but Randolph has recently shown that the risk is very small.

Although the complications that arise during or following the performance of ophthalmic operations in general will be dealt with under their appropriate headings, it is deemed advisable, even at the risk of repeating some of the matter detailed in other sections of this work, to mention here at least some of the special accidents and complications of the more common operations, and the measures at our command to combat them.

In the operations for *enucleation of the eye* (q. v.) it is usually advised to have the stump of one of the eye muscles, generally the

internal rectus, left long enough to afford a grasp for the forceps, whereby the ball may be subsequently steadied. If this is not done on this muscle, some other should be so left. Should this hold not prove sufficient the ball may be grasped with the thumb and finger, or it may be dislocated forward after the muscles are all cut, allowing the lids to close behind and hold it. Or a spoon, with a fissure in the bowl, may be passed under the ball and the nerve fitted into this fissure. In the case of phthisical eyes the best fixation is secured by passing a strong suture through the ball before beginning the operation and controlling the ball by means of it.

The eye ball may burst in removing it, especially if its coats are ulcerated or otherwise thinned. More careful dissection is called for to insure a clean removal, and if the contents of the ball are septic, infection of the operative field is more apt to occur. Extraordinary efforts at disinfecting the wound should be used.

Especially when the ball is collapsed, but even under ordinary conditions, the scissors may button-hole the sclera in dividing the muscles, or in cutting the optic nerve. Except that the subsequent steps of the operation are more difficult and tedious, no special harm is apt to follow, though a bungling operation is a source of chagrin to the operator. If a piece of sclera is cut out from the posterior pole of the eye in attempting to sever the nerve, it had best be searched for and removed, together with a section of the nerve.

It may happen that in tenotomy and advancement of ocular muscles the surgeon fails to penetrate the capsule of Tenon and to pass the hook beneath the tendon of the muscle, but pushes it between the conjunctiva and capsule, where it meets little or no resistance. With the bloodless field made possible by the suprarenal preparations this is not apt to happen, but it is a possibility to be borne in mind by the beginner.

The most common complications in muscle operations pertains to the stitches cutting out of both muscles and sclera. Many ingenious methods exist for placing sutures in the muscular tissues so they will not cut out, the best being some plan of tying the suture, as in the Worth operation. Scleral anchorage is more of a problem. Sutures passed deeply and at right angles to the line of traction are most secure. By bringing the muscle forward and attaching it to the scleral stump of the tendon, a secure fastening is easily obtained, and in the proper position on the ball. Many operations (e. g., Hulen's) prepare for the contingency of the suture cutting out by having additional or secondary ones placed to tie in case of need. Some such plan is very desirable until a method is devised that will prevent this complication from arising, as without it the only

thing is to watch the eye slowly return to its original faulty position to be corrected by a fresh operation.

The tearing out or breaking of a suture at the time of operation may be avoided by care or remedied by the introduction of fresh sutures.

It is important in these and other operations where sutures are employed that no knot or end should touch the cornea, as corneal ulceration may be thereby induced, with the possibility of most disastrous results.

Operations involving corneal incisions may be complicated by a variety of accidents.

Wrinkling of the cornea may occur in old people. When the chamber refills the cornea resumes its normal shape, and this accident need occasion no alarm.

A bubble of air may enter the chamber. It will disappear, or may be stroked out with a spatula just as blood and cortical matter are removed. If let alone it will be absorbed.

Prolapse of iris into the wound may occur, either with the iris simply engaged in the wound or projecting through it. If let alone this condition may result in a distorted pupil, irregular healing of the wound, iritis, infection, immediate or remote, glaucoma or sympathetic ophthalmia. An attempt therefore should be made to replace the iris by manipulation with a spatula. In this way the iris can often be replaced, and a round pupil and a free wound secured. If from the size or position of the wound, or other reason, the iris will not remain in place, but continues to prolapse, it should be grasped with forceps, drawn out a little from the wound, and then cut off. Unless it is drawn out from the chamber a little it may be found that the pillars of the coloboma (cut edges of the iris) are as unruly as the original prolapse, and cannot be replaced within the chamber.

Should this be the case, or should an excision of the iris have been the original operation, and prolapse of the cut edges appear, the edges should be repeatedly replaced by passing a spatula through the wound and onto each half of the iris in turn at as near right angles as possible with the edge of the iris wound. By moving the spatula toward the center of the pupil the iris is unfurled and spread out smoothly, and will usually remain so. Otherwise additional pieces must be removed from the pillars until they will remain in place.

If some of the iris remains in the wound, we have the condition resulting as hernia or "healed-in-iris." Sometimes this causes a permanent dark spot in the line of the wound, and sometimes the

scar is white throughout, as if no iris was caught in the wound. Such a scar is firm, not unsightly, and not a cause of trouble, and can result from a very considerable prolapse. On account of the possibility of this favorable termination, a prolapse of the iris that cannot be cleanly excised or satisfactorily replaced on account of adhesions that have formed between the iris and the edges of the wound through which the knuckle of iris protrudes, may be let alone. Other alternatives are incision of the prolapse with a knife, or cauterization with the actual or chemical cautery, both of which plans tend to produce a flat white scar.

There may be delay in the closure of the wound. This is usually due to the inclusion of a portion of iris or lens capsule or lens matter between the lips of the incision. Careful toilet of the wound should prevent this, or if it occurs some such cause should be carefully searched for with a magnifying lens and good illumination, and removed. Occasionally a corneal wound will be slow to unite without apparent cause.

The wound, once closed, may reopen. This may occur as the result of increased intra-ocular tension, or from pressure on the eye. The dangers of such an accident are hemorrhage, prolapse of the ocular contents and infection. Rest is the principal agent in bringing about a closure of the reopened wound.

In making a corneal incision the knife may not penetrate the whole thickness of the cornea, but pass between the layers, splitting the membrane. The incision must be made over.

The incision may be made too short for the performance of the contemplated operation. It may either be enlarged with scissors or a blunt-pointed knife, or the operation postponed.

Besides the complications enumerated as occurring with incisions of the cornea, there are a few others that pertain to an iridectomy. Hemorrhage into the anterior chamber has been mentioned.

Detachment of the iris may occur, usually as the result of some unexpected movement of the eye after the iris is grasped with the forceps. As clean an excision of the fragments as possible must be made, and especial care exercised to see that no tags remain in the corneal wound.

The iris may be button-holed, and the sphincter left, instead of a section of the whole width of the iris being removed. This can be avoided by grasping the iris at the pupillary margin with the iris forceps preparatory to its excision. Should the little bridge be left,

it can be engaged with a blunt hook, and either broken or drawn out and cut off.

Premature escape of the aqueous may in cataract extraction not interfere much with the operation, but if it occurs before the counter-puncture is made it may be necessary to postpone the operation until the anterior chamber reforms.

The iris may be caught on the point or edge of the knife blade. If it cannot be disengaged the incision should be completed regardless of injury to the iris, which can be subsequently trimmed up to make a neat iridectomy.

The knife may be entered upside down. If the blade is narrow it can be rotated to the proper position, or it can be withdrawn and the operation postponed.

Choroidal hemorrhage may occur at any time after the corneal incision. It is due to rupture of the choroidal vessels when their support is removed following the emptying of the anterior chamber. The patient experiences pain, depression, shock and sometimes vomiting. The wound gapes and vitreous and then blood flow from it. This may immediately follow the corneal incision, or may come on several hours later. Treatment is of no avail and the eye is always lost.

Prolapse of the vitreous may occur, either before or after delivery of the lens. If before the delivery of the lens, the vitreous (and iris) which has prolapsed should be excised, and the delivery of the lens effected with as little pressure on the ball as possible. It is usually best to deliver the lens under these circumstances with a wire loop or lens scoop.

If the lens has been delivered and the vitreous prolapses, the speculum or lid elevator should at once be removed, the lids closed and eye left quiet for a moment. Loss of vitreous is often due to muscular spasm, in which event the recti participate, and if all disturbing influences are removed the spasm may subside, and the prolapsed vitreous recede. Otherwise it should be excised as close to the ball as possible, and the toilet of the wound gently completed.

The lens may be dislocated during extraction, especially in cases of fluid vitreous. Should this occur it is usually best to wait a while, and if the lens does not reappear in the pupillary space, to close the eye and apply a dressing. It is said that the cataract will sooner or later reappear in the pupillary space, and may then be extracted.

The lens may be expelled by the patient "squeezing"—orbicular spasm—at any time after the corneal section. Often this is accompanied by prolapse of the vitreous.

The accidents most apt to happen in connection with excision of the lachrymal sac are failure to locate the sac and rupture of the sac during its extraction. The first can be avoided by locating the lachrymal crest and cutting down on it. It is a sharp ridge of bone that forms the anterior boundary of the groove in which the sac rests.

Rupture or puncture of the sac during the exposure is an unpleasant accident, as the contents thereof, often purulent, may infect the wound, and the clean removal of the sac is made less easy. If any of the mucous membrane lining the sac is left behind, a new sac will form from it. It should be the surgeon's object, therefore, to remove the sac intact, which is accomplished by careful dissection, and with dull dissectors. Should rupture occur, thorough disinfection of the wound is necessary, and after as clean a removal of the sac as possible, the whole cavity should be curetted. It will probably then he best to pack the wound with gauze and have it heal by granulation.

It may be stated here that wounds of the eye and its appendages (operative and other) are treated on the same principles of surgery that should govern the treatment of all wounds, namely, cleanliness, restoration of parts to their normal positions and fixing them there, and the removal of hopelessly damaged parts.

The post-operative conduct of the removal of foreign bodies is fully described in the section on **Injuries to the eye.**

For the treatment, primary and secondary, of lid wounds, if they are extensive or when they occur in children, it may be best to give a general anesthetic especially if it is necessary to apply dressings. The parts should be thoroughly washed with soap and water, applied with gauze or cotton and not with a brush, and if greasy, as after some accidents in factories, a preliminary cleansing with sweet oil should be carried out. It has been pointed out by Crile that the hands of those working in grease and oil require much effort to cleanse them, and since the grease and oil are not in themselves particularly objectionable, it is best not to try to remove them at all, as the tissues will be subjected to further bruising and the end sought will probably not be attained. This might be borne in mind when similar conditions are present about a wound of the lids. In cases where such a state of affairs exists, the antiseptic qualities of tincture of iodine can be employed to great advantage. The free application of this substance to wounded and lacerated tissues where infection is feared, is easily made, not objectionable in any way, and most efficient. It is to be highly recommended.

Careful search is to be made for foreign bodies in the lids, especially when the nature of the injury renders the presence of one possible.

It is rarely necessary to condemn and remove any flap or tag of the wounded lid tissues; all parts should be carefully cleansed and replaced. The wounds should be closed with silk, using either the interruted or the continuous stitch. The former stitch is preferable, as being more adaptable and permitting of a part of it being removed without affecting the whole line of suture. If the wound involves the lid margin, especial care is necessary to secure accurate apposition of the wound edges. It is better to employ a stitch which will penetrate the lid substance from its free border and lie, when tied, parallel to and just within the row of lashes, rather than to rely on stitches passed through the skin of the lid. The importance of using fine needles and suture material is appreciated by ophthalmologists, but general surgeons are prone to endanger good cosmetic results by the use of material that is too clumsy for delicate work. Stitches should be removed early, that is in 24 or 36 hours. They are foreign bodies, a source of irritation and infection, and should be dispensed with at the earliest possible moment. Their use can sometimes be dispensed with by employing, instead, narrow strips of adhesive plaster.

Wounds of the conjunctiva and sclera are treated on the same principles. It is often possible by suturing the overlying conjunctiva to avoid scleral stitches, but when necessary a fine suture, not passing entirely through the sclerotic, can be used to advantage. In general the margins of linear scleral wounds, like corneal wounds, are kept in apposition by the action of the lids, and do not need sutures. Especial care should be exercised in the case of scleral wounds to see that none of the ocular contents remain in the wound. If portions of the iris, vitreous humor or ciliary body should be so engaged, they ought to be replaced with a spatula, or if this is not possible, the prolapsed part should be excised. If the wound of the sclera tend to gape and expel the vitreous, or if the vitreous has prolapsed or presents in the wound, the scleral wound should under such circumstances be closed with a stitch or a conjunctival flap. This is important on account of the great danger of infection of the vitreous occurring when it is exposed.

Corneal wounds are apt to be accompanied by prolapse of the iris. This hernia should be carefully replaced with a spatula. By manipulation with the same instrument the edges of the wound

should be brought into the best possible apposition. If a prolapsed iris is torn, or will not remain in position when replaced, it should be drawn out a little from the wound and cut off. The iridic stump is then replaced.

Ordinarily one must rely on the lids to keep, by their pressure, the edges of a corneal wound in position, as it is seldom wise to suture a corneal wound. Corneal stitches should be made with a fine suture and a round needle, but if the corneal wound is very extensive and tends to gape, it is best to free the conjunctiva over a sufficiently large area and make a flap, which can be drawn over the cornea. By freeing the conjunctiva all around the edge of the cornea, it can be raised and brought together so as to completely cover the cornea and without undue tension. When the stitches are removed the conjunctiva will resume its normal position, there being little tendency for it to adhere to the corneal wound.

In wounds affecting the eye-ball cleanliness should be secured on the lines laid down.

The eye is often injured by burns of hot metal, powder, etc., and by caustics (chemical burns), such as lime (mortar) and acids. These injuries are always the cause of anxiety, since vision may be impaired from the resulting scar if the cornea is burnt, while scarcely less unfortunate are the results produced by cicatricial contraction after burns of the conjunctiva and lids.

The treatment consists in the removal of the offending substance, and its neutralization in the case of caustics. If a caustic alkali is the cause, the eye should be washed with milk. If lime, the eye should be flooded with oil, and then a solution of cane-sugar dropped into it. Acids should be neutralized with alkalies. When this is thoroughly done and all foreign substances removed, the treatment is along the usual antiphlogistic lines. If the cornea is deeply burned an opacity will result, and if the conjunctiva is burned, an adhesion of the lid to the ball (symblepharon) is to be feared. If the fornix conjunctivæ is involved in the burn, a symblepharon is almost sure to follow. It can be subsequently remedied by operation.

In dealing with the important matter of post-operative dietetics we are not confronted with such problems in the post-operative feeding of ophthalmic patients as are met with in abdominal operations, for instance, and the question is, on the whole, simple. If the patient has taken a general anesthetic, no food or drink should be given until the stomach is quiet and the nausea and vomiting have ceased. The stomach can then be tested with a teaspoonful

of ice water, and if this is retained, water may be more freely given, as well as milk, broths, etc. Solid and semi-solid food should be withheld for 24 hours. After that time, or from the completion of the operation if a general anesthetic has not been required, the patient should be put on a light diet, such as milk, cereals, eggs, soup, etc., with a few vegetables, and little or no meat, until he resumes his usual activity. In case the operation has involved the interior of the eye-ball, food that requires much chewing is usually to be avoided until the wound in the ball has closed, since the motion of chewing may disturb the eye and lids a little. Except for such precautions as are usually taken in the way of avoiding articles known or apt to cause gastro-intestinal derangement, and in the temperate employment of all kinds of food, the question of a post-operative dietary calls for no special consideration.

A question one is often called on to consider is that of the use of tobacco and alcohol after operations on persons addicted to their use. This decision should largely rest upon the amount of disturbance their withdrawal is likely to produce. If the craving is great, it is better to allow the stimulant and let it be used openly, safely and moderately, than, as may be the case, secretly, immoderately and in a clumsy or otherwise unsafe manner. The same may be said of the use of narcotic drugs by patients who are habituated to them.—(E. C. E.)

After-vision. Perception of an after-image (q. v.).

Agamodistonum. This is a small, trematode worm that is occasionally found in the human body, and may affect the eyes. See **Ocular parasites.**

Aganoblepharon. (L.), n.n. (Obs.) Celio's name for abnormal adhesion of the eyelids.

Agar-Agar. n. A substance resembling isinglass made from a sea-weed found in India. It appears in commerce as colorless strips, is very soluble in water and forms a thick jelly, which is used as an article of food in the East Indies. It is largely employed in laboratory work as a medium for cultivating certain bacteria.

Gifford and Suker have used agar-agar injected into either the eviscerated eyeball or into the orbit after enucleation. Both observers agree that the advantage—that of providing a pad or stump for an artificial eye—is only temporary.

Agaric. n. A genus of fungi, including mushrooms and toad-stools.

Agaricus stercorarius, Oculo-toxic symptoms from. Reports of cases of poisoning with this fungus are rare; detailed accounts of eye symp-

toms are still rarer. The following case history resembles that of intoxication from *Amanita muscaria* (q. v.). One-half hour after eating a meal containing this agaricus, nausea, frontal headache, and dizziness occurred. When the patient tried to walk he looked toward the ground and walked with difficulty. Consciousness remained, but attempts to read failed, because the print could not be recognized. More than three hours after eating the mushrooms a soporose condition set in, accompanied by wide, fixed pupils, and then the patient walked about as if he were intoxicated, and he did not seem to recognize his surroundings. Recovery in a day or two.

Agastya. An ancient East Indian physician of unknown date, who is said to have written 38 treatises, "embracing the whole sphere of medicine."—(T. H. S.).

Agate-glass. A variegated glass made by melting together waste pieces of colored glass.

Agati grandiflora. An East Indian tree, whose flower juices are used for dimness of vision.

Age, Changes in the eye due to old. There are many senile changes in the eye that are not generally indicated, at least not by marked functional disturbances. Without special importance from this standpoint are gradual loss of the luster of the cornea, formation of the arcus senilis, shallowing of the anterior chamber, contraction and decreased motility of the pupil (due to rigidity of the iridic tissues), a stronger light reflex from the lens, yellowish tinge of the lenticular nucleus (due to increasing density of the fibres), as well as colloid deposits on Descemet's membrane, on the anterior capsule of the lens and on the vitreous lamella of the choroid. Of still greater moment are decreased transparency of the vitreous humor (with occasional floating opacities) as well as fluid vitreous with detachment and contraction of the latter.

Weakness of the zonula may lead to displacements of the lens, and there may set in cystoid degenerations of the inner granular layer of the retina, and other changes that are necessarily accompanied by decrease in visual acuity. The defect in vision is, of course, more strongly marked if decided opacities of the lens develop, or if sclerosis of the retinal and choroid vessels sets in, and especially if a degeneration of the choroid and retinal tissues supervene. It must not be forgotten that the cerebral portions of the visual apparatus may be damaged by arterio-sclerosis and that, finally, paralysis of the eye muscles, due to lesions about the nuclei of the motor nerves, may occur.

Agenesia. (L.), n.f. Defective development of a portion of the body.

Agenesis corticalis. See **Amaurotic family idiocy.**

Agerasia. (L.), n.f. A hale old age, i. e., without the feebleness usually accompanying it.

Agilops. (F.), n.f. An obsolete term for lachrymal fistula or an abscess that has opened externally.

Aglaukopsia. Achloropsia. Green blindness, or as Hering more properly puts it red-green blindness.

Aglia. (Obs.) A speck or spot upon the cornea or sclera.

Aglobulie. (G.) Diminution of red blood-corpuscles.

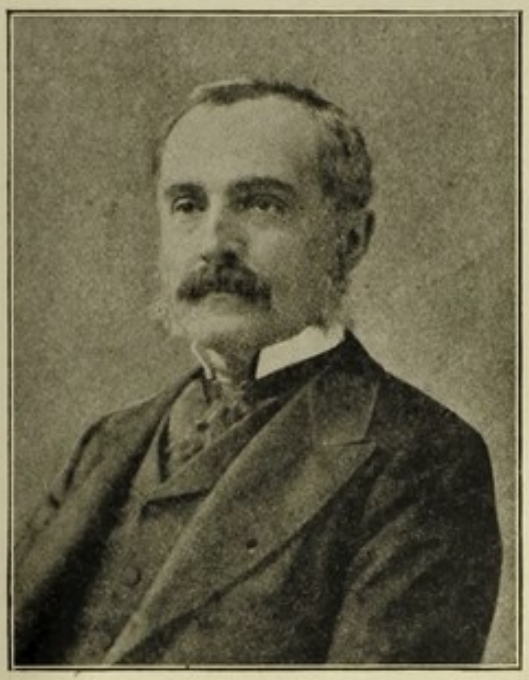
Agnew, Cornelius Rea. This well-known surgeon was born in New York City, Aug. 8, 1830, and died there April 18, 1888. He performed in that city the greater portion of his work. His ancestors, Huguenot, Irish and Scotch, came to America from time to time during the eighteenth century. His father was William, his mother, Elizabeth Thomson, Agnew.

When fifteen years of age, he entered Columbia College—an institution which, in after years, was to owe much to his labors—and, at the age of nineteen, received therefrom the degree of bachelor of arts. In the same year he began to study medicine—after the fashion of the time—with a preceptor, Dr. J. Kearney Rogers, who for many years was surgeon to the New York Hospital and to the New York Eye Infirmary, as well as Professor of Anatomy in the College of Physicians and Surgeons. In the last-named institution the subject of this sketch attended the regular course, and, in 1852, received his professional degree. Serving for a year or more as house surgeon in the New York Hospital, he proceeded, in 1854, to what were then the western wilds south of Lake Superior. There for about a year he practised in a village which is now Houghton, Michigan.

Receiving without solicitation the appointment of surgeon to the Eye and Ear Infirmary of New York City, he returned to his native town early in 1855. Soon, however, he sailed for Europe to prepare himself still further for the arduous duties of his new position. This he did solely on his own initiative, and because of the deep conscientiousness for which he was ever noted.

He did not, however, while abroad, confine his attention exclusively to the study of ophthalmology and otology. In Dublin, for example, though he studied under William (afterwards Sir William) Wilde, deviser of "Wilde's Incision" for mastoid abscess, he be-

came, at the same time, a resident pupil of the lying-in asylum. In London, a little later, though he studied under William Bowman and George Critchett, he devoted much attention to general medicine and general surgery. Finally, in Paris, where his masters in ophthalmology were no less personages than Sichel and Desmarres, he found time to attend the clinics of Velpeau and Ricord.



Cornelius Rea Agnew.

Returning to New York late in 1855, he entered upon a career as general practitioner, and soon was appointed surgeon general of the state. Three years later, he was appointed medical director of the New York Volunteer Hospital.

In 1856 he married Mary Nash, daughter of Lora Nash, a New York merchant.

In his later years Agnew devoted himself exclusively to diseases of the eye and ear.

Dr. Agnew was a man of strongly marked and wholly natural executive ability. Hence it was that, first and foremost, he was a founder of institutions. He was one of four to start the Union League Club of New York City. He assisted, in 1864, in organizing the School of Mines of Columbia. In 1866, at the request of the entire faculty, he established an ophthalmic clinic in the College of Physicians and Surgeons of New York. Two years later he brought into existence the Brooklyn Eye and Ear Hospital, and, the following year, the Manhattan Eye and Ear Hospital of New York. He

was also one of the founders of the New York Ophthalmological Society.

In 1869 he was elected to the clinical professorship of diseases of the eye and ear in the College of Physicians and Surgeons—a position which he held till his death.

Agnew's contributions to ophthalmic literature and his inventions are numerous and valuable. He devised, for example, an excellent operation for divergent strabismus, which he described in detail in the *Transactions of the American Ophthalmological Society,* for 1886, p. 31, under the title, "A Method of Operating for Divergent Squint." His "operation for thickened capsule" is also an important procedure, often described today by European ophthalmologists even in their smaller manuals.

As a lecturer, Agnew was always simple, clear and interesting. According to one of his assistants, Chas. H. May, of New York, "In his first lecture, I remember, he always laid stress upon the necessity for the ophthalmologist being observant, and he regularly illustrated the difference between *seeing* and *observing* by the following anecdote: A man was preparing to end his day's work one summer afternoon and found that he had allowed comparatively little time for catching the boat which connected with his train. He hastily closed up his office, and rushed to the pier. He saw the ferry boat in the slip, with a space of one or two feet between the boat and the slip. He made up his mind that he could just catch the boat by running. He ran, and, giving a final jump, landed on the boat, knocking down one or two passengers at the same time. Picking himself up, he was accosted by one of the passengers whom he had inconvenienced, with the remark: 'You big goose, the ferry boat is coming in, not going out.' Agnew used to lay stress upon the anecdote, saying that the man saw the ferry boat and the fact that it was not in the slip, but he failed to observe that it was coming in and not going out."

Dr. Agnew was a man of slender build and middle height, dark-eyed, dark-complexioned, and, when the present writer knew him, with the remains of a raven blackness still lingering in his rapidly whitening hair. He was gently dignified in manner and, even in serious conversation, had a way of smiling softly from time to time, as if a pleasant undercurrent of thought were playing beneath the more immediate matter. The present writer recalls with a kind of poignant gratitude the fact that his own fast-failing, but afterwards excellent, eyes, were tested for the first time by this careful and courteous physician. He recalls especially the manner in which,

when he had received from Dr. Agnew's hands the folded bit of paper containing the results of the test, he was taken gently by the shoulders, while a pleasant voice observed: "Young man, be there in you much or little, the glasses which you will get in accordance with this prescription will certainly prove to be a kind of turning-point in your life." Then—that characteristic smile.

Agnew was a very religious man, and took an abiding interest in things pertaining to the welfare of the church. He was never intolerant, however, but, as in his scientific labors, was thoughtful, earnest, careful never to offend and more attentive by far to the duties which he himself had to perform than to looking up defects in the services of others.

He was a tireless worker, a successful organizer, a profound scientist, a truly great man.—(T. H. S.)

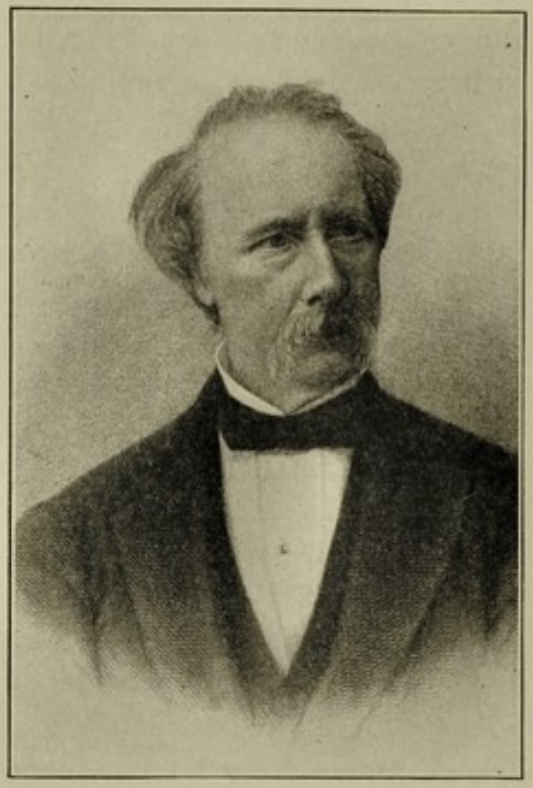
Agnew, D. Hayes. One of the greatest of American surgeons, and, for one engaged in general work, an excellent ophthalmologist. He was born in Nobleville (now Christiana) Penna., Nov. 24, 1818. He studied medicine with his father, a physician of considerable importance locally, entered in 1836 the Medical Department of the University of Pennsylvania, and in 1838 received his degree from that institution. In 1844 he entered commercial life, made therein an exceedingly dismal failure, as those of scientific tendencies are wont to do, and, in 1847, returned to the practice of medicine. His rise to general popularity, as well as to renown among his fellows, arrived very slowly, but came, as a matter of course, to stay. Unrivalled as an operator, he was also an impressive teacher and a clear and forceful writer. "Brilliant" is hardly the word for any of the accomplishments of Dr. Agnew. Though all he did was interesting and though he possessed an extremely attractive personality, yet the salient characteristic of his performances in every division of his work was thoroughness, solidity.

His *magnum opus* was *"The Principles and Practice of Surgery,"* in three volumes—which appeared from 1878 to 1883. Concerning this work Agnew's greatest (but sincere and outspokenly generous) rival, Samuel D. Gross, remarked to its author, "You have produced a great and noble work, one creditable alike to yourself, your profession, and your country."

Ophthalmology received in this masterpiece of Agnew's, a clear and comprehensive treatment, one that attracted the favorable attention of all the ophthalmologists of the day. In addition to this memorable service in his chosen field, Agnew was undoubtedly one of the past masters of operative oculists. Few have ever performed

an operation on an eye with better judgment, greater gentleness, or more extreme precision. He was one of the surgeons to the Wills Eye Hospital from 1866 to 1868.

Dr. Agnew was straight, tall, and impressive. His height he is said to have had in common with other members of his family. His father is declared on good authority to have been the shortest of seven brothers, though he was six feet two, the tallest being six feet seven. Agnew was quiet and unobtrusive in his ways, but forever cheerful, sometimes actually genial, and invariably col-



D. Hayes Agnew.

lected and calm. Nothing, in fact, ever disturbed the cool placidity of Agnew, unless it was, when manufacturing a gentle, friendly joke—a sly, cunning, good-natured dig, that left behind a feeling of endearment rather than any sort of hurt.

In the operating room Dr. Agnew wore, as a rule, a very old linen duster, buttoned close up in front, and, as a matter of course, very clean, but, even in front, very patchy, and ragged and disreputable-looking behind. Former students of the great surgeon inform me that their memory of the man is inseparable from his "operating duster."

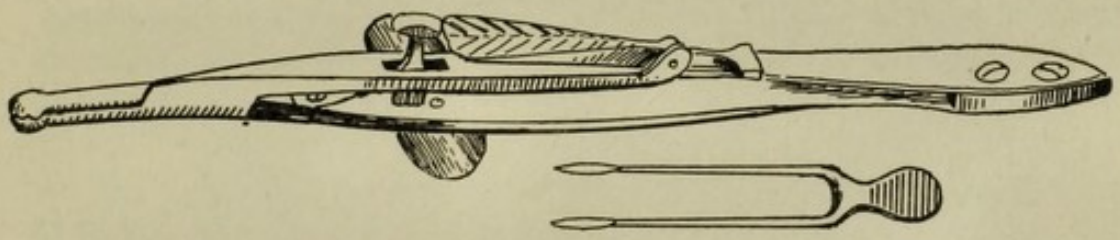
Agnew came before the country prominently as one of the physcians in the case of President Garfield.

Agnew died Mar. 22, 1892.—(T. H. S.)

Agnew's advancement operation. In this procedure the operator made a horizontal incision beginning 2 mm. from the nasal margin of the cornea, and extending to the semilunar fold. This was carried down to the sclera and muscle to be advanced. A strabismus hook, with an eye drilled in its free extremity, and armed with waxed silk, was then swept beneath the upper edge of the tendon, going far enough back to include every straggling band; and the ligature so introduced was tied close to the insertion in the sclera. A free tenotomy was done on the opposing external rectus muscle. The tendon to be advanced was raised by the ligature placed around it, and was divided at its insertion. Two retentive sutures were now introduced through the tendon far enough back to produce the advancement desired, and to take a firm hold rather deep in the muscle. The needles were passed from the conjunctival to the scleral surface of the tissues, one near the upper, the other near the lower margin of the tendon. After these were placed, the end of the tendon included in the ligature was cut off. The ligature served to hold the tendon, which can be more conveniently done by the Prince's advancement forceps.

Then each needle was carried beneath the conjunctiva, above or below the cornea respectively, so as to take a firm hold in the sclera and emerge about 2 mm. from the corneal margin in the vertical meridian. Both sutures were drawn up before either was tied. —(E. J.)

Agnew's bident. For the extraction of lenses freely floating in the vitreous humor, various methods have been proposed. Agnew (An



Agnew's Bident for the Extraction of Dislocated Lenses.

Operation with a Double Needle, or Bident, for the Removal of a Crystalline Lens dislocated into the Vitreous Chamber. *Trans. Am. Oph. Soc.*, 1885, p. 69.) used a bident (see the figure), passed 6 mm. from the limbus through the sclera, with which he harpooned the lens. The latter was then pushed into the anterior chamber and extracted through a corneal section made below with a keratome.

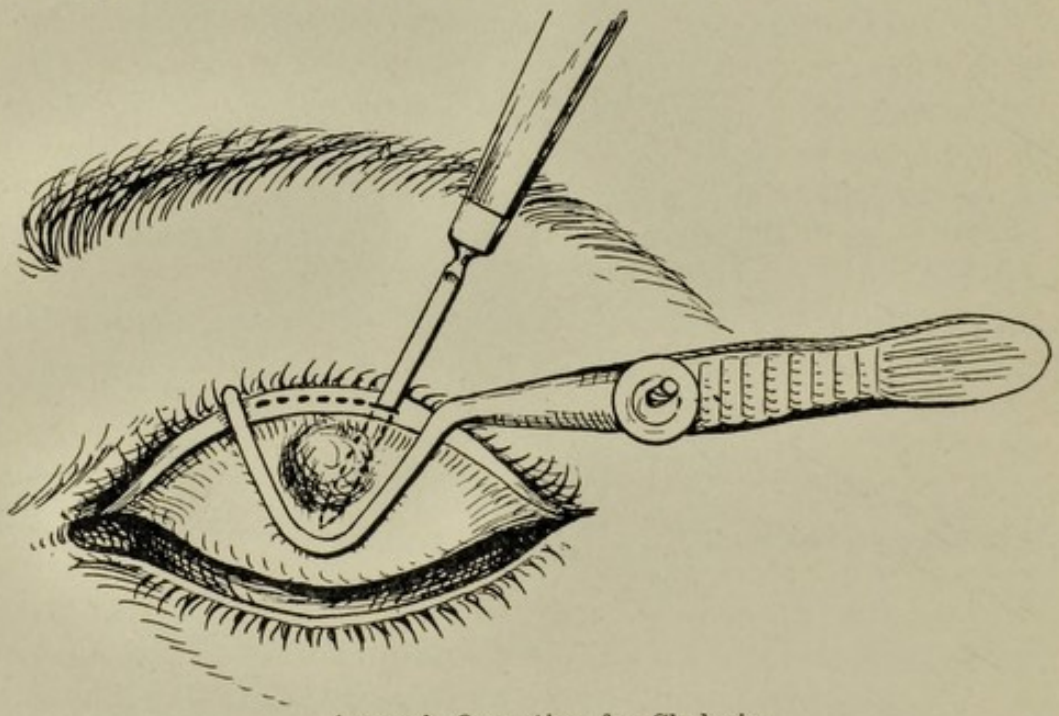
Agnew's procedure was imitated successfully by Webster and

Pomeroy. Noyes placed the patient on a table, resting on his chest and abdomen, face downward. He then passed a cataract needle through the sclera, transfixed the lens and extracted it.—(P. A. C.)

Agnew's enucleation operation. Agnew's method of enucleation, as described by Beard, is essentially as follows:

After making the circum-corneal incision, and undermining the conjunctiva, the superior rectus is caught by a strabismus hook and cut. Before freeing the point, however, another hook is passed under the internal rectus tendon, thus keeping the globe fixed from time to time by the hooks instead of forceps, as muscle after muscle is severed. Enough of the external rectus is left attached to the globe to serve as a handle, to be held by the forceps, so that the eye may be pulled toward the nose, in order to bring the optic nerve and oblique muscles into prominence, to facilitate their severance by the scissors.—(F. A.)

Agnew's chalazion operation. The eye is cocainized, and with a fine hypodermic needle a drop or two of 1 per cent cocain solution



Agnew's Operation for Chalazion.

is injected into the growth and the tissues at the margin of the lid where the incision is to be made. The injection will be facilitated by the use of a Wilder's U-shaped clamp, placed on the lid over the chalazion after the eye has first been cocainized. After the clamp is fixed, the fine hypodermic needle can be passed between the blades into the tissues of the lid margin. The clamp prevents the cocain from getting into the general circulation and limits its action to

the part to be operated on. In two or three minutes the tissues are completely anesthetized, and if the growth is in a part of the lid that can be seized between the thumb and finger, the clamp may be removed; if not, it may be left in place as a means of holding the lid and giving a bloodless field. (See figure.)

Holding the lid between the finger and thumb so as to give a clear view of the lid margin, a Graefe cataract knife, or a Beer's knife, is then passed through the middle of the lid margin into the tumor. The margin of the tarsus must be accurately split, the incision being of such a length as to include all the diseased Meibomian glands. The knife is then withdrawn and most of the contents of the chalazion follow it, but the lid should still be held firmly between the finger and thumb. A small curette with serrated edges is then introduced into the wound, and the walls of the cavity are thoroughly curetted. During the incision and the curettement, the surgeon's finger and thumb form a perfect guide, as they can feel every motion of the instruments in the tissues.

When all the contents have been removed, light pressure over the cavity is maintained for a few minutes to prevent it from filling with blood. A light pressure bandage is then applied which may be removed the next day.

The operation, when performed in this manner, is painless and no visible scar remains.—(W. H. W.)

Agnew's operation for secondary cataract. See **After-cataract and its treatment.**

Agnew's peritomy operation for pannus. The severed portions of the conjunctiva are pushed backward to a distance of five millimeters by means of a convex-edged scalpel. With the same instrument, the episcleral tissue is also scraped away till the sclera is quite bare, and, where practical, the scrapings are excised. The larger trunks of the corneal vessels are gently scratched longitudinally with the point of the knife, or, what is perhaps better, each of them is touched where it crosses the limbus with a small, red hot, bulbous electrode. No clots of blood nor shreds of fibrin should be left about the field of operation.—(C. A. O.)

Agnivesa. An ancient East Indian physician and priest, of unknown date. From him it is said that Charaka (one of our two chief authorities for ancient East Indian medicine—including, of course, ophthalmology) drew the material for his medical treatise, entitled "Ayur-Vida," or "Science of Life."—(T. H. S.)

Agnoea. (L.), n.f. Loss of perceptive power from disease. Also written **agnoia.**

Agnosia. Loss of the power or ability to recognize persons and other objects.

Ago. (It.), n.f. A needle.

Agrammatism. n. A form of aphasia in which the person is unable to form words grammatically and to arrange them properly in sentences.

Agrandissement. (F.), n. Magnification or amplification with a lens.

Agraphia. (L.), n.f. Inability to write, as a result of disease of the central nervous system. The patient may form lines, in the attempt to write, or may be able to fashion single letters but rarely words or sentences.

Agraphia literalis. A variety of agraphia due to a disease of the central nervous system, in consequence of which the patient cannot form letters, but writes only "pot-hooks" or other meaningless signs.

Agraphia verbalis. A variety of agraphia (q. v.) in which letters may be correctly formed, but the words out of which they are fashioned are fanciful or without meaning.

Ague tree. See **Sassafras.**

Aguilonius. The author of a large, but, for the most part valueless, Latin folio, entitled "*Opticorum Libri Sex,*" (Antwerp, 1613). The work should, however, be remembered by ophthalmologists because of its introducing to the scientific world the terms, "horopter" and "radius communis," as well as the conceptions which these terms express.—(T. H. S.)

Agyptische Augenentzündung. (G.) Trachoma.

Agyrias. (L.), n.f. (Obs.) Cloudiness of the crystalline lens.

Ahmad b. Junus al-Harrani. A distinguished Cordovan physician, chiefly remembered to-day because of the fact that, together with his brother Omar, he studied the diseases of the eye under Ibn Wasif at Bagdad for almost 22 years—941 to 963 A. D.—(T. H. S.)

Ahnlichkeit. (G.) Similitude, analogy.

Aiguille. (F.), n.f. A needle.

Aiguillé. (F.), adj. Needled.

Aiguille à acupuncture. (F.) Acupuncture needle.

Aiguille à appareil. (F.) A sewing-needle used in making bandages.

Aiguille à cataracte. (F.) Cataract needle.

Aiguille à injection hypodermique. (F.) Hypodermic needle.

Aiguille arrondie. (F.) A rounded needle.

Aiguille droite. A straight needle.

Aiguille emmanchée. (F.) A needle with a handle.

Aiguille exploratrice. (F.) Exploring needle.

Aiguille plate. (F.) A flat needle.

Aiguille thermo-électrique. (F.) Thermo-electric needle.

Ailerons ligamenteux. (F.) Cheek ligaments; adventitious tendons.

Aimant. (F.), n. A magnet.

Aimantation. (F.), n. The use of a magnet for any medical or surgical purpose.

Aimanté. (F.), adj. Magnetized.

Aimantin. (F.), adj. Magnetic.

Aiming, Participation of the eyes in the act of. See **Marksmanship, Ocular factors in.**

Air. Atmospheric air. As is well known our atmosphere contains, by volume, free oxygen, 21 parts, carbonic dioxide 0.03 parts, watery vapor and a small percentage of other gases and floating impurities, all largely diluted with free nitrogen, 78 parts. What influence, if any, is exerted by these gases in the rare uses made of air in ophthalmic therapy is unknown.

A current or blast of hot air is recommended by some surgeons for the relief of iritis, glaucoma, corneal ulcer and other painful diseases of the eye but in all of them it is probably the heat that is the essential factor in this treatment.

Koster has recommended intraocular injections of sterile air in tubercle of the iris, ciliary body and choroid tract. Later, Terson suggested the subconjunctival use of sterilized air in corneal ulcer and other external diseases of the eye.

Caralt has made use of subconjunctival injections of sterile air in many ocular maladies. He believes their action to be due to an increased leucocytosis, set up by the presence of oxygen in the subconjunctival tissues, and feels justified in making the following conclusions:

The injections are harmless, painless, analgesic; and remove adhesions of the subconjunctival space. They stimulate leucocytosis, and hasten the removal of the products of inflammation.

They have little or no antiseptic power, and are therefore inferior, in presence of virulent infection, to the injections of mercurial solutions.

Their lymphagogic and osmotic power is less than that of injections of sodium chloride, and the latter should be used in intraocular infections.

In scleritis, and sclerosing keratitis, and also in tuberculous and filamentary keratitis, they are the treatment of election.

They seem to be specific in tuberculous iritis.

They are the best treatment known in hypertrophy of the limbus in spring catarrh, and in bulbous keratitis dependent on herpes or traumatism.

They are of value as an adjuvant method in various forms of ulcer.

Very good results with hot air were obtained by Koll (*Zeitschr. f. Augenheilk.*, April, 1912), in a number of cases, especially children, with impetiginous and squamous eczema of the face, as shown by a few illustrative clinical histories. The action of the heat and relatively dry air current consists at first in a superficial drying of the secreting surfaces and with this and the intense heat a destruction of the superficially located bacteria; secondarily it produces a considerable hyperemia, with its beneficial effect of promoting the healing and alleviating the pain and itching. Hot air is best furnished by the electric hot air douche and the technic is very simple. From a distance of from 10 to 15 cm. the hot air current is directed to the diseased parts until a visible drying and hyperemia is produced. Caution is necessary to avoid burns. This can be easily done by a rotary movement of the applicator and by increasing the distance from the face.

The experience at the Nancy clinic in the treatment of corneal ulcer with the hot air douche is recorded by Rozet. The air-stream was well borne at a temperature of 65 to 70 C. and was followed by improvement of acute ulcerative processes within one day, while chronic processes were healed within four weeks.

In sterilizing air it is only necessary to draw it into the container (generally the barrel of a syringe) by placing the needle point in the center of a good-sized alcohol flame and "sucking" the air through the flame while slowly withdrawing the piston.

Airoform. See **Airol.**

Airol. BISMUTH OXYIODO-SUBGALLATE. AIROFORM. This compound is a light, odorless, tasteless, grayish-green powder slowly changing to red on exposure. It is insoluble in water or alcohol, contains 24 per cent. of iodine, is used as a substitute for iodoform and has been employed as a 10 per cent. ointment, which must be free of water, that decomposes it.

Airol is used in the treatment of both infective and interstitial keratitis. As a substitute for iodoform it is also useful as a dry dressing in plastic operations on the lids and as a disinfectant dusting powder in the treatment of corneal ulcer.

Airy, Sir George Biddell. This scientist, British Astronomer Royal, was born at Alnwick on the 27th of July, 1801, and died in 1892. He

is well known for his contributions on optics to the Royal Society and other scientific associations. It is said that he re-discovered the optical condition which we know as astigmatism.

Akamathesia. (L.), f.n. Blunting or blurring of the perceptive faculties.

Akamathesia optica. (L.) Psychic blindness.

Akbari. An Arabian ophthalmologist of the Middle Ages, whose name is mentioned in Halifa's *Book of Sufficiency in Ophthalmology.* Nothing else is known about him.—(T. H. S.)

Akeidopevirastik. (G.) The employment of needles or trocars for diagnostic purposes.

Akératodiaphanie. (F.), n. A corneal opacity.

Akestoma. (L.), n.n. A new growth formed of granulation tissues.

Akestom. (G.) Cheloid.

Akinesia iridis. (L.) An obsolete term for rigidity or immobility of the iris.

Akinesie. (G.) Akinesia paralysis, motor paralysis.

Akinésie de l'iris. (F.) (Obs.) Rigidity or immobility of the iris.

Akiurgie. (G.) Operative surgery.

Akiurgisch. (G.) Relating to operative surgery.

Akklimatisiren. (G.) To acclimate.

Akklimatisirung. (G.) Acclimation.

Akkommodation. (G.) Accommodation.

Akkommodationsabnahme im Alter. (G.) Accommodative loss in the aged.

Akkommodationsanstrengung. (G.) Effort of accommodation.

Akkommodationsapparat. (G.) Accommodation apparatus.

Akkommodationsauspannung. (G.) Tension of accommodation.

Akkommodationsbedürfnis. (G.) Necessity of accommodation.

Akkommodationsbereich. (G.) Range of accommodation.

Akkommodationsbestimmung. (G.) Determining accommodation.

Akkommodationsbreite. (G.) Range of accommodation.

Akkommodationsbreite, Relativ. (G.) Relative range of accommodation.

Akkommodationsfähigkeit. (G.) Power of accommodation, faculty of adaptation.

Akkommodationsgebiet. (G.) Accommodative range.

Accommodationskraft. (G.) Power of accommodation, faculty of adaptation.

Akkommodationskrampf. (G.) Spasm of the ciliary muscle.

Akkommodationslähmung. (G.) Paralysis of accommodation.

Akkommodationslähmung bei Diphtherie. (G.) Paralysis of the accommodation in diphtheria.

Akkommodationslähmung bei Lues. (G.) Paralysis of the accommodation in lues.

Akkommodationslinie. (G.) Line of accommodation.

Akkommodationsmuskel. (G.) Ciliary muscle.

Akkommodationsphosphen. (G.) Accommodation phosphene.

Akkommodationsruhe. (G.) Relaxation of accommodation.

Akkommodationsschwäche. (G.) Weakness of accommodation.

Akkommodationsstörung. (G.) Disturbance of accommodation.

Akkommodationstheorie. (G.) Theory of accommodation.

Akkommodationsvermögen. (G.) Accommodation, ability, capability and capacity of.

Akkommodationveränderungen im Alter. (G.) Changes in accommodation in the aged.

Akne. (G.) Acne.

Akognosie. (G.) Acologie; therapeutics; operative surgery.

Akoin. (G.) Acoine.

Akologie. (G.) Knowledge of surgical instruments and their use.

Akribometer. (G.) Instrument for measuring minute objects.

Akrisie. (G.) Absence of crisis; doubtful nature of a disease.

Akroblast. (G.) Term applied by J. Kollmann to tissue of germinal wall.

Akrochordon. (G.) A pedunculated tumor; mollusc or wart.

Aktinogramm. (G.) Skiagram.

Aktinomyces. (G.) Actinomyces.

Aktinomycesdrüsen. (G.) Actinomycotic granules.

Aktinomycesfaden. (G.) Actinomyces thread.

Aktinomycesgeschwulst. (G.) Actinomyces tumor.

Aktinomykose. (G.) Actinomyces. A parasitic micro-organism of animals and man forming rosettes of minute club-shaped elements, whence its name of the ray-fungus.

Aktinomykose der Orbita. (G.) Actinomyces of the orbit.

Aktinomykosemiliare der Choroidea. (G.) Miliary actinomyces of the choroid.

Aktol. See **Actol.**

Akyanopsia. Another spelling of **acyanopsia,** or blue-blindness. See **Color sense** and **Color vision.**

Akyanopsie. (G.) Blue-blindness.

Alactocus. (L.), adj. Bringing forth the young blind, as in the case of the lower animals.

Al-Akfani, Sams ad-din Muh. b. Ibrahim b. Said as-Singari al-Misri b. This exceedingly late Egypto-Arabian ophthalmologist (died at

Cairo 1348 A. D.) is the author of an extant work upon the eye, entitled *The Discovery of Filth in Eye-Diseases,* which is partly scientific and partly superstitious in character. In the 15th century a commentary on the book was written by Nur ad-din Ali al-Munawi called *Protection of the Eyes.* Otherwise it seems to have made but little impression either on the Eastern, or on the Western, ophthalmologic world.—(T. H. S.)

Alaun. (G.), n. Alum.

Alaunerde. (G.) Alumina.

Alaunicht. (G.) Alumish.

Alaunig. (G.) Aluminous.

Alaunkuchen. (G.) Aluminium sulphate.

Alaunmehl. (G.) Impure alum.

Alaunmolken. (G.) Alum whey.

Alaunstein. (G.) Alunite.

Alaunstift. (G.) An alum stick or point.

Alaunwasser. (G.) Alum water.

Albargin. GELATOSE SILVER. Coarse, yellowish, shining powder, very soluble in water; is a compound of silver nitrate with gelatose, containing 14 per cent. of silver. It is found in the market only in the form of 0.2 grm. (3 gr.) tablets.

In the absence of distilled water, dilute solutions of albargin may be made with the ordinary water supply. It is advisable, however, to prepare concentrated and stock solutions with distilled water and to protect them from light by storing the solutions in brown glass bottles. To dissolve albargin even boiling water may be used without decomposition, as is the case with other albumen compounds of silver. If ordinary spring water is employed it should be added gradually to the albargin with occasional shaking, as with the contrary order turbidity may be caused; when distilled water is used however such a precautionary measure is not necessary.

Albargin stains on clothing are easily washed out with soap and water when fresh. Old stains, which have been exposed to light, are easily removed with hyposulphite of sodium, by steeping the articles of clothing in a warm 10 to 20 per cent. solution until the stains have disappeared.

For treatment of the eye 10 to 20 per cent. albargin solutions in glycerine are used. Twenty per cent. albargin glycerine solutions are also sold under the name of "Prophylactol."

This silver compound is regarded by Barnemann and others as superior to all other argentic salts in the treatment of infectious diseases of the eye. It is non-irritant but soon kills the various

pathogenic cocci. It does not decompose on exposure to light and its solution gives a neutral reaction. It is used in 2 per cent. solutions wherever silver nitrate or protargol is indicated. It is sold in 3-grain tablets, 50 in a glass tube.

A. C. Bartholomew finds albargin less irritating than and quite as satisfactory a germicide as argyrol and protargol.

Albasir. The Latin name of an Arabian ophthalmologist, cited, or apparently cited, in the Continens of Rhazes. Nothing else is known about him, and his very existence has been questioned.—(T. H. S.)

Albedo retinæ traumatica. (L.) This is a term applied by Hirschberg to simple contusion of the retina *(commotio retinæ);* in other words to that condition of temporary (in some instances permanent) loss of vision due to direct or indirect trauma of the eyeball. The lesion of the retina is comparable to the changes (molecular and other) that occur in the cerebral substance after concussion of the brain.

Alberti, Salomon. (1540-1600.) This anatomist was a professor at Wittenberg, Germany, who is remembered by ophthalmologists solely because of his discovery of the lachrymal sac, and his invention of the Latin name by which that structure is still universally known—*lacus lachrymalis.*—(T. H. S.)

Albiduria. (L.), n.f. Albuminuria.

Albinism. Also known as CONGENITAL ACHROMA and CONGENITAL LEUCODERMA. Congenital absence of dermal pigment but unaccompanied by organic changes in the skin. This condition also involves the choroid coats and the irides. It is most frequently found in dark skinned races. The deficiency of pigment may be in slight or very pronounced degree. As regards its etiology it is considered by some to be due to heredity, consanguinity, or the admixture of alien blood. No proof can be furnished to substantiate any of these theories. By others it is held to be a disease. It is evidently an evidence of arrested development with an hereditary tendency. All the members of a family may be affected or some may escape, those affected being in other respects normal individuals.

Ocular defects, however, may be present, such as corectopia, polycoria, ectopia lentis and congenital cataract. Pigment is lacking from all pigmented tissues of the body. The skin is light, delicate and thin appearing; the hair soft, fine, downy, white and usually scant. The iris is pinkish, the fundus reflex brilliant. The facial expression characteristic, due to squinting which results in a corrugated brow.

Photophobia, nystagmus and amblyopia are almost constant ac-

companiments of albinism. The entrance of light from many points and angles results in dazzling reflections and lack of definition, giving rise to the three above-named symptoms, viz., photophobia, nystagmus and amblyopia. The fields of vision and color perception are usually near normal. In a subdued light the albino finds his greatest comfort and consequently is able to get along quite well at night.

Complete albinism is a permanent condition. Incomplete albinism may improve as the child grows older, the eyes becoming a grayish blue or blue color.

Partial, absolute albinism may occur in both eyes or be limited to one or part of one. All the membranes of the eye are never completely without pigment. A tendency to disease, especially cataract, has been accorded to the lighter eye where one eye is relatively or absolutely albinotic.

The refraction may be myopic, hypermetropia or astigmatic; but no one of these conditions predominates and is not in itself the only cause of the usual amblyopia, which has been explained as being due in great part to the dazzling and consequent lack of definition.—(W. F. H.)

Lagleyze (*Ophthalmic Year Book*, 1908, p. 155) finds that the important causes of this congenital condition are consanguineous marriages and, to a less extent, heredity. Cordoba, a portion of the Argentine Republic, was for more than half a century almost completely isolated, on account of political dissensions. The inhabitants became almost all related to one another; and this population furnished a relatively large proportion of albinos. Of his 27 cases, which represented 13 families, Lagleyze found 13 patients in 5 families who were children of consanguineous parents, first cousins or uncle and niece. The parents of 9 were not related, and in about 5 this point was not known. In Levy's case the parents were first cousins. Nance reports a case in which no consanguinity or heredity could be traced.

With reference to symptoms Lagleyze notes that deficient intelligence, sometimes mentioned in connection with albinism, seems to have no essential relation to it. Nystagmus is rarely absent. Acuteness of vision is always diminished. Astigmia of about 4 D. is mostly present. But the preponderance of myopia over hyperopia, mentioned by some authors, was not observed. Strabismus was present in one-third of the cases.

For the *prevention* of albinism Lagleyze would rely on preventing the marriages of persons affected with it, and all marriages between

blood relations. Komoto has sought to give relief by injecting India ink under the conjunctiva, and into the edges and inner surface of the lids. He tried to get the same benefit, without the disfigurement, by using lead carbonate. But while this caused only a slight temporary inflammation and little disfigurement, it produced very little improvement in the patient's vision. He reports a case in which he practised the injection of India ink. Previously the patient could only count fingers at 5 feet. By repeated injections, vision was brought up to 20-50 in each eye. The deformity caused by this procedure might be rendered less noticeable by narrowing the palpebral fissure.—(Ed.)

Albino. A person affected with albinism.

Albinotic. Pertaining to an albino; affected with albinism.

Albinismus. (G.) Albinism.

Albinoismus. (G.) Albinism.

Albinotisch. (G.) Albinotic.

Albinuria. (L.), n.f. Albuminuria.

Albinus, Bernhard. This illustrious surgeon and body-physician to the first King of Prussia, as well as father of the still more famous Bernhard Siegfried Albinus, was born at Dessau, Germany, in 1653. He was, for a time, professor at Frankfort a. O., and, for 19 years, at Leyden. He is remembered by ophthalmologists because of a cataract-needle, proposed, though not invented, by him. It was a highly elaborate affair, the operative extremity of which, though a needle, when introduced into the eye, became, on the pressure of an outside spring, a delicate pair of forceps. The instrument seems never to have been actually employed by Albinus himself. He died Feb. 27, 1721.—(T. H. S.)

Albinus, Bernhard Siegfried. This worthy son of Bernhard Albinus [the renowned professor of surgery, first at Frankfort a. O. and later at Leyden; also body-physician to the first King of Prussia] was born at Frankfort a. O. in 1697. At the age of 5 he accompanied his father to Leyden, and, when only 24, succeeded him as professor of anatomy and surgery in the University at that place. He was a very patient investigator, teacher and operator. He was a well known student and teacher of anatomy; in fact he has been called "The Reformer" of that subject. He is chiefly remembered by ophthalmologists because he was the first to furnish an illustration of congenital coloboma of the iris.

He died, after many years of ill-health—borne without complaint—in Leyden, Sep. 9, 1770.—(T. H. S.)

Albizzia lebbek. The sirissa tree of India, whose leaves are used in ophthalmia.

Albolene. A bland excipient of the vaseline class, marketed as a proprietary remedy and sold both in the liquid and solid forms.

H. McI. Morton in all affections of the eye with secretion uses the following application at night time along the interpalpebral margin to prevent adherence of the lids and so permitting drainage of the sac:

℞

Acid. boracic.	gr. x.
Albolene (solid.)	℥iv.

Albrand's test-types. See **Examination of the eye.**

Albucasis. A distinguished Arabian physician and ophthalmologist. See **Abul Kasim ben Abbas al-Zarawi.**

Albuginea del occhio. (It.) The sclerotic.

Albuginea oculi. (L.) The sclerotic coat of the eye; the sclera.

Albuginée de l'oeil. (F.) The sclerotic.

Albugineous. adj. Pertaining to the sclerotic.

Albuginitis. (G.) Inflammation of tunica albuginea.

Albugo. (Obs.) A white spot, as upon the cornea.

Albumen. WHITE OF EGG. There is also dried egg albumen, official in the P. G. as albumen ovi siccum; serum or blood albumen; Tata-albumen, a translucent, gelatin-like modification of egg albumen and "Tropon," a proprietary powder said to contain 90 per cent. of albumen.

Among the few uses of this agent in ocular therapeutics is making alum (q. v.) and copper sulphate curds or poultices for recent ecchymoses, acute conjunctivitis and the bites and stings of insects, ulcerative blepharitis and other diseases of the lids.

Albuminoid. adj. Resembling albumen.

Albuminuria, Disease of the eye in. Apart from the well-known retinal and optic changes (albuminuric retinitis, retinitis gravidarum, renal vascular retinitis), about to be described, albumen in the urine has been found in various forms of association with other ocular lesions, notably with paralysis of the ocular muscles, iritis, cataract, cyclitis, several forms of choroiditis and retinal angiosclerosis.

In 1827 Bright called attention to the loss of vision accompanying renal diseases; in 1856 the retinal changes were first observed in the living eye by Heymann; and in 1859 Liebreich gave an accurate description and an ophthalmoscopic picture of the fundus changes of albuminuric retinitis.

Of 935 cases of kidney disease, tabulated by Groenauw and Uhthoff, albuminuric retinitis was present in 209, or 22.4 per cent.; Wagner met it in 6 per cent. of his cases, while in Galezowski's cases 31 per cent. showed albuminuric retinitis. While the disease has been observed a few times in children, as a rule the patients are over 40 years of age, and the majority are between 40 and 50 years old. Men are more frequently affected than women, in the proportion of about 7 to 3. As regards the form of kidney lesion present in albuminuric retinitis, the small contracted kidney is the most frequent; chronic diffuse parenchymatous nephritis (large white kidney) forms a close second; the nephritis of scarlatina is third; and the least frequent are the rare cases of amyloid degeneration. As a rule, both eyes are involved in the retinal changes, and it rarely happens that the second eye remains entirely well for the period of a year.

According to Porter, in the majority of cases of renal disease there is no disease of the retina; and a majority of renal cases showing retinal changes also show changes in the blood-vessels. He concludes that the eye disease does not depend so much on the existence of the renal affection as on the fact that the vessels are diseased. Almost without exception the cases of albuminuric retinitis which he observed were found in syphilitics. Owing to vascular changes incident to syphilis, hemorrhages and fatty degenerations are to be expected in the retina. In nearly four thousand post-mortem examinations he has never seen one-sided nephritis. Some foreign authors have contended that in unilateral albuminuric retinitis only one kidney is diseased.

Persons with nephritis often complain of morning headache, nausea, vomiting, etc. The defect of vision is an early symptom, but comes with a late stage of the renal disease, and often with a dilated left cardiac ventricle. Albuminuric retinitis comes after vascular tension has been long increased and elimination begins to fail, and, although appearing as a late sign, it is often the first symptom which leads to a correct diagnosis.

The ophthalmoscopic signs of albuminuric retinitis include vascular changes, hemorrhages, white spots, exudations and optic neuritis. These changes are found chiefly in the posterior pole. The optic-nerve head is reddened, its boundaries are ill defined, the veins are broadened and tortuous, and the arteries are narrowed. The retina about the papilla looks grayish and opaque and small hemorrhages are visible. The arteries often show white streaks on both sides of the red blood-column. In some cases papillitis occurs

either in the beginning of the ocular disease or long after the appearance of the retinal changes mentioned above. In these cases probably there is often a coexistent brain lesion with increased intracranial pressure, and a fatal result is to be expected. Papillitis, however, can occur in albuminuric retinitis without brain lesion.

If, as is often the case, the preliminary stage of hyperemia is absent or is not observed, glittering white patches form the first sign in the retina. They are often arranged in groups surrounding the papilla like a ring and coalescing form large white spots. The inexperienced observer may mistake this condition for opaque nerve-fibres in the retina. Both present large white plaques passing from the papilla, but in the congenital condition (opaque nerve-fibres) signs of inflammation are absent. The exudation of a recent chorioiditis is to be distinguished from albuminuric retinitis by the less brilliant whiteness of the patches, and by the fact that they are accompanied by vitreous opacities and pigment collections, while hemorrhages are absent. In the macular region the white spots frequently form a stellate figure. Hemorrhages are found in great variations. In some rare instances the retinal change is present as a retinitis hemorrhagica, and the white spots are either entirely absent or are present in small numbers. In other rare cases the spots are found in the chorioid as well as in the retina, and pigmentation is present. These are cases of primary inflammation of the uveal tract. The frequency of involvement of different portions of the retina has been estimated by Schlesinger. He found hemorrhages and typical lesions in 77 per cent. of all cases of albuminuric retinitis, white spots alone in 14 per cent., and involvement of the papilla alone in 7 per cent. The ophthalmoscopic picture is thoroughly typical when both the disseminated white spots and the stellate figure at the macula are present, but an exactly similar picture is sometimes seen, together with papillitis, in some cases of sarcoma of the brain without kidney lesions. According to Laqueur, the same is true of some cases of diabetes mellitus, and also of patients whose urine never contained albumin. A similar picture may be found in poisoning, anemia, and syphilis. The white stellate figure at the macula is not always characteristic of kidney lesion. On the other hand, it may be absent in albuminuric retinitis, and, on the other, it is sometimes seen in cases where albumin is never present in the urine.

The visual disturbances of this disease comprise a greater or less loss of visual acuity, without, as a rule, contraction of the field of vision and without loss of the color- and light-senses. Cen-

tral scotoma is often present. The loss of vision is usually slow, rarely rapid, complete blindness being seldom observed. If it suddenly occurs in both eyes, it is suggestive of uremic amaurosis; if unilateral blindness or great loss of vision occurs rapidly, the case is likely one of embolism of the central retinal artery.

Albuminuric retinitis may show improvement or even complete cure, but many patients die before the retinal disease undergoes retrogressive changes. If the kidney lesion improves, the surgeon may hope for improvement in the ocular condition. In some cases the retina improves regardless of the extension of the renal affection. Retinal improvement, when it occurs, is slow, and the stellate appearance of the macula is the last to disappear. The optic nerve head may become whitish and atrophic and useful vision may remain. Some cases show alternating loss and improvement of vision for a long period. Complete blindness as a result of this disease is extremely rare. Complications are not common, and include detachment of the retina, hemorrhage into the vitreous humor, hemorrhagic glaucoma and embolism of the central retinal artery.

The anatomic changes in albuminuric retinitis are found chiefly in the posterior pole, rarely reaching forward as far as the equator, and never involving the ora serrata. They consist of edema and inflammatory deposits. The edema accounts for the diffuse cloudiness which is visible ophthalmoscopically. The blood-vessels, not only of the retina, but also of the uveal tract, frequently show sclerotic or hyalin changes in their walls. The radial fibres of Müller undergo proliferation, and their interstices are filled with a fibrinous deposit. In the retinitis albuminurica of pregnancy changes in the retinal vessels are occasionally absent.

Hemorrhages occur into the retina and at times break through into the vitreous humor. The white spots, which are visible with the ophthalmoscope, depend on granular or fatty degeneration of the supporting tissue, upon fatty degeneration of cells, particularly in the two granular layers; or upon the presence of foci of varicose hypertrophied nerve-fibres. The stellate figure in the macular region depends chiefly upon fatty degeneration of Müller's supporting fibres, which radiate from the fovea centralis, and here do not, as in other places, push through the retina. Weeks questions this explanation. His researches lead him to believe that the changes in Müller's fibres are due to post-mortem alterations. The chorioid on microscopic examination shows similar changes, viz.: lesions of the vessels and inflammatory changes.

In the optic nerve, together with hypertrophy of the connective tissue, there is edema or pronounced inflammation. Generally the inflammatory changes involve only the papilla and end at the lamina cribrosa, without further extension centrally. Gurwitsch found hyalin bodies in the head of the optic nerve and in the granular layer of the retina.

The cause of retinal detachment in albuminuric retinitis is explained by Leber and Nordensen in this manner: the small elevations, especially around the papilla, depend upon a primary exudation into the subretinal space, while further detachment can be attributed to shrinking of the vitreous humor.

In typical cases the diagnosis of albuminuric retinitis is not difficult, but it must be remembered that, while the ophthalmoscopic picture is highly suggestive, it is not pathognomonic, similar fundus changes being met with in rare instances in cases of intracranial tumor, lead encephalopathy, pachymeningitis hemorrhagica, anemia, syphilis, and diabetes mellitus.

Tumor of the brain, as a rule, is easily distinguishable from Bright's disease. However, in some cases of cirrhotic kidney there is little or no dropsy, headache and vomiting are often prominent and distressing symptoms, and pain may be most severe in the back of the head; epileptiform convulsions and even hemiplegia may be present, while the ophthalmoscopic changes may be similar to those found in cerebral tumor.

In the differential diagnosis it will be necessary to give attention to the following points:

The condition of the urine. While the finding of albumin and tube-casts will clear the diagnosis, in some cases of cirrhotic nephritis albumin may be scanty or entirely absent and tube-casts may be so few as to escape detection.

In all forms of Bright's disease, except possibly in the pure form of waxy kidney, the blood-pressure is high, the arteries are atheromatous, and the left ventricle is hypertrophied. In the absence of a valvular lesion these symptoms are highly suggestive of renal disease.

The ophthalmoscopic changes, *per se*, can never be taken as an absolutely certain guide, for the appearances typical of one condition are, in some rare and exceptional cases, met with in the other.—(J. M. B.)

The treatment of albuminuric retinitis is practically the treatment of the underlying conditions that give rise to it. These are fully

discussed elsewhere, especially under **Systemic conditions in their relation to ocular symptoms.**

Albuminuric retinitis. Degeneration of the retinal elements associated with albumen in the urine. The affection begins with either a neuropapillitis or with a diffuse peripapillary edema combined later with hemorrhagic placques. The hemorrhage is brought about by the increased vascular tension, and by arteriosclerotic changes of the bloodvessels; the neuropapillitis is brought about by the increased tension of the cerebrospinal fluid. The beneficial effect of lumbar puncture in these cases is, Chauffard (*Wien. Klin. Wochenschr.*, July 18, 1912), says, easily explained by the above theory. The origin of the placques which are also sometimes found in diabetic retinitis and in retinitis gravidarum is more difficult to explain.

Recently the retention of nitrogen and hypercholesterinemia were considered to be the cause of the formation of the placques. The placques show the characteristic lipoid reaction. For the formation of hypercholesterinemia the suprarenal gland is probably responsible. The suprarenal gland compensates the impermeability of the kidneys. The adrenalinemia causes increased cardiovascular tone with hypertension of the blood and cerebrospinal fluid. As the kidneys become less permeable the nitrogen and chlorids are retained. The pathogenesis and the character of the albuminuric retinitis are dependent upon the cholesterinemia, and the prognosis is influenced by the retention of the nitrogenous material.

The treatment of acute albuminuric retinitis is by lumbar puncture, and that of the chronic form is with appropriate diet. See **Retinitis, Albuminuric.**

Albuminurie. (G.) Albuminuria.

Album oculi. (L.) An obsolete term for the sclera or white tunic of the eye.

Alcalescenz. (G.) Alkalescence.

Alcalescirend. (G.) Alkalescent.

Alcali. (G.) Alkali.

Alcalimeter. (G.) Alkalimeter.

Alcalinisch. (G.) Alkaline.

Alcalinität. (G.) Alkalinity.

Alcalisch. (G.) Alkaline.

Alcalissiren. (G.) to render alkaline.

Alcanamusali. This physician is said to have been an Armenian; he was at all events the author of a celebrated work in Arabic on the diseases of the eye. See **Canamusali de Baldach.**

Alcmaeon of Crotona. A pupil of Pythagoras and a famous philoso-

pher and physician, who flourished 500 B. C. To him has been attributed the discovery of the optic nerves and the Eustachian tubes. His belief in the existence of these structures, however, would seem to have been arrived at by speculative reasoning, not by actual anatomical investigation.—(T. H. S.)

Alcoati. His name in full is SALOMO FILIUS DE ARIT. ALCOATI, or, ALCOATI SALOMONIS FILIUS; improperly, ALCOATIM and ALCOATIN. An unimportant Spanish-Arabian ophthalmologist, whose one book is, with the exception of a single chapter, extant in Latin translations only. The work is entitled, *Liber de Oculis quem Compilavit Alcoati,* Christianus Toletanus, anno D. J. MCLIX. The style of the book is prolix and obscure, and the contents inaccurate and highly egotistical. For example, the author takes great credit to himself for making the handles of his cataract-needles of wood.—(T. H. S.)

Alcoatim. An unimportant Spanish-Arabian ophthalmologist. See **Alcoati.**

Alcoatin. An unimportant Spanish-Arabian ophthalmologist. See **Alcoati.**

Alcohol. ETHYL ALCOHOL. SPIRITS OF WINE. C_2H_5HO. Commercial alcohol contains varying proportions of ethyl alcohol, from 95 per cent. in alcohol, U. S. P., 90-95 per cent. in cologne spirits, to 50 per cent. in proof spirit and other mixtures.

In addition to the use of this remedy as a disinfectant of instruments, for the hands of the operator and the dermal field of operation, it is by some surgeons added in small quantities and for its stimulating qualities, to sprays, douches and even to collyria. Probably a number of popular proprietary remedies owe their value to the slightly disinfectant and vascular tonic effects of the alcohol (and essential oils) in these preparations. In this way we have known bay rum, French brandy, rose water, violet water, eau de cologne, spirit of lavender, spirit of camphor, whiskey and other alcoholic fluids used in the proportion of $\frac{1}{100}$ to $\frac{1}{200}$, with relief in simple hyperemia of the conjunctivæ. They are generally presented as aqueous collyria in, say, a teaspoonful to a pint of warm, boiled water. Doubtless, also, the remedial effects of that popular remedy Pond's extract (tincture of hamamelis) is mostly due to the alcohol it contains.

German oculists frequently order stimulating eye waters containing 5 to 10 per cent. of a useful alcoholic mistura oleoso-balsamica, official in their pharmacopeia. Its formula is: boric acid, two and one-quarter grms.; bitter almond water, 5 c. c.; rose water 100 c. c.

Ohlemann gives several alcoholic prescriptions suitable as eye-

washes, douches and collyria in simple hyperemia and conjunctivitis. Among them are: mercuric chloride, 3 grains; fennel water, rose water of each six fluid drams; oleobalsamic mixture three and a half fluid ounces.

Sig. Use a teaspoonful to a glass of water.

℞

Spt. melissæ co.	100.0 c. c. (℥iiiss)
Spt. lavandulæ	25.0 c. c. (f℥vi, mxv)
Spt. camphoræ	3.0 c. c. (mxlv)
Spt. ether nit.	2.6 c .c. (mxl)
Olei rosæ	0.1 c. c. (mjss)

Sig: Eye spirits—to be rubbed into forehead and temples.

Or this: oleobalsamic mixture, 10 c. c.; spirits of lavender, 20 c. c.; fennel water, 70 c. c.

Sig: Eye drops.

Mittendorf recommends an alcoholic mixture under the caption Spiritus Ophthalmicus, which, from personal experience, we have found of considerable value. It is intended to be well rubbed into the eyebrows, forehead and temples for the relief of ocular headache and other reflex asthenopic symptoms. The formula is:

℞

Spirits lavender,
Brandy, of each 3 fluid ounces,
Spirits of camphor, 1 fluid ounce.

We have also found effective, employed in the same way: chloroform, one fluid ounce; camphor, two drams; tincture of aconite, two fluid ounces; oil of peppermint, 20 minims; alcohol, two fluid ounces.

Sig: Shake well and apply every two or three hours. Do not allow any of the liniment to get into the eyes.

Alman has published a paper favorable to the use of alcohol compresses in the treatment of eye diseases. Recently it is also recommended as hypodermic injections in supraorbital and other forms of neuralgia.

Some of the ocular effects of poisoning by ethyl alcohol are conjunctival injections and swelling, both in acute and in chronic intoxication. In chronic poisoning, there is present, in addition, a paresis of the orbicularis palpebrarum, combined with anesthesia of the cornea, so that involuntary winking is almost entirely abolished; hence, "the fixed, unwinking stare" of the hard drinker, when sober as well as when drunk. The chief ocular lesion in chronic alcoholism is, however, a retrobulbar neuritis of the central

fibres of the optic nerve, constituting one of the principal signs of this common form of toxic amblyopia (q. v.)—(T. E. S. and Ed.).

Alcohol, Methyl. WOOD SPIRIT. COLOGNE SPIRITS. COLONIAL SPIRITS. COLUMBIAN SPIRITS. WOOD ALCOHOL. CH_4O. This fluid is obtained by the destructive distillation of woody fibre. It has (when unpurified) a nauseous spirituous taste and odor, has a sp. gr. of 0.7995, boils at 55.1° C. and mixes freely with water, ether and ethyl alcohol. In its "deodorized" or "purified" state it is known by various names (see synonyms) and, although a virulent poison, has been widely sold in America as a substitute for ordinary or ethyl alcohol.

The symptoms of poisoning from wood spirit, drunk, inhaled or rubbed in, either as "pure" Columbian spirits or as a common wood alcohol are definite, yet the exact manner and the ultimate form in which it destroys or cripples the internal organs are not well understood. Once absorbed, from either the stomach or the lungs, into the blood, it is not so easily eliminated or burned up as is ethyl alcohol. This peculiarity of methyl alcohol is of considerable importance and interest because, becoming cumulative in the system, small and frequent doses of the poison in the form of quack medicines, hair-tonics, cheap whiskey, or essences, rubbing the body after Turkish and other baths, burning in "alcohol" lamps, varnishing pianos, beer-vats, small rooms, etc., insidious and often unsuspected but serious damage to the digestion, sight and nervous system may be induced. The injury to the eyesight consists chiefly of a destructive inflammation of the optic nerve fibers or retinal elements (or both), followed by their atrophy.

The symptoms of acute poisoning are gastro-intestinal disturbances, more or less severe, accompanied by abdominal pain, general weakness, nausea, vomiting, vertigo, headache, dilated pupils and blindness. If recovery does not occur, there is marked depression of the heart's action, sighing respiration, cold sweats, delirium, unconsciousness, coma and death.

The blindness is bilateral and may set in a few hours after the contact with the poison, or it may be delayed for several days. It is generally complete, with a subsequent improvement, and finally, a relapse into permanent blindness.

The diagnosis can hardly be mistaken. Methyl alcohol poisoning presents a picture unlike that of any other intoxication. Acute abdominal distress, followed by blindness, should always awaken suspicion of methyl alcohol poisoning.

The prevention of poisoning by this insidious drug can only be brought about by prohibiting [or rendering unprofitable] the sale

of "deodorized" wood alcohol in all its forms; possibly by encouraging the use of "denatured" (ethyl) alcohol in its stead. The number of deaths may, meantime, be limited by putting all methylated preparations on the list of poisons and prosecuting all persons adulterating foods and drinks with it. Labeling it "Poison," or with the notice, "This fluid, taken internally, is likely to produce blindness," will certainly have a deterrent effect.

Methyl alcohol intoxication is an example of idiosyncrasy. As in the case of several other poisons, some persons are largely immune so far as permanent damage to the organism is concerned. If ten persons drink, say, 4 ounces of Columbian spirits within three hours, all will have marked abdominal distress and probably four will die, two of them becoming blind before death. Six will eventually recover, of whom two will be permanently blind. With still larger doses, the proportion of death and blindness will be greater. Poisoning by inhalation of the fumes of methyl alcohol generally occurs when the exhalations are mixed with rebreathed air, as in varnishing the interior of beer-vats, closets or small rooms, etc. It is also highly probable that in susceptible subjects repeated or even single methylated "alcohol rubs" may produce poisonous symptoms, through absorption of the spirit by the skin. Chronic (or partial) poisoning from methyl alcohol (in the shape of "nips" of methylated Jamaica ginger, bay rum, punch made with Columbian spirits, etc.) is the most insidious and probably not an uncommon form of intoxication. Its symptoms are not so pronounced or so easy of recognition as in the acute form, but the eyes, digestive apparatus and nervous system undoubtedly suffer. The use of ethyl or grain alcohol in the arts, as in the manufacture of varnishes, as a burning fluid, for "stiffening" hats, lacquering brass, etc., is without danger to life or eyesight. If a small percentage of naphthalin, for example, were added to it, the fluid would be undrinkable. A combination of ethylic alcohol with 10 per cent. of wood spirit (as in our denatured alcohol) would answer the same purpose. Such a mixture is the "methylated spirits" of Great Britain, where not a single case of acute poisoning or blindness from methyl alcohol is recorded, in spite of the extensive use of methylated preparations in the British Isles.

The treatment of methyl alcohol intoxication consists chiefly in getting rid of the poison from the stomach and intestines by means of the stomach-pump and rectal injections; stimulants, especially ethyl alcohol, strychnin and coffee; heat to the body and extremities. The treatment of the blindness is unsatisfactory. (Ed.).

See **Toxic amblyopia.**

Alcoholamblyopie. (G.) Alcoholic amblyopia.

Alcoholisiren. (G.) To alcoholize.

Alcoholisirung. (G.) Alcoholization.

Alcoholism. The various signs and symptoms due, or traceable to the influence of alcoholic liquors upon the system.

Alcoholophilia. (L.), n.f. Inordinate craving for alcoholic beverages.

Alcoholvergiftung. (G.) Alcoholic poisoning.

Alcol. (It.), n. Alcohol.

Alcool. The Arabic name for antimony (or its trisulphide) used in the East to color the eyebrows. Hence any fine powder used as an application to the eyes.

Alcool. (It.), n. A name for antimony or its trisulphide (used in the East as a pigment for the eyebrows). A fine powder used as an application to the eyes.

Alcoolat. (F.), n. A class of alcohol preparations, corresponding to the Spirits of the U. S. P.

Alcoolisme. (F.), n. Alcoholism (q. v.).

Aldehyd. (G.) Aldehyde.

Aldehydgrün. (G.) Aldehyde green.

Alder, Striped. See **Hamamelis.**

Alembrothsalz. (G.) Chloride of mercury and ammonium.

Aleppobeule. (G.) Aleppo boil.

Aleppo button. This curious disease, although also called Oriental button, is not confined to the near and far East, but is found in such widely separated countries as Algiers, the Crimea, Panama, and Natal. According to W. B. Adams, of the Syrian Protestant College, the true cause of the disease "has been demonstrated to be a curious oat-shaped microbe belonging to the animal kingdom. The 'button-makers' have been named Leishman bodies. How these germs invade the human system, and lower animals as well, is as yet unknown. Occasionally domestic animals are affected, and I recall an instance where a friend of mine had a dog afflicted with a large button on the end of his nose as badly as any resident of Aleppo."

Altounian of Aleppo, who has published a monograph on the disease, thinks that the mosquito is the carrier and implanter, and many observers agree with him, but not all. One thing is certain; the button always occurs on an exposed part or on a part covered so thinly that biting insects could pierce through to the skin. After enumerating some ten or a dozen remedies that have held the disease in check, Adams reports the cure of the button both in the Crimea and at Panama by freezing with ether.

"It was right here I saw a light. If ether has cured by freezing then carbon dioxid snow ought to cure the button quicker, easier, more effectually, for it is so much easier managed than an ether spray, and it produces a much more intense cold, as it has a temperature of –80 deg. C. Soon after reading Darling's article, a patient appeared with a button on his lower eyelid. As he was a college student it is obvious how serious it was for him to have one eye practically put out of commission for a year, with possible damage to it and a disfiguring scar on his face. The student had come from Aleppo within three or four months and it began just as he was about to depart for college. This patient required two freezings, because the button was so close to the eye I feared injury to the eyeball and consequently froze it for 20 seconds, allowed the papule to thaw, and repeated the freezing twice, making 60 seconds altogether."

"In my case histories I have notes on 20 cases of Aleppo button treated with carbon dioxid snow since Jan. 20th, 1912. I have treated the buttons in all stages, from small papules of two or three months duration to enormous ones as large as a dollar, and some have been in the late stage of suppuration and crusting. I freeze the whole surface of the button thoroughly, giving at least 60 seconds of firm pressure with the carbon dioxid snow crayon. There is a slight stinging sensation, quite bearable, and the button remains as hard as wood for a minute or two, then it swells very considerably, and in half an hour to one hour the surface blisters, oozes serum freely for two or three days, crusts over, and in ten days to two weeks this crust falls off and reveals the button healed. There is no button there. As recorded in my notes on the first case treated, 'It is cleared entirely, faded, melted, disappeared.' In the cases that are from two to four, or five months old, that is, buttons that have not reached the stage of mixed infection, which is responsible for the suppuration, the treatment leaves a scarcely discernible scar. The suppuration buttons naturally are the longer in healing and leave more of a mark, because there has been more or less destruction of tissue by the process of suppuration; but even so, the after mark is far less than if the button goes through its long course of a year's suppuration and slow healing."

Aleukemic plasmoma. This term was introduced in 1908 into ophthalmologic literature by Pascheff with a description of three cases. Rund published a similar case, which he classed under the group of aleukemic heteroplastic lymphomas. An identical case is reported by Deutschmann. It was characterized by a chronic thick-

ening of the conjunctiva of the upper lid without symptoms of irritation. The surface was smooth, with a yellowish shine from the depth. The tumor was fixed to the tarsus and extended from one canthus to the other, without involving the retrotarsal fold. Excision was easy; it was detached from the tarsus without difficulty.

Microscopically it consisted of plasma cells, which showed no dependence on the adventitia of the vessels. There was no hypertrophy of the submucous tissue, and the tumor did not present an adenoid structure. Therefore Deutschmann (*Zeitschr. f. Augenklk.* Mar., 1912) considers it as a true tumor, not an inflammatory irritation. Clinically, the affection could not be distinguished from hyalin and amyloid degenerations of the conjunctiva, which also shows histologically an enormous formation of plasma cells and more or less marked new formation of vessels. The author proposes to designate all these tumors plasmomas, because they are real new formations and all consist of plasma cells.

Aleuritesöl. (G.) Candle-nut oil.

Aleuronoid particles. In certain amphibians, birds and fishes the outer zone of retinal pigment contains brightly-colored particles (in association with fat droplets), to which this name has been given. They are not found in mammals, including man.

Alexander Benedictus. An excellent plastic surgeon, ophthalmic and general, who flourished in the latter half of the 15th century. See **Benedetti.**—(T. H. S.)

Alexander de Spina. The re-discoverer of spectacles, a monk who dwelt in the Dominican cloister of St. Catherine at Pisa for many years, and who died in 1313. The following passages from the *Chronicle of the Cloister* show that he was not (as has sometimes been supposed) the first, but only the second, discoverer of "eyeglasses": "Brother Alexander de Spina, a good and modest person, understood how to make whatever he saw, or any restorative that he happened to hear about. Eyeglasses, which were first made by somebody who, however, would communicate nothing about them, he prepared by himself, and then communicated to others concerning them with a willing and joyful heart." Alexander, though not a physician, was, plainly enough, qualified by nature to be a good and true one. The second passage runs: "Brother Alexander de Spina, of Pisa, could make with his hands whatever he would, and was wont to communicate his arts to others out of good-heartedness. As, at that time, somebody had first invented "peepers," (as the people called "eyeglasses"), by means of a certain beautiful, new and useful discovery, and no one would communicate the

art of their preparation, then did this good man and artist, after he had seen, at once and without any teacher, proceed to learn it, and he thenceforth taught it also to others, whoever wished to know."

For the sake of completeness, it ought to be added that the name of the "first" inventor of "eyeglasses" is to this day unknown. It should also be expressly stated that the view so commonly held to the effect that spectacles were known to the ancients, is wholly erroneous. The commonly cited passage from Suetonius relating to Nero and his emerald has, in fact, nothing at all to do with spectacles; for Nero's emerald was a concave mirror, not a lens of any sort. Equally fallacious are the conclusions which attribute the invention of spectacles to the Chinese.—(T. H. S.)

Alexander of Tralles. A most distinguished physician of the Greek Middle Ages (A. D. 525-605) was born at Tralles, in Lydia. His father, Stephen, and one of his brothers, Dioscurus, were famous physicians. Other notable brothers were: Metrodorus, the grammarian; Olympius, the jurist; and Anthemius, one of the architects of St. Sophia. Alexander studied medicine at first with his father, then with the father of the Indian traveller, Cosmas, and afterwards with many another well known instructor. For the purpose of rendering more complete his medical education, he travelled in Cyrene, Spain, Gaul, Italy and Greece. Then he settled in Rome, where he lived until his death. Some years before his death, however, he became unable to practice, and, from that time forth, devoted himself exclusively to the composition of his immortal *Twelve Books on Medicine*. In this work, which, for the most part, must be conceded to be only a compilation, the author affords, none the less, evidence of great powers of observation and original reflection. Over and over again, Alexander warns his contemporaries against the blind acceptance of authority—an admonition greatly needed in that day, and one which its giver took thoroughly to heart himself. He was an excellent diagnostician, and gave much time to inspection, palpation, percussion, etc. He would seem to have made a number of dissections—a remarkable fact for the time. He mentions rhubarb, and is said to be the first in history to have done so. (The "rhubarb" mentioned by Dioscorides—A. D. 40-90—was only the garden variety, or pie-plant.)

Great as was the Trallean Alexander in general medicine, he possesses for ophthalmologists rather a slight importance. The ophthalmic portion of his Twelve Books is, in fact, little more than

a collection of prescriptions, with which the compiler would seem to have had but little experience.—(T. H. S.)

Alexia. WORD-BLINDNESS. A form of aphasia (and psychic blindness) in which the patient does not recognize ordinary printed or written words or letters.

As an example of this condition, a woman, aged 32, without constitutional affections, suddenly became blind after being delivered of triplets. Gradually some improvement took place, leaving a complete right-sided, and incomplete left-sided, homonymous hemianopsia, with wrong projection and faulty conception of the size of objects, amnesic aphasia, alexia and agraphia, and visual hallucinations. The preserved visual field had the shape of small central islets. The ophthalmoscopic condition and pupillary reaction being normal and other symptoms wanting, there were in the opinion of Endelmann (*Archiv f. Augenheilk.*, 1912, p. 177), only two possibilities with regard to the etiology, *viz.*, thrombosis of the cerebral arteries and encephalitis from autointoxication during the puerperal state. The marked psychic symptoms seemed to favor the second hypothesis.

The affection was, according to the symptoms, localized in the parieto-occipital lobe and the left angular gyrus, the center for letters. The alexia alone could be attributed to a lesion of the white subcortical substance, but the simultaneous agraphia indicated that also the cortex was affected and that it was a cortical alexia. In similar cases of Bauer, Chevallereau, and Meyer, the labor was of greatest importance for the origin of the disease, but the immediate causes of the cerebral affection varied, *viz.* nephritis, acute anemia of some portions of the brain after profuse hemorrhages, and the assumption of an embolic process in the brain. The faulty appreciation of the size of objects and the wrong projection were explained by disturbance of the constant relation between centripetal excitation and cortical perception of motion by the hemianopsia.

Souques reports a case of acquired alexia, in which the autopsy showed destruction of the association fibres connecting the visual cortex with the left bridge convolution between the first and second occipital convolutions. Ball reports, also, a case of developmental alexia. A boy of 15 was kept back in school because of his reading, which was that of a child of 7, although his vision was good, and in other respects he was bright in his studies. The defect was noticed from the time he entered school, at 6 years of age. Shortly before this he had a series of eight epileptiform convulsions, without complete unconsciousness. Ball says of his patient: "The ef-

forts of the last 9 years to teach him to read and spell have, for the most part, been useless.'' These efforts were chiefly the school training, which, after the first year, he had to take with younger children.

Hinshelwood says that the oldest of his patients, a boy of 18, after he had spent 7 years in school, had learned less than he was able to teach himself in the four years that had elapsed since leaving school, in his attempts to spell out the results of football matches from the newspapers. It should be recognized that children with this defect even in slight degree, never get a fair opportunity in ordinary school classes.

Alexia, Optical. Inability to recognize either written or printed words.

Alexia, Subcortical, of Wernicke. That form of alexia or literal alexia in which the patient is unable to recognize any letter in a word is very unusual; in any event, alexics are usually capable of the recognition of *numerals*. Although the patient cannot copy either written or printed words he is able to write from dictation or spontaneously, but cannot read what he has just written—even his own signature. He can, however, recognize the writing if he be allowed to follow the written lines with the point of his pen. Apart from written words he recognizes and names objects he sees, and apparently is, except in the particular mentioned, in good mental condition. This condition constitutes the subcortical alexia of Wernicke—the ''pure'' word-blindness of Déjerine.

Alexie. (G.) Alexia; word-blindness.

Alexipharmakom. (G.) Antitoxin, protective drug.

Algarothpulver. (G.) Algaroth's powder; basic chloride of antimony.

Algen. (G.) Algeous.

Algesimeter. (G.) Instrument for testing sensibility to pain.

Alginsäure. (G.) Alginic acid.

Algometer. An apparatus for testing or measuring the degree of sensibility of a part to pain.

Algue de Java. (F.) Agar-Agar (q. v.).

Alhazen. The full form is, Abu Ali Muhammad b. Al-Hasan ibn Al-Haitam al-Basri. He is to be confounded neither with the physician, Abd ar-Rahman b. Ishaq b. al-Haitam, who came later, nor with another Alhazen—he who, in the 10th century, translated Ptolemy's *Almagest*. This personage was not a doctor, but a mathematician, whose great importance to ophthalmologists arises from his services in the field of physiologic optics. He was born at Bassora, A. D. 965, and died at Cairo in 1038. Having boasted his

ability to construct an apparatus whereby the inundations of the Nile could be controlled, he was summoned to Egypt for the purpose by the Caliph Hakem. Knowing his inability to make good his words, Alhazen pretended to become insane. On the Caliph's death, he promptly recovered his reason.

He was a hard student, and is said to have copied three books—*The Elements of Euclid, The Mathematics and the Almagest of Ptolemy*, once a year. This he did for 150 denarii, on which amount he managed to support himself.

As a stylist, he is always prolix and often obscure. He was, however, the greatest writer on optics between Ptolemy (who flourished A. D. 150) and Kepler, who published his revolutionizing optical work in 1604. None of the Arabic manuscripts of Alhazen's great book are extant, and we know it solely in its Latin translation, *Opticae Thesaurus Alhazeni* Libri vii. To Alhazen, as to Galen (who died 210 A. D.) the principal organ of sight was the crystalline humor. The image of any object seen was supposed to fall on the anterior surface of this body, and the impression thereon produced to be carried by the retina (whose foremost parts were thought to be very closely united with the edges of the lens) backward to the optic nerve, and then, by that intermediary, to the brain. From each and every point on the external object, a single ray was supposed to proceed to the eye and to fall upon the lens. The old-time theory that the act of vision was carried on by rays of pneuma (or innervation) which, coming from the optic nerve, passed out from the eye to the object looked at and returned with information, was by him rejected utterly and given its final quietus.—(T. H. S.)

Ali Abbas. His full name is ALI IBN AL-ABBAS AL-MAJUS—i. e., the magician, or fire-worshipper; he was also called HALY ABBAS. This distinguished Persian physician of the Arabic period was born some time in the 10th century and died 994. He was body-physician to the Emir, Adhad ed-Dauda. His chief work is *al-Maliki, Liber Regis*, or The Kingly Book, so called because of its dedication to the Emir above-mentioned. This work is divided into two parts—a theoretical and a practical, of ten books each. He declares his intention in the composition of the work to have been the production of something which should constitute a kind of golden mean between the extremely prolix and ill-digested Continens of Rhazes, on the one hand, and the over-condensed and much too highly systematized "Liber ad Mansorem" of the same distinguished writer, on the other. The result is decidedly satisfactory,

for all historians of ophthalmology agree that The Kingly Book is a model of completeness combined with conciseness.

In The Kingly Book diseases of the eye are treated, first, in the 13th chapter of the 10th book of the 1st part. The subjects are all discussed, as one might readily suppose, in exact anatomical order: Diseases of the Conjunctiva; Diseases of the Cornea; Diseases of the Ciliary Region; Diseases which Arise between the Pupil and the Lens [in this department, following the fashion of the time, he included cataract]; Diseases of the Lids; Diseases of the Corner of the Eye; Diseases of the Optic Nerve; Diseases of the Other Nerves and of the Muscles which Move the Eye and the Lids. In the second (the practical) Division, he speaks for the most part of the cataract operation, as it was practised in his day.

For an account of the cataract operation, as practised among the Arabs, see **History of ophthalmology**; also, **Tabari** and **Ali ben Isa**.—(T. H. S.)

Ali ben Isa. He was also called JESU HALY. This famous writer, the most important of the Arabian ophthalmologists, flourished at Bagdad in the first half of the eleventh century. His *Memorandum Book for Eye-Doctors* was the earliest special work on ophthalmology which has been preserved entire, and it stood, furthermore, as the standard text-book on its subject not only in Islam but also throughout Christendom for several centuries. We may add that, even today, it is in use among the Arabs. It underwent, soon after its first appearance, two Latin and one Hebrew translation. The only complete translation, however, into a modern European tongue is that of Hirschberg and Lippert (Ali ben Isa, *Errinerungsbuch für Augenärzte, aus arabischen Handschriften übersetzt und erlautert*. Leipzig, 1904.)

Because of its classical character and historical importance we shall consider the Memorandum book in considerable detail. The work is divided into three books, the subjects of which are as follows: (I) The Anatomy and Physiology of the Eye, (II) The Diseases of the Eye which are Recognizable by the Senses, (III) The Diseases of the Eye which are not Recognizable by the Senses. We shall review each of these books in its order.*

Book I. THE ANATOMY AND PHYSIOLOGY OF THE EYE. This book follows Galen (2d century A. D.) very closely. After a few pre-

* I have followed very closely the exposition of Hirschberg, as needs must be in a case like this. Until the monumental labors of this distinguished writer had been completed the Memorandum-Book of Ali ben Isa (as well as numerous other important writings from the Arabic middle ages) were practically inaccessible to the writers and workers of the west.

liminary generalities concerning the needs and nature of the eye, the author proceeds to describe and discuss the various parts of that organ, and, incidentally, their functions. The crystalline humor, he says, is the essential organ of vision. It is wholly devoid of color, in order that it may be the more easily affected by all hues and tints. It is somewhat curved, which renders it less susceptible to injury, yet, at the same time, moderately flattened, in order that numerous objects of sight may at any one time stand opposite to it. Behind this body lies the vitreous humor, on which the crystalline lens depends for its nourishment. Then comes the retina, made up of blood-vessels and the terminal expansion of the optic nerve. The retina feeds the vitreous humor, and, through this humor, carries the power of vision to the crystalline. The most anterior parts of the retina are closely united with the equator of the lens. The optic nerve is covered by both the membranes of the brain, the hard one being for protection, the soft one, however, for nourishment. From the optic nerve itself proceeds the retina, from the softer covering thereof, the choroid. The choroid, as well as the retina, is closely incorporated with the equator of the lens, and, all along the way from the nerve to the crystalline body, it provides nourishment to the retina. The sclera is simply a prolongation of the harder covering, or coat, of the nerve. It protects the whole eye.

In front of the crystalline humor, lies the arachnoid membrane [anterior capsule of the lens]; in this, if you peer within another's eye, you see the image of yourself. In front of the arachnoid lies the aqueous humor, which keeps both the uvea and the crystalline moist. It also serves to conduct the visual power from the lens to the outer world, and, in return, the inward-entering image of the object that is looked at. In front of the aqueous humor lies the uvea.*

It is shaggy on its rear, smooth on its anterior, surface. It nourishes the aqueous humor, as well as the cornea, which has no vessels of its own. Further, it separates the crystal from the cornea, and its central perforation collects the visual pneuma (or spirit). Next forward comes the cornea, transparent, hard, and composed of four layers. The conjunctiva binds the eye together from without.

The eye possesses nine muscles. Of these, the one in the greater corner of the eye moves the globe in the direction of the nose; the one in the smaller corner, however, moves it toward the temple. An upper muscle directs the eye upward, and a lower one turns it down.

* Here, as Hirschberg points out, is plainly to be perceived the (of course mistaken) view of the Arabs, as well as of the ancients, that the iris lies snugly in contact with the cornea.

Two are oblique, and rotate the eye. Three are seated at the root of the optic nerve, and hold it tense. [We may here remark that Ali ben Isa shared the common error of his and all preceding days, to the effect that the ocular musculature of man is identical with that of the herbivora—an error which very naturally arose from the fact that dissections were practised chiefly on cattle, swine, apes, etc., and seldom, if at all, on human beings.]

These muscles are set in motion by the second pair of nerves [today called the "third" pair]. These nerves originate in the brain, behind the optic nerves.

The upper lid has a muscle to raise it, on the upper margin of the eye-cavity; and two to lower it, in the two corners of the eye. The under lid has no muscle.

The optic nerve arises from the two sides of the posterior portion of the anterior ventricles of the brain. As the two nerves pass forward, they curve toward the median line, until they come together and unite. Thus the hollow spaces in the two nerves mutually communicate. Thus, too, arises the figure of the Greek letter X, or chi. The nerves then separate, and each proceeds to the eye corresponding to the side of the brain from which the nerve in question had its origin.

It can be proved that the hollow spaces in the two nerves communicate, the one with the other, and in this way: If a person closes one eye only, the pupil of the open eye enlarges. There are two advantages of this arrangement: (1) When either eye is lost, the total quantity of light is directed to the other. (2) With two eyes, a person is enabled to behold each object singly.

The manner in which the visual pneuma (or spirit) has its origin, is as follows: In the liver is formed the natural spirit. The clearer part of this, after passing to the heart, becomes the vital spirit. The clearer part of this, again, after mixing with the air of the breath, reaches the brain, and there is formed into the soul-spirit. This presses through the hollow passages of the optic nerves to the eyes. Then sight takes place in this manner. The visual spirit runs out from the eye, unites with the external air, and proceeds to surround the object at which the eye is looking. Then it goes back into the eye through the cornea and the pupil, and prints an impression on the crystalline humor. [It will be especially noted that, according to Ali ben Isa, as well as according to the ancients, the picture is formed on the anterior surface of the lens, not on the retina.]

Book II. THE VISIBLE DISEASES OF THE EYE, AND THEIR TREATMENT. There are four periods of a disease: Beginning, increase, height,

and abatement. In the beginning should be employed repressive remedies; in the end, those which are solvent. Ocular remedies come from all the three natural kingdoms. In combined remedies, simple medicines are joined together, either against the disease, or for the strengthening of the medicine, or for their better penetration into the ocular membranes, or to make them hold fast, or for the preservation of their medicinal virtues, or for the lessening of their severity.

The after-effect of a severe medicine must have ceased before that medicine can be employed again.

Of diseases of the lids there are twenty-nine. Of these the most important is trachoma, of which there are four stages. The first stage exhibits little grains in the inner surfaces of the lids. The treatment is by evacuation and the rubbing-in of the red, sharp collyrium. A radical cure is produced by the sprinkling-in of powdered galls. The second stage is distinguished by a greater rawness. Here, too, the rubbing is the principal thing. But, first, any accompanying ophthalmia and ulceration must be removed. A collyrium of verdigris is good, if preceded by vigorous rubbing with the sound. The third stage is still worse, and exhibits on the inner surface of the lid the picture of a burst fig. The treatment consists of evacuation and the rubbing with king's-salve and green collyrium. The fourth stage is even worse; there are pain and hardness and often disease of the hairs. The chief remedy is rubbing with the instrument which is called the rose [see sketch, herein, of **Halifa**] and with the scalpel. Generally, when the trachoma has become chronic and inveterate, nothing at all is of any use, except the rubbing with sugar and the iron; but so long as it is still thin and in the beginning, it can be corrected by sharp medicines.

Chalazion is treated with salves, and, in necessary cases, by incision. So, too, calcifications. Growing together [symblepharon] presents itself (1) between lid and cornea (2) between lid and conjunctiva (3) between the two lids. The first two should be carefully separated, the latter split upon the sound, or with the sickle. [Ali ben Isa's treatment of symblepharon, it will be observed, was not very well developed.]

Superfluous lashes are situated behind the natural lashes, and lean away from them. They can be cured in five ways: (1) By strong medicines, or by rubbing in rock-salt or frog's blood, after pulling out the hairs. (2) Through glueing the hairs with mastich and the like, when the misplaced lashes are few in number. (3) In this case, also, by burning with a thin-headed iron. (4) By the threading-in

of the hair, or of the few hairs. (5) When the false hairs are numerous, the tucking-up of the lid should be considered—that is, by the splitting of the edge of the lid, folding the lid-skin, and then removing the requisite portion.

The inturning of the natural hairs requires the same treatment as the superfluous lashes.

For lice in the lid, one should work-in an oil containing alum and louse-wort.

Of chemosis, the first variety is caused by bloody matter. It requiries blood-letting. If the patient be an infant, the venesection should be performed on the nurse. [Then follows a list of local applications.] The second variety is caused by bilious blood, and its color varies even to greenish.

Inflammation of the lid margins produces, in the region of the lashes, thickening, reddening, the formation of ulcers, and, if it be chronic, the falling out of the lashes. The treatment is chiefly with the mild red salve. Itching in the lids requires frequent bathing and, locally, dross of zinc.

The hydatid is a fatty-sticky body, seated externally on the upper lid, near the brow, elastic, and occurring chiefly in children and those in whom the moist element preponderates. The lid is heavy, the eyes weep and are fearful of the light. One must thin the diet, let blood, cup, and remove the hydatid by operation.

The mulberry consists of red, relaxed flesh, which hangs down, mostly in the under lid, occasionally also in the upper. Sometimes blood runs out of it. The treatment consists in purification of the body and in the eradication of the tumor, in necessary cases with after-treatment by caustics.

The cystic tumor is not, like the abscess, accompanied by inflammatory swelling and pain, but it has an envelope peculiar to itself. There are four varieties: (1) the honey sack (2) the water-gruel sack (3) the flesh sack (4) the tallow sack. During the extirpation one must exercise care to destroy the sack, because otherwise a particle remains. Such a particle should be treated with caustics.

Relaxation of the lid is lengthening of the upper lid, so that the lashes curve against the eyeball. One should anoint the lid with drying remedies; in necessary cases perform a lifting operation. Dead blood in the lid occurs in consequence of injury and of vomiting. If the lid is hot, one should cool it with sandal and the like; afterwards, one should bathe it with lukewarm salt and water.

Diseases of the tear-corner are of three kinds: Tear-fistula, caruncle-swelling, and overflow of tears. Tear-swelling is an abscess

between the greater canthus and the nose. Sometimes it opens, and, if neglected, becomes a fistula and threatens even the eyeball. There is also a second kind of tear-swelling, which does not open, under pressure throws out no pus, now enlarges and now gets smaller. The treatment is with medicines for the lighter cases; for the others, cautery and trepannation.

Treat this disease, like the abscess, with blood-letting and purgation, and rub the place with celandine, saffron, myrrh, and the like. When it has opened, bind it up with a verdigris pad. But it is best to hasten with the surgical treatment. The form which inclines outwardly is the easier to cure. One must split it, remove the corrupted flesh, and rasp the bone. If the sound indicates rawness, the bone is diseased and cauterization is necessary. This should be performed with small burners. The perforation (trepannation) is carried out, while turning, with a solid, three-cornered sound, until blood presents itself in the mouth and nose. If the site of the fistula is hidden from thee, then do not press out [the contents of the swelling] for two or three days, till the pus has collected therein.

The caruncle, which lies on the upper end of the canal between eye and nose, sometimes undergoes an enlargement, and then prevents the tears from pouring themselves into the nose; wherefrom originates a lachrymal abscess. Treat the enlarged caruncle with strong medicines, like verdigris; however, one must leave the normal amount of caruncle, or epiphora would follow in consequence.

Epiphora is based upon wasting of the caruncle, so that that organ no longer sufficies to prevent the overflow of tears. If the caruncle is entirely atrophied, there is no cure. If it is only diminished in size, it can be enlarged by celandine, saffron, and alum.

The blood-spot consists of blood which has escaped into the conjunctiva as a result of tearing in the bloodvessels; either from injury, or from vomiting, or without perceptible cause. In order to avoid inflammation, one should let blood and drop in woman's milk.

Pterygium [zafara-finger-nail] is a tendinous elevation of the conjunctiva, proceeding as a rule from the larger corner of the eye to the cornea, and even on into that membrane. It restrains the movement of the eye, and sometimes deteriorates the sight. The kind which is in the beginning and is still thin, is treated with strong medicine, as with burnt copper, ammoniated salt, and the like, also with lid-cosmetic. If, however, it is large and hard and in-rooted, nothing helps but an operation. If it permits of elevation with a little hook. then one can easily peal it off with a lancet. If, however, it has grown tight, then one should incise it a little at the sides with

the points of the scissors, in order to assist the lancet in getting under it. On the cornea operate with the utmost gentleness; in the larger corner of the eye cut away the pterygium with the scissors, however in such a way that the caruncle is left behind. Often the pterygium holds the conjunctiva fast. This membrane should not be cut away, otherwise squint will ensue.

Pannus [a disease not mentioned by the writers of antiquity] is a net of thick, blood-filled vessels, which spread themselves over the eyeball and also covers the cornea, and makes itself red and thick, and is accompanied by tears, redness, and itching. One kind is deeply seated. It requires evacuation of the body and purification of the head, as well as also inunction with black collyrium and lid-cosmetic. The second kind is superficial. One sees in the conjunctiva red vessels, and upon the cornea something like a smoke, and therein red vessels. With these are heat, pain, and fear of light. If the pannus is chronic, nothing helps but an operation.

The phlyctenule is a solid elevation in the conjunctiva; now red, now white; now in the larger now in the smaller corner of the eye; also multiple, like a string of pearls, near the margin of the cornea; now accompanied by a red, and now by a white, eyeball. Strew queen-powder [made of Persian gum, white sugar, coral, etc., finely powdered] into the eye. If redness of the ball is present, precede the strewing of the powder by the use of the white salve.

Of diseases of the cornea there are thirteen. Of ulcers there are seven kinds, four of which are superficial. The first is called "smoke." The second is "cloud," which is whiter and smaller than the first kind. The third is called "argemon," and is seated on the rim of the cornea, and is red on the outer, but white on the inner side. The name of the fourth is "nicoma," that is, "branching." For its depth, the first variety is called "bothrion," that is, "ditch." The second is called "faluma," that is, "the painful;" it is broader and less deep. The third is called "ficauma," that is, "the burning;" it is a dirty, crusty ulcer, which, in long-standing cases, causes the flowing-out of the humors of the eye.

At first, one should bleed and purge; after that employ upon the eye what restrains and numbs, like the white salve composed of lead and opium. The patient should sleep upon the side of the ulcer, in order that the pus may not consume the ocular membranes. Thin the diet, but, in cases of long duration, not too much. If the opening of the ulcer delays, drop into the eye buck-horn decoction. After the opening, cleansing remedies are proper, like the white salve which contains cadmia, etc.

The pustule of the cornea arises by exudation between two of its four layers. The one behind the uppermost is the lightest; it is black and clear. That behind the third layer is the worst, and appears white. Not all pustules discharge, sometimes their contents are absorbed. The treatment of pustules is the same as that of ulcers; only when the pustule becomes chronic and does not open, then must thou treat it with sharp, opening remedies—wolf's milk, asafœtida, etc. Of corneal scars there are two varieties—the little cloud and the white spot. For these the evacuation of the body is not indicated, but only the local employment of purifying remedies.

Cancer in the cornea arises from the black-bile humor, with most intense pain and is as incurable as the leprosy. However, one ought to try to lessen pain; one should give the patient fresh milk and lamb's meat, purify the body and put into the eye a powder of cadmia and hæmatite.

Of pus behind the cornea there are two varieties. The one has the form of the section of a nail, and occupies a very small place. The other occupies a larger space, so that sometimes the matter covers the entire black, and it is the more unkindly.

The arching forward of the cornea, which, indeed, should be distinguished from pustule, is treated by bandaging and by astringent remedies.

Of diseases of the iris there are four. The enlargement of the pupil is bad, if congenital; worse, if acquired; for it occasions a scattering of the sight. The cause is either (1) dryness of the uvea; (2) inflammation of the uvea, as a result of injury or of inflammation of the brain with headache (3) increase in the egg-white humor [aqueous]. In the latter form, there follows complete blindness; in all the others, the complete or partial escape of the visual power is peculiar: the patient sees all objects smaller.

The narrowing of the pupil is also either congenital, and then to be commended; or acquired, and then very bad. The latter arises from six causes: (1) moist relaxation of the uvea (2) diminution of the egg-white humor [aqueous] (3) earthy, hard obstruction of the pupil; so that one no more can see the hole (4) excessive heat, which draws the hole together, in consequence of inflammation of the brain-membrane or of a hot abscess (5) a very large abscess, which presses the pupil together (6) dryness of the mixing of the uvea, especially in old men. In narrowing of the pupil, one sees things larger; the cause is thickening of the visual spirit.

Of prolapse of the uvea there are four kinds. In the first, the cornea is torn; there presents itself an appearance which resembles

the head of an ant. In the second, the formation is larger, and is called the fly's-head. The third is still larger, touches the lashes, injures the eye and is called the grape-shaped elevation [staphyloma]. The fourth is scarred over, and, according to Paulus, carries the name of "the nail-head." "Before the lips of the corneal wound get thick, thou shouldst bind up strongly. Bestrew the eye with hæmatite, ashes of zinc, etc. Let the bandage stay on, and, in the 3rd and 4th varieties, let into the compress a lead plate of a weight of 5-10 drachmas. If, however, the prolapse is already old, in case more than two years have gone by, then do not attempt any treatment, thou wilt not effect a cure. If thou wouldst merely improve the appearance of the eye, then treat it with the iron—but not with the expectation that any sight will return. Pass a needle under the prolapse, underbind it, and cut it off. A few physicians reject the cutting off: they underbind the prolapse until it dries up and falls off with the threads."

The tearing of the pupil, that is, the solution of continuity in the uvea, is either small and not complete—when the vision is but little affected; or it is large and complete, when the egg-white humor [aqueous] flows away and out through the cornea; the crystal is not protected, and the visual radiation cannot collect itself.

The cataract is an exudation, which hardens in the anterior plane of the pupil; it sets a partition-wall between the crystal and the outgoing light. [The reader will here observe the implied reference to the predominant ancient and mediæval theory of vision, which was that a visual spirit—here called "the outgoing light"—passed from the brain, forward through the supposedly existent hollow passage in the optic nerve to the eyeball, then, via the retina to the margin of the lens (with which the terminal retinal filaments were supposed to be intimately incorporated) thence, through the lens, and out of it via its anterior surface, on through the pupil and into the outer atmosphere, where, mingling either with the air or with certain elements therein, it proceeded to the object looked at, surrounded it, and returned via pupil, lens, retina and nerve, to the brain with the visual information so secured.] Its beginning is difficult to recognize. However, the physician sees in the patient's pupil a kind of fog or cloud, and the patient complains of seeing things like flies or gnats. If the cataract has become confirmed, it is easy to recognize: the sight is lost and the pupillary color is changed. There are eleven colors of cataracts (1) air-color (2) glass-color (3) white (4) sky-blue (5) green (6) yellow (7) red, or gold-color (8) blue (9) gypsum-color (10) black (11) quicksilver-like.

Causes of cataract-formation are wounding, old age, long-continued illness, chronic headache, moist and thick diet.

The cataract-exudate lies between uvea and cornea. [The reader will recall in this connection that, until the absolute demonstrations of Brisseau and Maitre-Jean in 1705, it was wholly unknown that a cataract is really an opaque crystalline lens, and not an exudate into a space—absolutely imaginary, of course—between the crystalline and the pupil, or between the pupil and the cornea.] Not all cataracts are cured by operation, the air-colored, however, of a verity, if it is not complicated with stoppage of the optic nerve or sight-disturbing contraction of the pupil and when it has arrived at ripeness.

Testing for an operable cataract. "(1) The unripe cataract becomes wider, if thou rubbest thy thumb for a moment against the lid. (2) The color of the easily operable cataract is that of steel or lead, that of the almost hardened, however, like gypsum or a hailstone. (3) If one closes the other eye, the pupil of the cataract-eye enlarges. (4) The cataract eye retains the perception of light. (5) Lay a bunch of wadding on the eye, blow against it, and take it away immediately. In case the cataract moves and is clear, an operation is required.

Take care not to perform the operation when the body is overfilled, or when there exists a corruption of the bodily humors, or headache, cough, cold, or the like; and when the pupil does not widen and contract, even though the cataract seem clear. Cataract from an injury thou needest not operate upon, because a piece thereof will remain in the hole of the pupil." [Probably the author has in mind the capsular involvement.]

Treatment: In the beginning of a cataract, purify body and brain by purgation and phlebotomy. Forbid moist, thick foods. Stroke the eye with gall-remedies, etc., but this diet helps only in the beginning of the affection. When, however, the cataract has become confirmed, and has formed itself into a favorable one, then proceed to the operation with foresight and care. Have the patient sit in the shadow, with his face to the light. "Sit thou correspondingly higher. Bandage the other eye, in order that it may not, by its movement, excite movement in the eye which is under operation, and in order that thy testing, after a resultful operation, may be with one eye only. The assistant, behind him, should hold his head. Lift his upper lid, let him look toward his nose. Remove the tail-end of the cataract-needle by its own breadth templewards from the margin of the cornea—a little higher than the center of the pupil—

and make therewith a puncture in the conjunctiva. Then turn the instrument round, set the three-cornered point upon the marked spot, and press hard until thou feelest that it has arrived in a roomy space. Thereupon, let the point be a little inclined toward the temporal side, while the thumb and forefinger of thine other hand, between the lids, hold fast the ball of the eye. The extent of the inward pushing should be the distance of the point of perforation from the margin of the pupil. [Here again comes in the mediæval—as well as ancient—misconception of what it is that constitutes a cataract.] Then, too, the needle should rest firmly on the thumb. At this point speak kindly to the patient, that his anxiety may be allayed. [Ali ben Isa seems to have been a gentle and thoughtful man, as well as an experienced and skilful operator.] Now lay upon the eye a pad of new cotton, and blow upon it with warm breath. Then turn the needle a little until thou seest it above the cataract, for the copper is visible on account of the clearness of the cornea. [For a description of the instruments employed in ocular surgery during the Arabic middle ages, see the sketch of **Halifa.**] The uvea [iris] is, in that moment when thou turnest the needle, thrust back and not perforated. If the needle has not come to the place of the cataract, then push it a little forward; if it has gone past, draw it back a little, until it rests exactly above the cataract. Then raise the handle of the cataract-needle a little upward; immediately the cataract sinks downward: The velvet-body of the iris draws upon it by means of its tufts. Do not hasten to withdraw the needle at once.

If the cataract stays down, it is well. If it mounts again, press it once more down. If it still returns, thou oughtest to scatter it in different directions. If, however, it has gone down, then draw the needle out, and, indeed, very gradually, the while turning it. Bandage, bed the patient in the dark, let him lie as if dead, with attentive service, and take only liquid diet. On the third day, bandage anew, and let him sit up. Bandage until the seventeenth day."

Now and then the conjunctiva is lax, so that the needle does not enter well: then make first the perforation with a lancet, and afterward introduce the needle.

Book III. THE INVISIBLE DISEASES OF THE EYE.

The visual appearances produced by cataract and those proceeding from stomach and brain should be distinguished. If the appearance be alike in the two eyes, as to color, size and time, they arise from disease of the stomach. If different in the two eyes, or occuring in one eye only, this indicates the presence of a cataract. So, too, when one of the two pupils is the cloudier. If three or four

months have already passed since the beginning of the visual appearances, without they being able to detect a trace of fog in the patient's eye, then the trouble arises from disease of the stomach. Likewise, when it is made worse by indigestion. The pathognomonic sign of visual appearances proceeding from disease of the brain is simultaneous inflammation in the head, while the eyes appear to be sound.

If it comes from the stomach, purify with the bitter remedies, if from the brain, give to drink of barley-water and make cooling applications to the temples; if from sharpness of the sense-perception, give benumbing remedies; if from the beginning of a cataract, then employ the remedies already mentioned.

Of diseases of the egg-white humor [aqueous] there are: color change, dryness, dryness of the separate parts of the structure, enlargement [increase in quantity] thinning, thickening.

If the egg-white humor become too plentiful, there forms a complete partition wall between the pupil and the light; on the other hand, an insufficient separation if it becomes too scanty. If its inspissation be moderate, that hinders vision in the distance; if excessive, it results in the formation of cataract. If the egg-white becomes gray, the person sees as if in a fog; but red in case it be tinctured with blood, and yellow in case of jaundice. The discoloration of the egg-white sometimes occurs only at certain times, because of vapors from the stomach; or only in certain of its parts. Also the drying can occur either in parts or throughout the whole humor; in the latter case the eyeball diminishes in size and is blind. In thickening, enlargement, and liquefaction, the cataract-treatment is proper; in the drying out and the diminution, that of wasting of the eyeball.

Of diseases of the crystalline humor there are sixteen. Shifting to right or left causes in children squint, that upward or downward, double vision. Discoloration (according to one of the four kinds) causes a corresponding colored vision. Dislocation forward makes a blue, backward, a black, eye: this causes no harm to the power of vision. Enlargement produces smaller-vision, diminution, on the other hand, larger-vision. Drying up of the crystal causes a blue condition (glaucoma) and blindness, liquefaction, on the contrary, water-eye. Hardening and thickening annihilates the visual power.

The visual spirit suffers injury in relation either to its quantity or its quality, and both, always, in one of two ways. If it is copious, the person sees far and near. If it is scanty, only things near are seen. If it is thick, then the sight is dull. If it is thin, then is seen distinctly only that which is near. Whoever sees only in the dis-

tance and not in the near, like an old man, on account of the thick or moist visual spirit, he must be evacuated, avoid warm food, and place in the eye styptic medicine or lid-cosmetic. Whoever sees in the near and not in the distance, on account of dryness or scantiness of the visual spirit, is hard to cure; one should order moist food and moistening remedies.

Nightblindness arises either from moistness of the egg-white, or from thickening of the visual spirit, or from liquefaction or clouding of the crystal, or from continually remaining in the sun. One must make the diet thin, and rub into the eye sharp medicines. While goat-liver is being roasted, have the patient lean over its steam, rub the eye with the broth, and eat up the roasted liver.

Dayblindness arises from dryness or scantiness of the visual spirit. These patients should be treated with that which moistens head and brain, and be directed to bathe frequently in luke-warm fresh water.

Of diseases of the vitreous humor there are twelve: Alteration of the color into reddish, yellowish, blackish, whitish; liquefaction, dessication; increase, diminution; hardening, thickening; solution of continuity. Every injury which befalls the vitreous humor, affects also the crystal. The treatment should be according to the predominant mixture in the body and in the head.

The diseases of the retina arise either from an improper mixture [dyscrasia] or from a solution of continuity. In the latter case, vision ceases, because of the light pouring out over the entire eye.

The diseases of the optic nerve are of three kinds: the first kind includes the eight diseases of its homogeneous parts, besides expansion and contraction, likewise evaporation of the visual spirit; the second kind comprises the organic diseases, like obstruction, compression, inflammatory swelling and the like; the third is the separation of continuity. All diseases of this nerve impair the visual power—either strongly or moderately or little. Sometimes the visual power disappears as a result of disease of the brain. That is recognized by a good diagnosis.

The expansion, or scattering, of the light arises either from dilatation of the pupil; or from tearing of the retina—then sudden; or from dilatation of the light-nerves. Dilatation is a disease, expansion the symptom. Hasten with the treatment of the head pain; stroke the eye with the styptic collyrium and all the remedies of use in the beginning of cataract.

Obstruction, compression, inflammatory swelling of the optic nerves. The first comes from cold, moist secretions, which pass down from the brain to the optic nerve, fill it up, and hinder completely

the exit of the visual spirit. Diagnosis: On closure of the sound eye, the pupil of the diseased eye does not enlarge. Obstruction and inflammatory swelling arises from abundant moisture, which pours into the nerve itself. [The anatomical supposition was that the optic nerve contained a hollow space or way, for the passage of the "visual spirit"—which, supposedly, passed out from the eye for the purpose of examining objects and returning with information. Our author bases on the anatomical supposition the pathological suppositions (1) that obstruction of the nerve is caused by cold and moist secretions blocking up the passage-way, or lumen, of the nerve, while (2) compression and inflammatory swelling in the nerve are caused by an exudation, or extravasation, of moisture into the nerve-tissue itself.] In these two conditions the eye sees a little, the patient has a feeling of weight in the depth of the eye-cavity. [As the reader has probably already noticed, "obstruction" is our "atrophy," and the other two forms of trouble are "neuritis."]

In tearing [dilaceration] of the optic nerve the eye lies deep, after it has been driven forward, and is blinded. This is the consequence of a thrust or a blow, and is incurable. If spasm attacks the muscles at the place of disemboguement of the optic nerve, then this fastens the eye; if paralysis, then results ocular prolapse.

Prolapse of the eye arises either from paralysis of these muscles or from an attempt at throttling, or in consequence of the pain of grief. [Had he in mind Basedow's disease?] In the first variety, purify the body, stroke the eye with binding and strengthening remedies, and temple, forehead, and front-head with labdanum. In the second variety, blood-letting is proper, in the third, the evocation of the monthly purification. For the eye employ astringent remedies and the bandage, also with a lead plate. Wasting is diminution and flattening of the entire eye. Gymnastics, massage, oily food, a light collyrium of the dross of zinc, cadmia, etc., are to be advised.

Diseases of the choroid are: corruption of the mixture [dyscrasia] —either a simple, as the warm, cold, moist, dry, or a compound, as the warm-dry, cold-moist—besides thickening, overfilling, inflammatory swelling and the like. Always the crystal suffers from these, and, in the case of inflammatory swelling, the optic nerve also.

The sclera too is attacked by corruption of the mixture or solution of continuity. The diagnosis of the former rests on supposition, according to the predominant mixture in the body, and in accordance with that too the treatment is arranged.

The muscles of motion fall into spasm or paralysis. If the upper muscle cramps, it draws the eye upward; if it is paralysed, the eye

goes downward. In a similar way in the case of the lower muscle. Through both of these arises that kind of squint which sees a thing as two.

If the muscle which lies in the larger angle of the eye is paralysed, the eye draws back into the smaller angle. In a similar way it happens with the muscle which lies in the smaller angle. This is the squint of children.

Paralysis of one of the two turning-muscles (obliqui) occasions an oblique position of the eyes.

The squint of children which exists from birth is treated by directing (training) the vision straight. [How old, after all, is this new procedure!] The kind of squint which is later acquired, arises from heat and dryness [i. e., of the bodily humors, not the environment] from diseases of the head, and is treated by the cure for hyphema.

Weakness of vision results from many causes, from obstruction of the optic nerve, narrowing and widening of the pupil, etc. But also on the side of the brain—then shouldst thou treat this. The treatment of weak sight is that of cataract in its beginning. Keep the patient away from salty, sour, thick, vaporous foods. Give him wormwood syrup or vinegar of sea-onion. Bleed from the veins of the forehead or from those of the corners of the eyes, employ collyria of sagapen, opoponax, benjamin gum, and the like. The weakness of sight produced by continual weeping and by drying out, demands moistening. The visual weakness of the convalescent, one generally does not treat—except by strengthening the patient.

The preservation of the health of the eye is effected by the way of living. The healthful way of living is different for every person, according to his temperament. The health of the eye is preserved by the giving up of everything which has a weakening effect on the sight; and by the rubbing of such medicines as hinder moistures —dross of zinc, cadmia, etc. The collyrium called "clarifier of the eyes of sculptors" consists of pomegranate juice, aloe, pepper, and rocksalt: the older the better.

Headache and migraine, which follow pain in the eyes, belong to the worst symptoms. Sometimes the pain radiates to the roots of the eyes. In hot inflammation of the head occur, simultaneously, madness and protrusion of the eyeballs. The different kinds of headache are discriminated by fine diagnosis. Hast thou correctly recognized the cause, then do not quickly change the treatment, even though results are not secured immediately.

By excision of the temporal arteries and their cauterization are

treated headache and sharp, biting catarrhs and heat with abscess in the temporal muscles and chemosis. As to the treatment of the matters which flow down into the eye, those which come down into the eye from the outer surface of the skull heal easily with salve, together with the abstraction of blood from the head-veins and the cauterization of these vessels; but those matters which descend from the inner surface of the skull are difficult to heal.

Much space has been given to Ali ben Isa and his wonderful *Memorandum-Book for Eye-Doctors,* because in the opinion of the writer, he is the most important ophthalmologist, or at all events, ophthalmographer, between the beginning of time and the 18th century A. D.—(T. H. S.)

Alizarin. (G.) Alizarine.

Alkalescenz. (G.) Alkalescence.

Alkaliblau. (G.) Alkaline-blue (litmus).

Alkalien. (G.) Alkaline.

Alkaline antiseptic. See **Dobell's Solution.**

Alkalisch. (G.) Alkaline.

Alkalisiren. (G.) To make or render alkaline.

Alkalisirung. (G.) Alkalization.

Alkalität. (G.) Alkalinity.

Alkalizität. (G.) Alkalinity.

Alkaloide. (G.) Alkaloids.

Alkanamusali. Said to have been an Armenian. This man was the author of a celebrated work in Arabic on the diseases of the eye. See **Canamusali de Baldach.**—(T. H. S.)

Alkanna. (G.) Alkanet.

Alkannarot. (G.) Anchusin.

Alkannawurzel. (G.) Alkanet root.

Alkannin. (G.) Anchusin.

Alketas of Halikos. The votive-tablet of this classical patient was exhumed in 1883 from the ruins of the temple of Asklepios at Epidaurus. It presents the following typical case-record from the pre-Hippocratic period: "Alketas of Halikos. This person was blind, and saw a vision. It appeared to him as if the god came to him, and opened his eyes with the fingers, when, for the first time, he beheld the trees in the sanctuary. As it became day, he left the temple, healed."—(T. H. S.)

Alkohol. (G.) Alcohol.

Alkoholauszug. (G.) Alcoholic extract.

Alkoholbestimmung. (G.) Estimation of alcohol.

Alkoholdämpfe. (G.) Alcohol vapor.

Alkoholfrei. (G.) Non-alcoholic.
Alkoholgärung. (G.) Alcoholic fermentation.
Alkoholgehalt. (G.) Amount of alcohol contained.
Alkoholgemische. (G.) Alcohol diluted.
Alkoholhaltig. (G.) Containing alcohol.
Alkoholhärtung. (G.) Alcoholic hardening, or to indurate.
Alkoholiker. (G.) One who drinks too much alcohol.
Alkoholisch. (G.) Alcoholic.
Alkoholismus. (G.), n. The various phenomena resulting from the ingestion of alcoholic liquors. Alcoholism.
Alkoholkrankheit. (G.) A disease from alcohol.
Alkoholmesser. (G.) Alcoholometer.
Alkoholmissbrauch. (G.) Abuse of alcohol.
Alkoholometer. (G.) Alcoholometer.
Alkoholpsychosen. (G.) Mental diseases due to alcohol.
Alkoholreich. (G.) Rich in alcohol.
Alkoholverband. (G.) Alcohol or spirit dressing.
Alkoholvergiftung. (G.) Alcoholic poisoning.
Allantiasis. (L.), f.n. Botulism. An intoxication produced by eating decomposed sausages. Among the symptoms are constipation, nausea, vomiting, imperfect vision, vertigo, muscular impairment, cardiac depression and coma, sometimes terminating in death. See **Toxic amblyopia.**
Allantoin. A proprietary remedy said by W. H. Bailey to stimulate cell growth and promote healing, especially in indolent ulcers of the cornea.
Allentesi. (It.), n. The presence of a foreign body in some part of the human organism.
Allenthèse. (F.), n.f. The entrance of foreign bodies into, the human organism.
Allenthese. (G.), n.f. Penetration of foreign bodies into some portion of the human organism.
Allenthesis. (L.), f.n. Penetration of a foreign body into some part of the human organism.
Allergy. Recent work done along the lines of immunity emphasizes the fact that advances made in one specialty in medicine almost invariably have an important bearing on others. This applies particularly to the recent work done on anaphylaxis, or, more properly, allergy.

Anaphylaxis, or allergy, may be defined as a state of hypersensitiveness due to the introduction into an animal of some foreign protein. Though anaphylaxis was first observed in animals, recent

work indicates that the factors producing this condition in animals probably play an important rôle in the causation of diseases in human beings.

In order that the reader may have a clearer conception of some of the phenomena of anaphylaxis, it might be well to review briefly the method of producing this condition in animals, particularly guinea-pigs, because of the readiness and characteristic manner in which they react. If we inject into a normal guinea-pig a small amount of horse serum, egg-albumin, or some other protein, the animal presents no untoward symptoms. But if this animal is re-inoculated after 12 to 14 days with a small amount of the same protein, it quickly develops symptoms of respiratory failure and dies within a few minutes. If the animal is re-inoculated within 10 days of the first dose, it fails to develop any symptoms and is immune for several weeks to further inoculation with the same protein. The first dose of the protein is called the "sensitizing dose" and the necessary period of time which must elapse before the second dose will produce symptoms, the "incubation period."

In the few acute cases reported in human beings, the symptoms resemble those seen in guinea-pigs. In man there is another form of allergy, the so-called "serum disease." This differs from the type I have just described in that the symptoms do not appear until 8 to 12 days after the serum has been given and are not so severe.

Most of the recent work on anaphylaxis indicates that the symptoms developing after the second inoculation are due to toxic substances liberated by the action of specific ferments on the foreign protein.

Abderhalden and others have shown that the serum of the injected animal contains a specific ferment capable of splitting the protein used for inoculation. Vaughan and his students have shown that toxic substances capable of causing symptoms similar to those observed in anaphylaxis can be obtained from any protein by hydrolysis. It has also been found that similar toxic substances can be obtained from various proteins if the ferment of pus is allowed to act upon them. The work done with bacterial proteins indicates that many of the symptoms observed in infections are probably due to poisons set free as the result of the action of specific ferments on the protein of the bacteria.

For purposes of diagnosis there are several tests to which the general principles of anaphylaxis apply. The first is the Calmette, or tuberculin reaction. Koch, in the early part of his work on tuberculosis, observed that if tubercle bacilli were injected beneath

the skin of a normal guinea-pig there was little, if any, local reaction though the neighboring lymph glands became greatly enlarged and caseous, but, if a tuberculous animal were inoculated beneath the skin with tubercle bacilli, there was a very severe local reaction accompanied by the separation of a slough. In other words, the animal was now hypersensitive to the protein of tubercle bacilli. Trudeau found the same held true for the eye. If tubercle bacilli were injected into a normal rabbit's eye, there was very little immediate reaction, but if they were injected into the eye of a tuberculous animal, the reaction was immediate and very severe. As the result of the above work Calmette has evolved his well known test for tuberculosis. The violent reaction accompanying a positive test is due to the poison liberated as a result of the action of the specific ferment on the protein of the tubercle bacilli contained in the test fluid.

Recently a similar test has been highly recommended by Meyer for glanders. He claims it is more accurate than any of the other laboratory tests. Here again a positive result indicates that the body contained a specific ferment capable of producing a strong poison when brought into contact with the protein of the bacilli of glanders.

Dunbar demonstrated conclusively that hay fever is caused by the pollen of various plants. He found that pollen introduced into the eye of a susceptible individual produced an intense irritation, whilst normal individuals were entirely unaffected by such a procedure. Clowes has recently found that the reaction is strictly specific, and that $\frac{1}{20}$ c. c. of a solution of one in five thousand of the pollen injected into the eye would produce flushing. With these aqueous solutions he was also able to produce definite skin reactions when rubbed into small abrasions. Here again we are dealing with poisons set free by the splitting of the proteins contained in the pollen.

It has been stated that the animals made sensitive to the protein obtained from the crystalline lens of beef react to lens-protein made from animals of widely different species. If this is true it differs from any other known protein and lends added weight to the view that sympathetic ophthalmia is due to hypersensitiveness of the uveal tissues. Many hypotheses have been advanced to explain this condition, but here we shall only discuss the possibility of its being due to hypersensitiveness of the uveal tissues of the other eye. Abderhalden has shown that ferments can be produced in the body which are able to attack some specific tissue protein of the host.

He found, and his observations have been amply confirmed, that the serum of a pregnant woman contains a ferment which will digest placental tissue.

In order that a ferment capable of attacking the normal eye may be produced, it would be necessary that the uveal tissues of the injured eye be destroyed, broken down and then absorbed. The hypersensitiveness would not appear until 10 to 12 days after the absorption of the broken down tissue, probably 14 days or more after the injury had been sustained. This conforms with the history of sympathetic ophthalmia. Of course, sensitization would not occur if the injured eye were removed before absorption of the broken down tissue had occurred. According to this view the changes in the other eye are due primarily to injury to the cells of the uveal tissues caused by the action of a specific ferment. The injury to the tissues is then followed by the usual non-septic inflammatory reaction as indicated by the rather extensive round cell infiltration. (J. W. Jobling). Additional treatment of this subject will be found under **Anaphylaxis.** See also, **Ocular anaphylaxis.**

Allgemein. (G.) General, constitutional.

Allgemeinansteckung. (G.) Constitutional infection.

Allgemeinbefinden. (G.) General condition.

Allgemeinbehandlung. (G.) General or constitutional treatment.

Allgemeinerkrankung. (G.) General or constitutional affection.

Allgemeinerscheinung. (G.) General phenomenon or appearance.

Allgemeinerscheinungen. (G.) General symptoms.

Allgemeingefühl. (G.) General condition.

Allgemeingesundheit. (G.) General health.

Allgemeinkrankheit. (G.) General or constitutional disease.

Allgemeinkrankheiten und Organerkrankungen. (G.) General or constitutional and organic diseases.

Allgemeinstörung. (G.) General disturbance.

Allgemeinveränderung. (G.) General or constitutional change.

Allgemeinvergiftung. (G.) Poisoning of the whole system.

Allgemeinwirkung. (G.) General or constitutional effect.

Allgemeinzustand. (G.) General state or condition.

Allheil. (G.) Panacea; cure all; a sovereign remedy.

Allmählig. (G.) By degrees.

Allochirie. (G.) Allochiria, a perversion of sensation in which an impression received on one side is referred to the opposite side.

Allochroé. (F.), adj. Capable of a change in color. Lacking uniformity of color.

Allochroic. adj. Changeable in color. Not of uniform color.

Allochroism. Variation in or diversity of color.

Allochromasia. (L.), n.f. Color-blindness.

Allochromatic. adj. Varying in coloration.

Allocromasia. (It.), n.f. Color-blindness.

Alloeopathic. Pertaining to or relating to alloeopathy (q. v.). See, also, **Allopathy.**

Alleopathy. A term used by Hahnemann to designate cure by inciting disease "of another kind," and said by him to be preferable to "Allopathy," which term really means "another disease."

Allometropia. According to Matthiessen, this is the variation of refraction for outer areas of the retina from the refraction at the macular region.

Allopathy. This is the term applied by Hahnemann to the school or schools of medicine opposed to homeopathy, and was intended to indicate that method of treating disease by the use of remedies whose action upon the healthy body produces symptoms *different from* those of the disease under treatment. To some extent the term has been adopted by the so-called *regular* school of medicine, although those who study and treat disease in a scientific manner belong to no sect, "-ism" or "-pathy" of any kind whatever.

Allophansäure. (G.) Allophanic acid.

Allorrhythmie. (G.) Allorrhythmia; morbid change in the cardiac rhythm.

Allotriophagia. Tunnel anemia. Tunnelanämie. Dirteater's anemia. Hookworm disease. See **Ankylostomum duodenale.**

Allotropie. (G.) Allotropism.

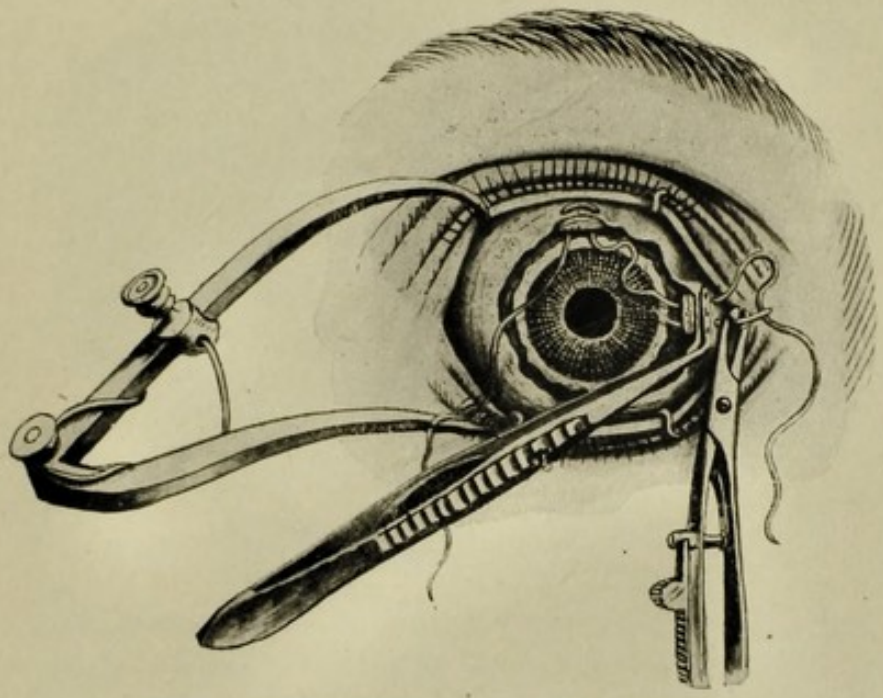
Allotropisch. (G.) Allotropic.

Alloxansäure. (G.) Alloxanic acid.

Alloys of steel. As is well known, steel is frequently alloyed with other metals, and this is an important point in *magnet operations.* W. M. Sweet has written upon the subject, and refers to the increasing use of nickel, manganese and other metals in steel-making, the employment of alloyed steel in the manufacture of tools, etc., for industrial operations. Now the effect of these alloys is to decrease the magnetic property of the steel, therefore to render the extraction of splinters from the eye by the magnet less certain.

Allport's operation for enucleation. This enucleation operation is the same as the Ferrall or Bonnet operation up to the step where the tendons are separated from the eyeball; at this juncture, instead of cutting off the tendons and allowing them to retract into the

socket, one proceeds as follows: The superior rectus is caught on a strabismus hook and pulled away from the eyeball. Another hook is then passed beneath the muscle and while one hook pulls the muscle from the eyeball the other is passed backward and forward between the eyeball and muscle to free entirely the muscle from any fibers connecting the muscle and globe. The second strabismus hook is then withdrawn, leaving the first in place. One blade of a strong pair of Prince's advancement forceps is then placed between the tendon and sclera, taking the place of the remaining strabismus hook, which is now withdrawn. The edge of the con-

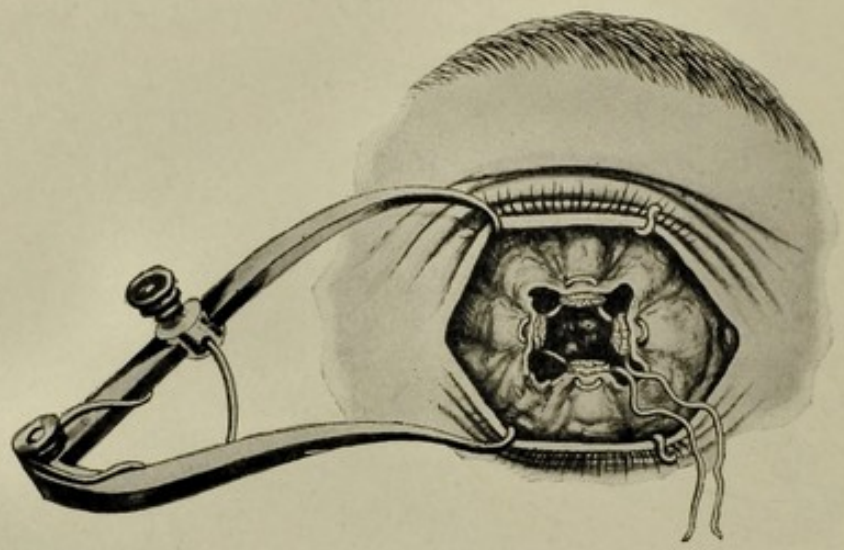


Enucleation of the eyeball. Allport's method.

junctiva lying over the muscle is seized by a pair of forceps and pulled forward, together with the capsule of Tenon, and the outside blade of the Prince's forceps brought down upon them and locked. The bent ends of the forceps now contain the tendon, capsule of Tenon and overlying conjunctiva. The tendon is separated from the eyeball by scissors passed between the forceps and the sclera, being careful not to wound the latter structure.

A needle and catgut suture should now be passed by means of a needle-holder through the conjunctiva, capsule of Tenon and tendon from without inwards and then back again from within outwards. This quilts the entire mass together by means of a firm, solid stitch that will not pull out; after which the two ends of the suture are carefully laid aside so as not to interfere with the next step in the

operation. The external rectus is then picked up, liberated, engaged in the Prince's forceps together with the conjunctiva and capsule of Tenon, cut away from the sclera, quilt-stitched with the same needle and suture, etc. The same steps are taken (in their order) with the inferior and the internal rectus, after which the needle may be withdrawn from the suture. The purse-string suture and its two free ends should be laid carefully aside to facilitate the subsequent steps of the operation which are exactly the same as in the Ferrall or Bonnet operation just described. The operation



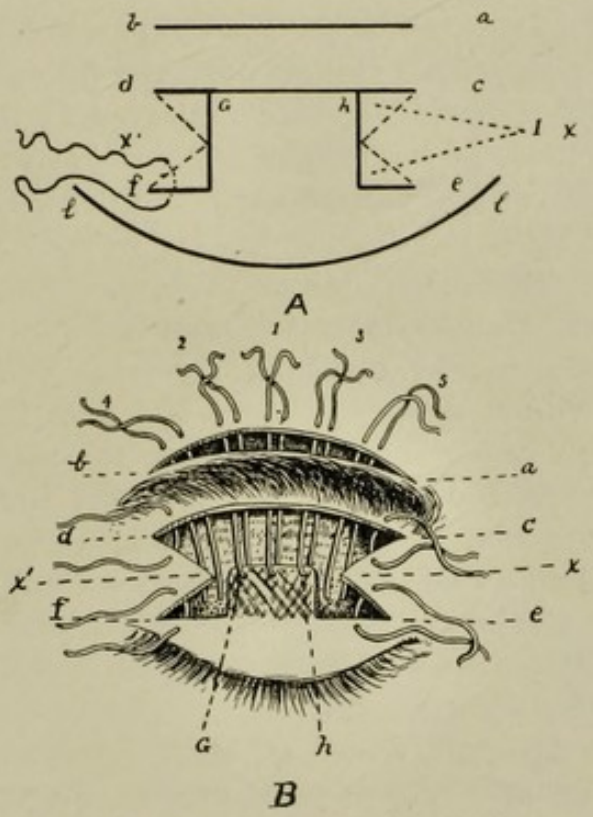
Enucleation of the Eyeball. (Allport.)

is completed by pulling the continuous suture containing the recti muscles, the capsule of Tenon and the conjunctiva together and tying the mass in a firm, hard knot. Great care should be exercised when the scissors are introduced to sever the optic nerve, that the suture is not cut in the process, an accident which is not at all impossible. If, however, this misfortune should occur the muscles should be painstakingly picked up and the continuous, purse-suture re-introduced as before. See, also, **Enucleation of the eyeball.**—(F. A.)

Allport's operation for ptosis. The chief features of this operation are a thorough denudation of the tongue flap so that it may grow to the raw surface of the bridge, and removal of the corners of the lateral flaps on the lid surface, to make them fit more accurately and thus avoid puckering of the lid.

The incisions are made like those described by Panas. (Modification of Panas' Operation for Ptosis. *Jour. Am. Medical Ass'n,* April, 1903; also personal note.) Allport however, making first

the incision above the brow, the length of the palpebral fissure and extending to the bone, *a*, *b*. The second incision, *c*, *d*, is made about the same length as the first, as in the figure, just below the eyebrow, and should also extend to the bone. Two parallel, vertical incisions extend from this incision to points about on a level with the superior border of the tarsus. Horizontal incisions, *e*, *f*, and *g*, *h*, are then made from these, as in the Panas procedure. The



Allport's Operation for Ptosis.

A. Diagram of the Incisions.

B. Field of Operation showing the Sutures in Position.

a, *b*, incision above the eyebrow, extending to the bone.

c, *d*, incision below the eyebrow.

g, *h*, superior border of the tongue flap, separated from its original position along the line of incision, *c*, *d*. The cutaneous surface is denuded of epithelium.

x, *x* lateral flaps, undermined and made pointed by cutting off the corners.

bridge is then undermined from one end to the other, and in addition to this it is everted, and all the soft tissues removed, making this flap, consisting mostly of integument, as thin as possible. The tongue flap should be dissected up, and this he also makes as thin as possible, dissecting away the muscle fibers. The cutaneous surface of the flap is thoroughly scarified (if possible denuded of epithelium) to make it adhere to the under surface of the bridge flap. This is a distinct advantage. The lateral flaps on the side of

the vertical incisions are also undermined and their corners cut off, as indicated in the figure, giving them a pointed appearance. Sutures are introduced, as in the Panas operation, three serving to hold the tongue flap in position under the bridge and uniting it to the upper lip of the superior incision; and two lateral ones, *4* and *5*, double-armed sutures that pass from the conjunctival side of the lid outward through the fascia, the loop remaining on the conjunctival side.

These lateral sutures, as in the Panas operation, serve to prevent ectropion. Four superficial sutures unite the skin at the angles made by cutting off the lateral flaps, as indicated in the drawing. All sutures, except those of the tongue flap, are removed in four days; the others are allowed to remain about ten days, to insure union of the parts.—(W. H. W.)

Alltäglich. (G.) Quotidian; daily.

Allyl alcohol, Oculo-toxic symptoms from. Workers who handle allyl alcohol [C_3H_6O, made by distilling glycerine with oxalic acid; a limpid liquid, with a pungent ordor] and breathe its vapor show marked secretion from the eyes and nose, the conjunctiva becomes reddened, followed by pressure pains in the head and the eyes. Farsightedness is said to occur after long-continued exposure to the action of this poison, and this refractive error is thought to be due to accommodative changes.

Allyl sulphocarbamide. See **Thiosinamine.**

Allyl thiourea. See **Thiosinamine.**

Almond Oil. See **Almonds, Sweet oil of.**

Almonds, Sweet oil of. OLEUM AMYGDALÆ EXPRESSUM. ALMOND OIL. A fixed oil expressed from the kernels of prunus amygdalus, bitter or sweet. It should be nearly colorless, odorless and with a nutty taste. It is slightly soluble in alcohol; very soluble in ether and chloroform. The pure oil consists mostly of triolein with some tripalmitin.

The pure oil makes a good base for eye ointments, especially when mixed with "cold cream," paraffin, wax or other firmer excipient. As a solvent for such alkaloids as atropia, cocaine, eserine, etc., it is probably inferior to castor oil or even olive oil. Like other oils it may be employed as an antidote in burns by lime and strong alkalies.

Al-Muwaffiq b. Saua al-Israili. A Jewish physician, archiater, or principal physician, to Saladdin, concerning whom, according to Hirschberg, Usaibia relates that he was "renowned for the sureness of his art and his superior knowledge in medical science, including ophthalmology and surgery."—(T. H. S.)

Alogie. (G.) Aphasia.

Alone glaucomatoso. (It.). The halo seen about single lights by persons affected with glaucoma.

Alopecia. Baldness. Loss of hair; e. g. alopecia of the eyebrow or eyelashes.

Alopecia areata. When this disease affects the eyelids or the eyelashes the latter may drop out, leaving the surrounding skin soft, smooth, and of a dull-white color. This disease is most commonly found in children and young adults, in which case the hair generally returns after three or four months. The new hair at first is colorless and downy, but later on presents a normal appearance. Fox (*Diseases of the Eye*, p. 52) advises in the way of treatment the administration of arsenic in varying doses according to the age of the patient, and the local application of the faradic current. The close proximity to the cornea contra-indicates the local application of alcohol, capsicum, cantharides and similar irritating preparations usually advised for this affection in the scalp.

Alopecia of the eyelashes. By this condition is understood the partial or entire absence of the cilia due to disease. It may be part of a general alopecia or may be caused by lepra, pityriasis, etc. Some cases of nervous origin are recorded, as, for instance, in Basedow's disease. More commonly, ciliary alopecia is observed with syphilitic alopecia of the scalp and eyebrows. Himly observed ciliary alopecia in scarlet fever; Rosenthal in leukoderma. Carrons de Villars and Cornaz also describe an **alopecia ciliorum congenita.**

Alopecie. (G.) Alopecia.

Alopecie der Wimpern. (G.) Alopecia of the eyelashes.

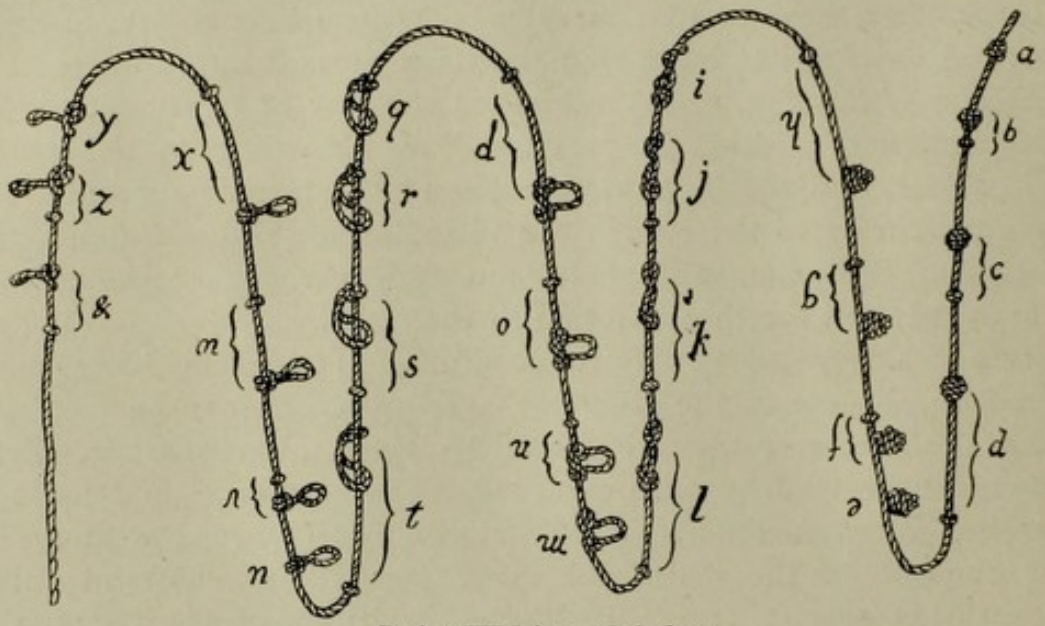
Alpha, Angle. n. See **Angle alpha.**

Alphabets and literature for the blind. We know there have always been attempts among the more ambitious of the blind to devise methods of communication with each other and with their seeing friends beyond the range of speech. Among the early peoples conventional objects to which an arbitrary value was assigned were used for this purpose. The Peruvians employed knotted strings (each knot having its meaning) which were passed like a rosary through the fingers.

The earliest authentic record of tangible letters used by the blind dates back to the sixteenth century; it is ascribed to Francesco Lucas, of Spain. Evidently no further use was made of his invention until Rampezzetto, an Italian, carved letters in wood; but as these were on a solid surface and could be used only after the manner of our stereotyped plates they were of value only in making the blind familiar with the letters of the alphabet.

In 1640 Peter Moreau, a notary, succeeded in casting letters in lead for the blind which gave him a name and a place among the earliest typographers.

It remained, however, for the idealist and philanthropist, Valentin Haüy, Frenchman and the brother of the creator of crystallography, through an accidental circumstance, which he regarded as providential, to make tangible letters practically available for the blind and to establish the first school for the training of those without sight.



String-Writing Alphabet.

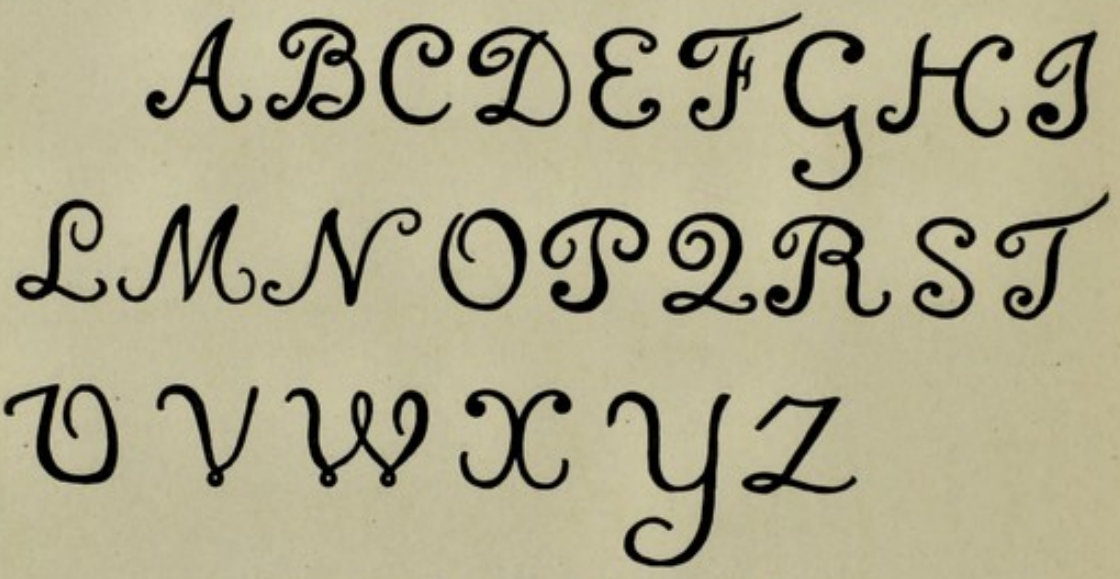
The Fair at St. Ovids was being held in 1771 where great crowds gathered daily. In one of the booths a man named Valindin had collected a group of blind men whom he had dressed in a fantastic way, and who by making sport for the crowd, attracted patrons to his café. The men wore long pointed hats. On their noses were huge paste-board spectacles without glasses. Behind their leader the expanded tail of a peacock and on his head the head-dress of Midas. Placed before a desk on which were music and lights they executed a monotonous chant in which the tenor, basses, and violins all took the same part.

Haüy was profoundly moved by this sight. That men, strong and able-bodied, should be reduced by the loss of sight to the necessity of earning their bread by making a ridiculous spectacle of themselves, as the only alternative of beggary, touched him deeply, and the more so when he saw that their condition did not appeal to the pity of the populace. The isolation and loneliness in which these men must live came to him so strongly that he was roused to devote

A Fair at St. Ovids.

his own sight and his own strength to ameliorate their pitiable condition. His first thought was "if only they could read music and make harmony instead of the horrible discordant sounds that now offend the ear!" and with the thought came the determination that he would teach them to do so.

"Yes," he said, "I shall substitute the truth for this mocking parody. I shall make the blind to read. I shall put in their hands volumes printed by themselves. They shall trace the characters and shall read their own writing, and they shall be enabled to execute harmonious concerts."

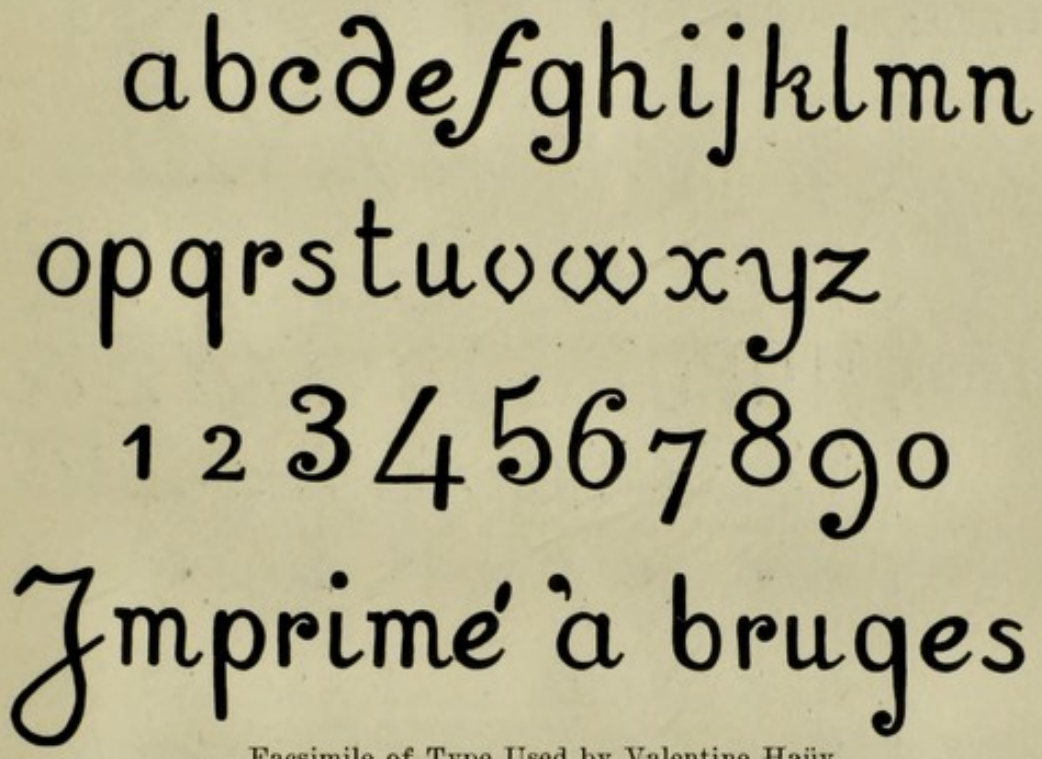


Specimen of Type Used at the Paris Institute.

More than ten years passed during which Haüy, with a sense of the practical rare with enthusiasts, gathered a few blind people about him and devoted his time to studying the methods employed by the few privileged blind who had succeeded in acquiring instruction. Among his pupils was one, a bright, intelligent lad, who had been a beggar, and whose name was Francois Le Sueur. One day while Le Sueur was sorting papers on his master's desk he came across a card of invitation which, strongly indented by the types in the press, had obtained in relief an imprint of certain characters. Proud of his work the blind lad called his master and showed him that he could deciper several letters on the card. It was a ray of light to the ever wakeful mind of Haüy. Immediately he traced with his pen some signs upon the same page. Le Sueur recognized them without hesitation. Impressions in relief, the greatest of Haüy's discoveries, was made. He did not rest until he had completed, after much groping, the practical application of his

process, but the search for the accessories and the perplexities of the inventor are not recounted in history.

Haüy had succeeded to such a point, however, that in 1784 he took his pupil to Paris, where he was exhibited at the Academy of Science as an example of the possibilities of training for the blind. The interest of the Philosophical Society was such that funds were provided by which he was enabled some years later to establish the

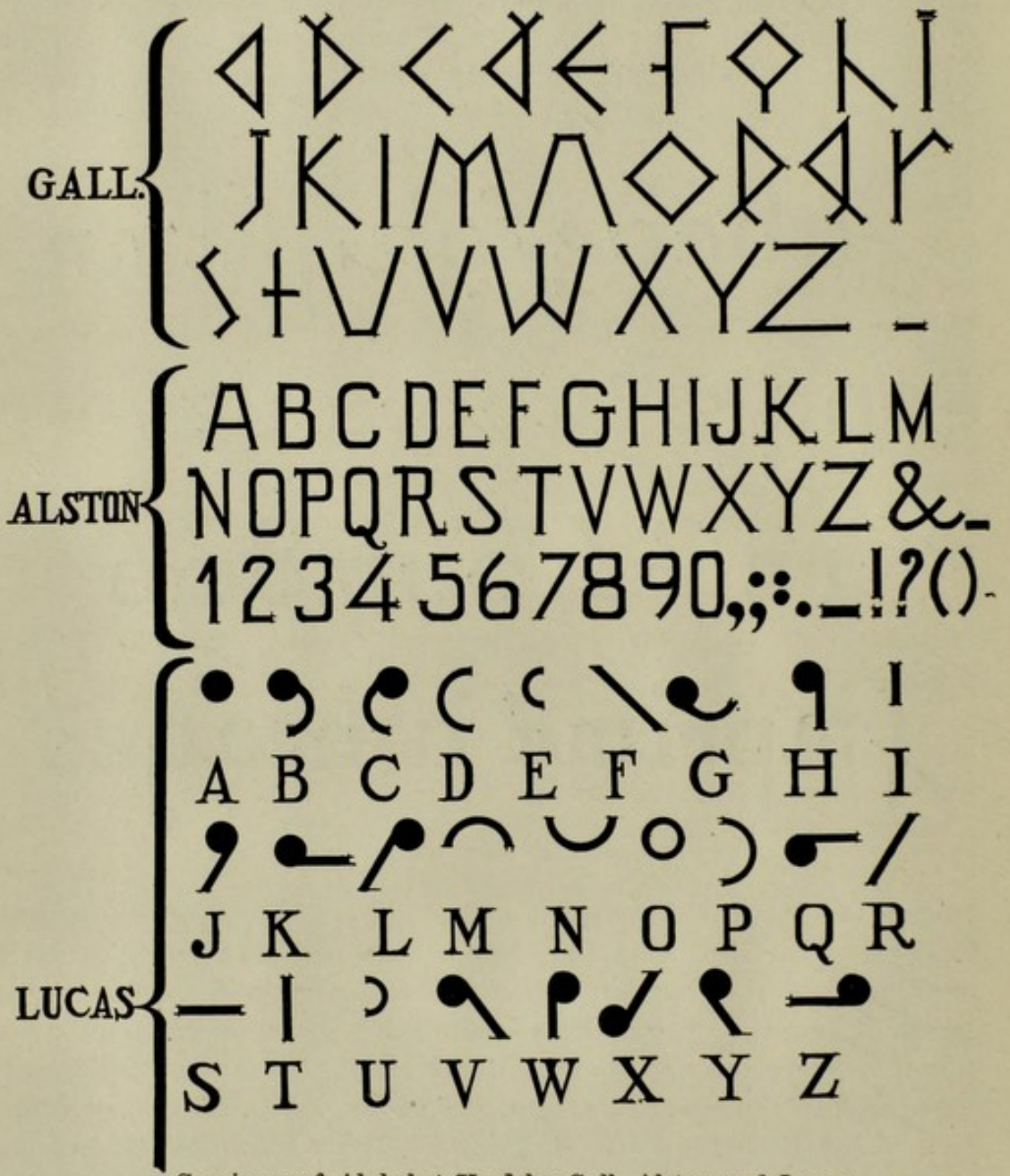


Facsimile of Type Used by Valentine Haüy.

Institution for the Young Blind, which was the first educational institution for the blind founded in Europe. The work which he accomplished was looked upon as phenomenal and excited the interest of Louis XVI, on whose invitation a group of his pupils were taken to Versailles and their skill exhibited. Then came the Revolution. His school was broken up, and Haüy fled to Russia, on invitation of the Emperor Paul, stopping in Berlin long enough to found a school for the blind there. Several years were spent in St. Petersburg, where, with great difficulty, he managed to start a school, returning to Paris in 1817, where he found the institution that he had established, remodeled and improved under the directorship of Dr. Guillié.

In an essay on the Education of the Blind, dedicated to the King of France, in 1786, Haüy tells of the desolate condition of the blind of his time, whose lot, indeed, seems to have been but little better

than that of the insane of the same period. In his essay on the subject of reading, he says: "Before our time various ineffectual experiments had been tried, sometimes by means of characters



Specimen of Alphabet Used by Gall, Alston and Lucas.

moved upon a board and raised above its surface, at other times by the use of letters formed upon paper by the puncture of a pin, and in that way the characters of the alphabet had been taught. Already something had been accomplished in teaching the blind to write. But the imperfect means which had been available had served only to open up to the blind possibilities of reading which they had not been able to realize.

"It had been observed that on the opposite side of a printed leaf coming from the press, the letters were sometimes raised above the surface but reversed in their positions and order. Characters were cast therefore, not as used in printing, but as they appear to the eye, and by pressing wet paper on these the first example of raised type which could be distinguished by the sense of touch was obtained. After having successively employed characters of different sizes, the form which could be most readily distinguished was determined upon, and this was employed for the printing of the earliest books.

The types used by Haüy, it will be seen, were of the italic form and were soon adopted in other institutions of like character.

In 1834 Mr. Gall, a printer of Edinburgh, attempted to improve the Häuy letters by use of an angular, Roman type. Notwithstanding the enthusiastic claims made for this type by its inventor "that the blind could skim over the letters with great rapidity," that "so great is the facility with which the blind are able to feel the letters that already they can read books printed with the common English size of type, the same as is used in papers printed for the Courts of Law," this was not borne out in fact.

A contemporary writer assures us that "even under Mr. Gall's own direction his pupils were able only to make out letter by letter and a few short words," and, "as for reading it was quite out of the question."

After Mr. Gall had published the Gospel of St. John in tactile letters the interest in the subject excited such general attention that between the years 1832 and 1835 no less than twenty different styles of letters were submitted to the Director of the Society of Scottish Arts, by whom a prize had been offered for the best method which should be proposed. Many of these showed much similarity in form, while others were impracticable, but at this time various types rapidly came into use and we learn that seven forms were employed in different parts of the world. Mr. Gall's angular letters were replaced at the Asylum at Glasgow by the ordinary Roman letter in relief, introduced by Alston and known by his name. At this time there were several attempts made to introduce stenographic forms, of which that of Lucas only attained any degree of popularity. It was adopted by the London Society for Teaching the Blind to Read, and has been discontinued only within recent years.

In America the most dominant figure in work for the blind is that of Samuel Gridley Howe, who in 1830 was made superintendent of the then recently incorporated School for the Blind in Massachusetts, and was sent abroad to study foreign methods for teaching

the sightless. From a manuscript on the Boston Line Type, written in 1906 by Miss Gazella Bennett, and loaned by the superintendent of the Perkins Institution for the Blind, the following facts are gleaned.

"Dr Howe at once became greatly interested in books for the blind and devoted much thought and time to devising a less bulky and less expensive method for printing and binding embossed books. When the Perkins Institution and Massachusetts School for the Blind was scarcely three years old, Dr. Howe had set up a press in which only lower-case letters were used; the lines of the letters were narrow and clear cut, hence most easily understood by touch; the interlinear space was decreased by slightly modifying the letters that fall below the line; the height of the face of the type was considerably diminished; and then paper especially prepared was used. The books were bound in single sheets, with the embossed surface of one left against the depressed surface of the preceding. In 1836, Dr. Howe published the *New Testament* in two volumes, subject matter which would have required twelve volumes in the French style of printing and binding. He sent out books in quick succession for the use of the school. In the years 1835 to 1837, inclusive, he printed the *Psalms, New Testament,* a grammar, a geography, an atlas, diagrams and a philosophy. In 1839 appeared *Viri Romæ.*

The Institution for the Blind in Philadelphia adopted the capital letter for the entire word, but made each letter quite small; and in the years 1838-9, from this press were issued the books of *Ruth* and *Proverbs,* some works in German, a library of selections, and a magazine of several volumes entitled the *Student's Magazine.*

In the years 1837 to 1839, inclusive, Glasgow sent out, also in small capitals, the *New Testament, Shorter Catechism, Liturgy, Selections from Eminent Authors,* and a reader.

In 1847 Staunton, Virginia, printed in French a book of *Colloquial Phrases,* two years later a collection of *French Fables* and in 1871, a *Little Story Book.* These were all in small capital letters.

In 1849, New York published a book of mathematics, *The Double Rule of Three.*

The press at Philadelphia continued its work with the book of *Esther,* and *Dictionary of the English Language.*

As often as Dr. Howe could secure money for the work he added valuable books to the library for the blind. We find Milton's *Paradise Lost* printed in 1855, and *Old Curiosity Shop* in 1869. Dickens

himself selected the book and gave fifteen hundred dollars that it might be embossed.

In 1856 a printing press was set up in Raleigh, North Carolina, in the School for the Deaf, Dumb and Blind. The deaf boys were employed in printing books both with ink and with embossed type. The work was discontinued in 1871. The lower-case letter was used, and the embossed books contributed by North Carolina were a hymn book, a reader, a grammar, Selections from Virgil's *Aeneid,* and Scott's *Lady of the Lake.*

In 1857, Mississippi and Kentucky appropriated money for printing embossed books and recommended the establishment of a national printing house. Later, Kentucky granted a charter to a body of trustees for the purpose of establishing a printing house for embossed literature. The first volume was issued from this press in 1865.

Napoleon Kneass, Junior, came forward in 1867, and gave embossed books proper literary form by uniting the capital and lower letters in printing. In due time all the printing offices adopted the combinations. Kneass published from his own press in the city of Philadelphia a few text books, Kneass' *Philadelphia Magazine,* and a music journal.

The American Bible House supplied Dr. Howe with funds for printing the *Bible* in embossed form early in the history of his work, and since then it has supplied Bibles to all blind persons asking for them.

The Society for providing Evangelical Religious Literature for the Blind, New York City, was incorporated in 1879, and has furnished a number of books and published the *International Sunday School Weekly* for at least twenty-five years.

The National Association for printing Musical Works for the Blind was united with the Printing House in Kentucky in 1873. Shortly after this an annual appropriation from Congress for providing tangible apparatus and literature for the blind was assigned to the same place, and the printing house at Louisville, Kentucky, became the American Printing House for the Blind. From its press the sightless reader has received sixty-three books of biography and general literature, forty-four text books, and nineteen readers. Its records show that from 1870 to 1879, inclusive, eleven thousand four hundred and sixty-six books were distributed. No books have been printed in line-type at the American Printing House since 1892.

In 1879, three years after Dr. Howe's death, Mr. M. Anagnos had a new printing press constructed for the Perkins Institution. It

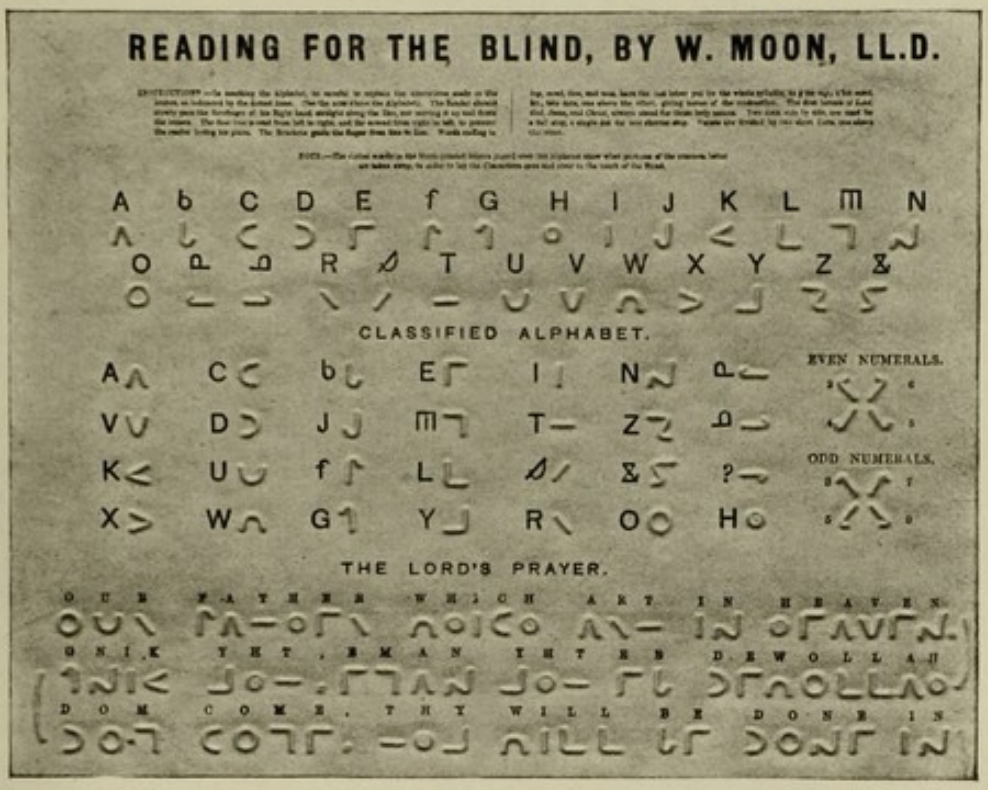
had all the modern improvements in machinery, and the shape of the letter was brought still more in conformity with the letters of standard print. The new press was styled the Howe Memorial Press. Then, with indefatigable zeal, and a courage inspired by the great need, Anagnos set himself the task of securing a printing fund of one hundred thousand dollars. Sixteen months later his purpose was more than accomplished, and since then uninterrupted work has gone forward in the printing office. As books began to be issued from the press, Anagnos asked the libraries in some of the larger cities and towns in New England to take, free of charge, as many embossed books as they could accommodate for the use of sightless readers in their vicinity. Under this arrangement embossed publications have been sent to Portland, Maine; Concord, New Hampshire; Boston, Lowell, Lynn, Somerville, Worcester, Fitchburg, and New Bedford in Massachusetts; Providence, Rhode Island; and Hartford, Connecticut. Numerous books were also sent to the Society for the Relief of Destitute Blind, New York City; the Working Home for Blind Men, and the Pennsylvania Industrial Home for Blind Women.

Since 1903, when the new postal law went into effect (which permits embossed books to pass through the mail free of expense) less use has been made of local libraries, as in most cases it is more convenient for the blind persons to get books from the post office than from a library.

During the year 1906, the circulating library of Perkins Institution distributed a few less than nine hundred books printed in line type. These were sent in response to applications from blind people whose homes represent the New England States, New York, Pennsylvania, Ohio, North Carolina, Georgia, Alabama, Tennessee, Illinois, Missouri, Wisconsin, Michigan, Minnesota, Dakota, Nebraska, Texas, Oklahoma, California and Canada. Some of these blind people read no other type and are wholly dependent upon the press and library at Perkins Institution for reading matter. During the spring months of 1907, the Howe Memorial Press prepared a memoir of Michael Anagnos, its founder and the far-seeing educator of the blind. Up to the present date, July, 1907, the Perkins Institution printing office has sent out one hundred and twelve books of biography and general literature, thirty-one text books of biography and general literature, thirty-one text books, and twenty-seven readers. As many of the books of general literature are in two, three, or even five volumes (*David Copperfield* requires five volumes), and several have passed through two and more editions it is conservatively estimated that since the year 1835, the press of

Perkins Institution has issued in line letter two hundred thousand volumes."

In the year 1840 a young man, William Moon (afterwards Dr. William Moon), of Brighton, England, who was studying for the ministry, became blind at the age of twenty-one years. Having made himself thoroughly acquainted with all the types then in vogue, he endeavored to instruct other blind persons in reading, but whilst



Moon Alphabet.

he found it possible to teach children with sensitive fingers, he discovered that about eighty per cent. of the blind were adults and that the different forms of the ordinary letters were too complicated for them to decipher, and the shorthand and phonetic systems were too difficult to understand and remember.

With no intention of introducing a new system, he gave careful consideration to these facts for five years, and ultimately devised a new type which is now known as the Moon type. It was found to be so simple in construction that the blind of all ages and capacities could feel it and read it, even after having failed to learn any of the older systems. In the Moon alphabet nine of the Roman letters are retained in their entirety; thirteen are ordinary letters simplified by removing portions of them to make them clearer to the touch; and only for the remaining four have entirely new characters been

introduced. The alphabet consists of nine characters placed in various positions. It is composed of the simplest geometric forms, such as the straight line, the acute and right angle, the circle and the semicircle. In order that the reader shall not lose his place, the first line is read from left to right and the second from right to left. The finger is guided by a curved bracket from the end of the line to the one below.

For half a century Moon devoted himself with untiring energy to the preparation of embossed literature in English and many foreign

Wm. Moon.

Miss Moon.

Robert Moon.

languages. At the present time 75,000 stereotyped plates are carefully preserved at the Moon Institution for the Blind, at Brighton, which, since Moon's death, has been conducted by his daughter, Miss Moon. The literature in the Moon type comprises, in addition to the books of the Bible in English and several foreign languages, many volumes of an educational and entertaining character, and astronomical works. There are many thousands of the blind in all parts of the world who are finding pleasure in reading these embossed books, which are an inexpressible comfort to them in their dreary and lonesome hours. Many of the readers are ninety years old, some are ninety-five, and a large proportion of them had previously tried, in vain, to learn the dotted and Roman letter systems.

In making it possible, by the introduction of the Moon type, to teach the adult blind to read, Mr. Moon (who later received the honorary degree of L.L.D. in appreciation of his work for the blind) in 1856 organized in London the first Home Teaching Society for the Blind, with a circulating library of embossed books in the Moon type. This Society at once proved to be a great success, and similar

societies were soon started in other places. In various parts of Great Britain and Ireland, America, Australia and other countries, there are at the present time about eighty home teaching societies and free lending libraries of the Moon books; and teachers (many of them blind) are engaged in visiting the blind in their own homes—teaching them to read and exchanging their books.

Home teaching for the blind was introduced into America in 1862 when William Moon, accompanied by his daughter, visited the United States and was instrumental in organizing home teaching societies in Philadelphia, New York, Boston, and Chicago. The one in Philadelphia, under the title of the Pennsylvania Home Teaching the Society and Free Circulating Library for the Blind, is the pioneer institution of its kind in America, and it now employs five teachers in different parts of Pennsylvania to visit and teach the blind in their homes. During the year 1912 no less than 20,924 of the Society's embossed volumes were circulated amongst the blind, not only in Pennsylvania, but in many of the other states of the Union. Books in all the embossed types are on the Society's shelves, but of the total number circulated 15,425 were in Moon type. The circulation of books amongst the blind has been greatly promoted in the United States and Canada by the granting of free transportation through the mails of embossed books loaned from public libraries. The introduction of the free-lending library in conjunction with the home teaching in Philadelphia has led to a very general provision of a department for the blind in other leading libraries throughout the United States.

Moon's type has already been adapted to some four hundred foreign languages and dialects, and of late years the publishing of the Scriptures in these has been taken up by the British Bible Society.

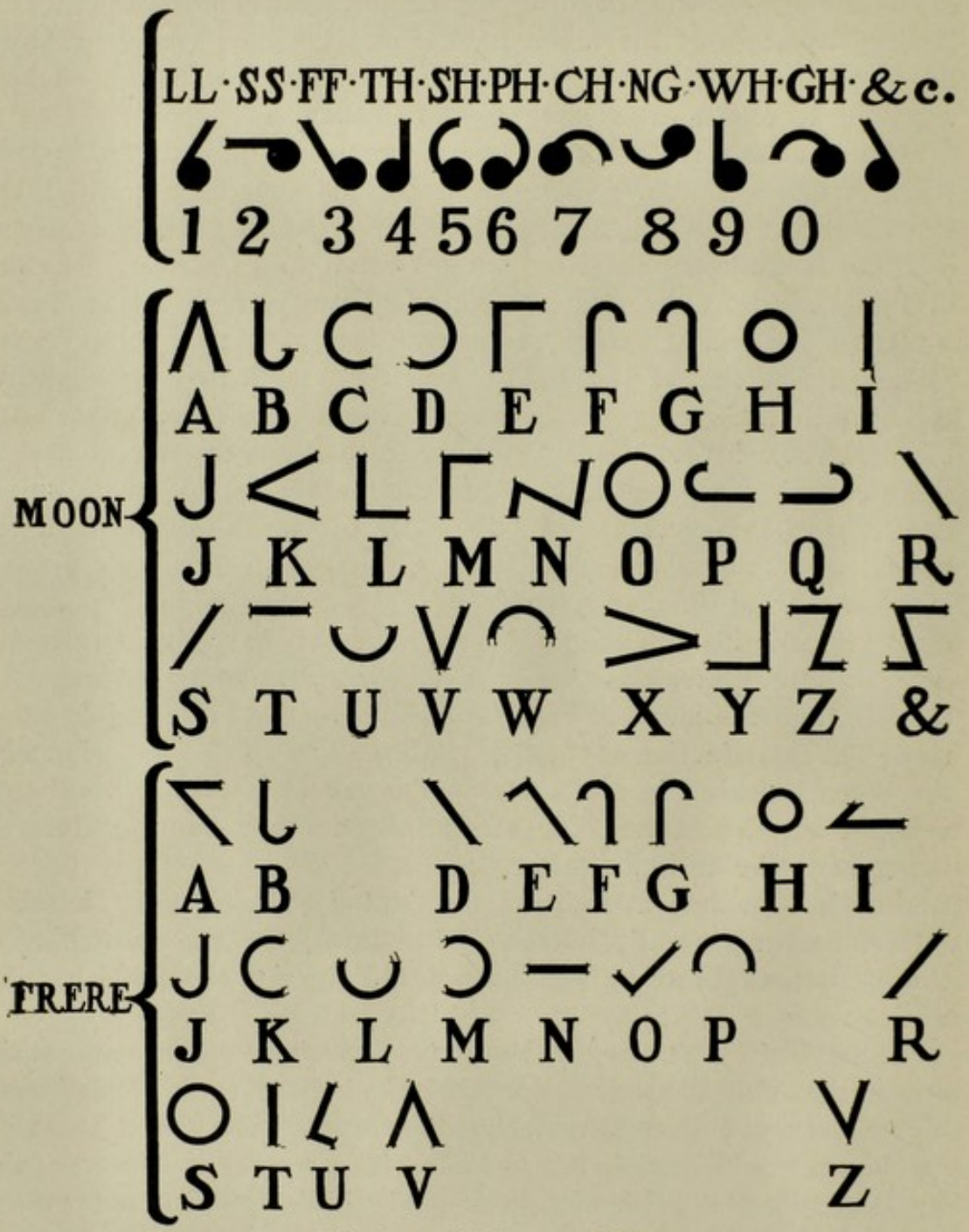
In the United States the Moon type, as it is much more easily acquired by elderly readers, is used by the Pennsylvania Home Teaching Society and Free Circulating Library for the Blind at Philadelphia, of which Robert C. Moon is secretary. Through this Association embossed books are loaned to blind readers throughout the United States.

The Frere alphabet somewhat resembles that of Moon.

It was to a blind man that the world owes the form of tactile print which is now almost universally employed throughout the world. Louis Braille was a musician and a teacher in the Institution Nationale des Jeunes Aveugles, founded by Haüy.

It had for a long time been known that raised dots were more

readily recognized by the finger tips than lines. A French officer by the name of Barbier, who was deeply interested in the blind, and

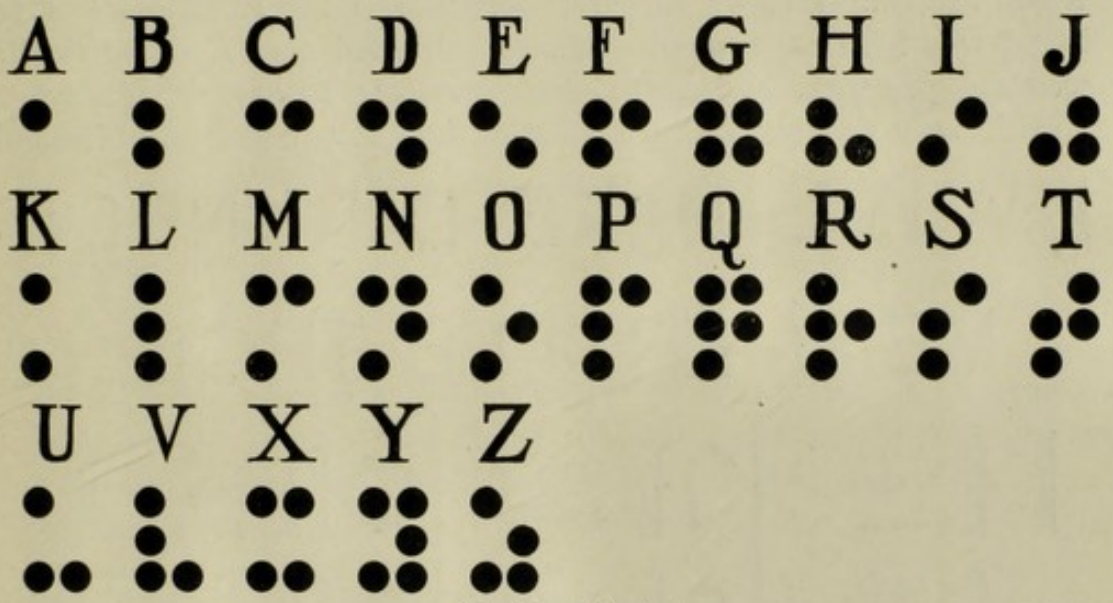


Alphabets of Moon and Frere.

of a philanthropic character, had invented and in 1820 had introduced a system consisting of twelve dots, susceptible of almost limitless combinations. The number of points made it extremely clumsy and unwieldy, and Braille modified it by reducing the number to six, not too many to be easily covered by the ball of the

finger. The following is a brief description of the Braille alphabet as given by the late Dr. Armitage of England.

"The group of six points is divided into upper, middle and lower pairs and the alphabet into three rows of letters, i. e., the first ten letters, from a to j, exhaust all possible combinations of the upper and middle points; the next ten, from k to t, are formed from the first by adding a lower back point to each, thus 'a' becomes 'k,' 'b' becomes 'l,' etc. The third row is similarly formed by adding two lower points; thus 'a' becomes 'u,' 'b' becomes 'v,' 'c' becomes 'x,' 'd' becomes 'y' and 'e' becomes 'z.' The fourth row of letters is formed from the first by adding a front lower point to the



Braille Alphabet.

first row. The only letter of the ordinary alphabet in this row is 'w.' It will be observed that 'w' comes out of its place in the alphabet. This is because the original French alphabet has been adhered to, 'w' being a letter not used in genuine French words. As originally arranged it was the last of the front row and has been there retained, as placing it out of position was considered a far less evil than altering the four last letters of the alphabet."

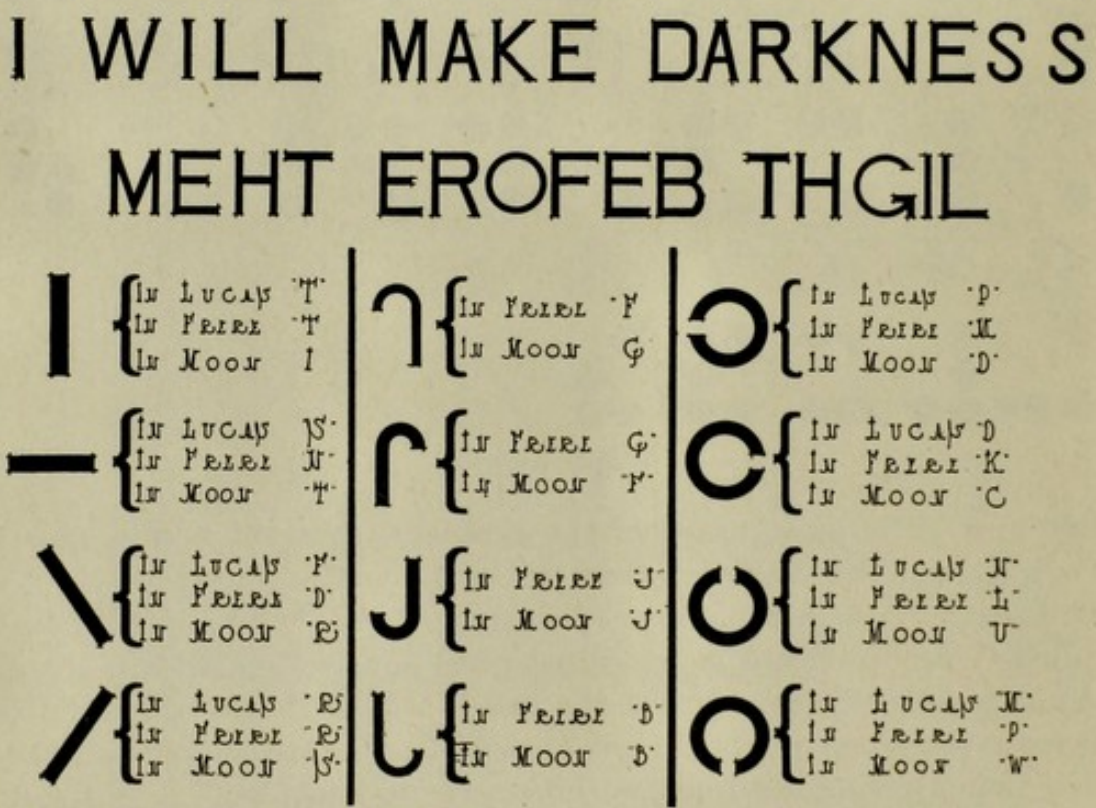
The Braille is admirably suited for music, of which an immense amount has been published and is now available.

"At present there is not an institution in the United Kingdom where the Braille system is not more or less used. In the best schools it is employed almost exclusively, and the extent to which it is used forms a pretty good rough test of the quality of teaching in a school. Some idea may be formed of the spread of the Braille system since the formation of the Association by the fact that since that time

it has sold about 20,000 styles, or instruments used for writing. The greater part of these have been used in the United Kingdom, though about 1,000 have been sent to France and Germany. Germany has at last realized the importance of Braille as an educa-

Frere's Method.

tional system. In 1873 the first Congress of the Instructors of the Blind was held at Vienna. I there exhibited specimens of Braille writing, printing, and maps, and strongly urged the claims of Braille as a universal educational system for the blind. The sub-



Moon's Method.

ject was referred to a committee, and at the next Congress, held in 1876 in Dresden, it was decided to adopt a modified Braille, in which, though the Braille frame was retained, the letters were altered in such a way that those letters which occurred most frequently in the German language were represented by the fewest points. The most experienced of the German teachers strongly objected to this decision, and it was reversed at the Congress held

in Berlin in 1879, which recommended the old Braille system for universal adoption. This was confirmed at the Congress held in Frankfort in 1882. At the International Congress held in Paris in 1878 the same conclusion was unanimously come to. There is now probably no institution in the civilized world where Braille is not used, except in some of those in North America. In all of these, however, the great value of writing is recognized by using some form of point system. Though the blind have much reason to be satisfied with this progress, much still remains to be done. In China, Japan and other parts of the world there is an immense amount of work to be done. I believe that not only would it be of the greatest possible advantage to the blind of these countries to receive a good elementary education, but that the blind, when taught to read, and when instructed in the Christian religion, would make most valuable native missionaries and colporteurs."

The *New Testament* is now printed in Chinese, and many of the dialects of India, China and other Eastern countries have been reduced to Braille.

At the time that the English were considering the adoption of the Braille form, America was also studying point print.

The arrangement made by Louise Braille, it will be remembered, was based upon the arbitrary placing of the points in accordance with a prearranged plan. In 1878 J. W. Smith, one of the teachers of the Perkins Institution, and later editor of the *Mentor,* a magazine in black print published in the interest of the blind, rearranged the plan of the dots so that fewer points were used in the letters most commonly employed.

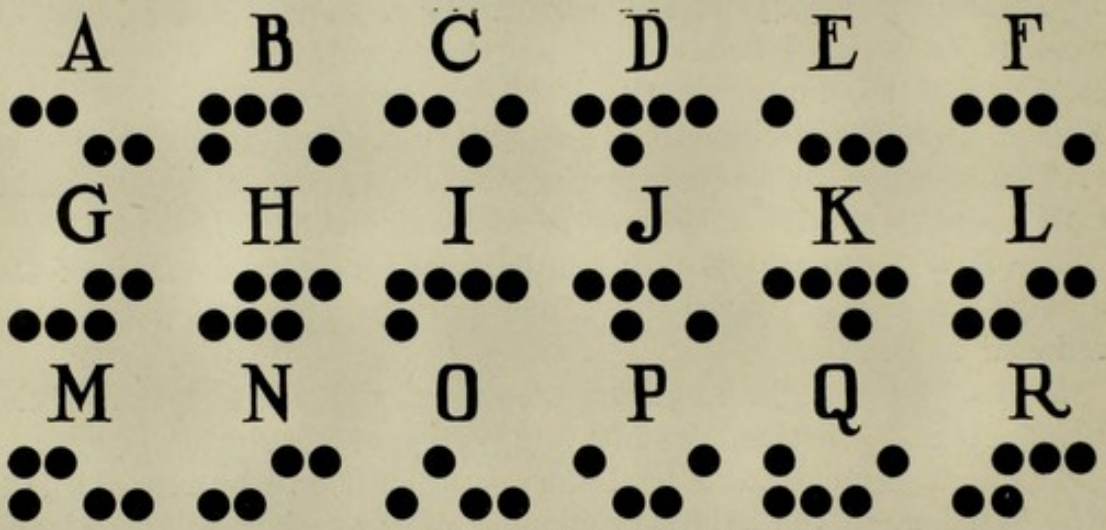
This latter system is now used in 23 of the 49 schools for the blind, including Boston, Philadelphia, Jacksonville, Ill., and Batavia, N. Y., which are the largest schools in the United States. In the latter both systems are employed.

In America the only system competing with the Braille except the Moon, (which now has replaced the Boston line and will always be in demand for those who lose their sight late in life) is the New York point print.

In the year 1870 Doctor Russ, then living in New York, devised a modification of the Braille based upon the following objections to the older system: As each Braille letter even when it consists of but a single point occupies an entire cell he proposed that the long diameter of the full letter should be horizontal, so that when fewer points are required less space is used. He objected to the arbitrary arrangement of the Braille letters by which they are

divided into rows in which the number of dots is regulated by rule and, as Smith did for American Braille, assigned fewer points to the letters more frequently employed.

His system was placed in the hands of Wm. B. Wait, then Superintendent, and now Principal Emeritus of the New York Institution for the Blind, who greatly improved it; writing a complete system of musicography, capitals, small letters, contractions, punctuation marks, adaptations from the Greek, signs of abreviation, etc., and enthusiastically urged its general adoption.



New York System of Point Type.

The following is a partial illustration of the system. Base forms of the New York Point System and the number of signs of each:—
: = 3 : : = 9 : : : = 27 : : : : = 81 : : : : : = 243 : : : : : : = 729

Upper points are designated by odd numbers, lower points by even ones.

1	1	3	1	3	5	1	3	5	7	
.	.	.	.	.	.	.	.	.	.	
.	.	.	.	.	.	.	.	.	.	
2	2	4	2	4	6	2	4	6	8	etc.

The subject excited an animated discussion, and a careful investigation of the proposed system was conducted by the British and Foreign Blind Association extending over a period of two years. As the members of the Committee were all either partially or wholly blind they were peculiarly well fitted to decide the relative merits of the two systems of tangible print. The conclusions published by Dr. Armitage were finally in favor of the Braille system and are sufficiently interesting to reproduce here.

"1. The gain in space of New York over Braille is said theoretically, to be 30 per cent. Practically this was found to be somewhat

overestimated. This gain in space is the principal advantage, though there seems also to be a slight gain in rapidity of writing. There are, however, some serious disadvantages to compensate for this gain in space.

"The New York system does not lend itself so well to interlining as the Braille, in consequence of the difficulty in distinguishing the characters, which are composed entirely of upper or entirely of lower points.

"In distinguishing such characters from each other the reading finger is guided, to a considerable extent, by the interval which occurs between the upper or lower points, as the case may be, and the next line and, as this is not possible with wide lines, it follows that interlining is not well suited to the New York characters; and if we compare the interlined Braille with the close-lined New York, it will be found that the gain in space of the New York has disappeared, while the Braille is far more legible.

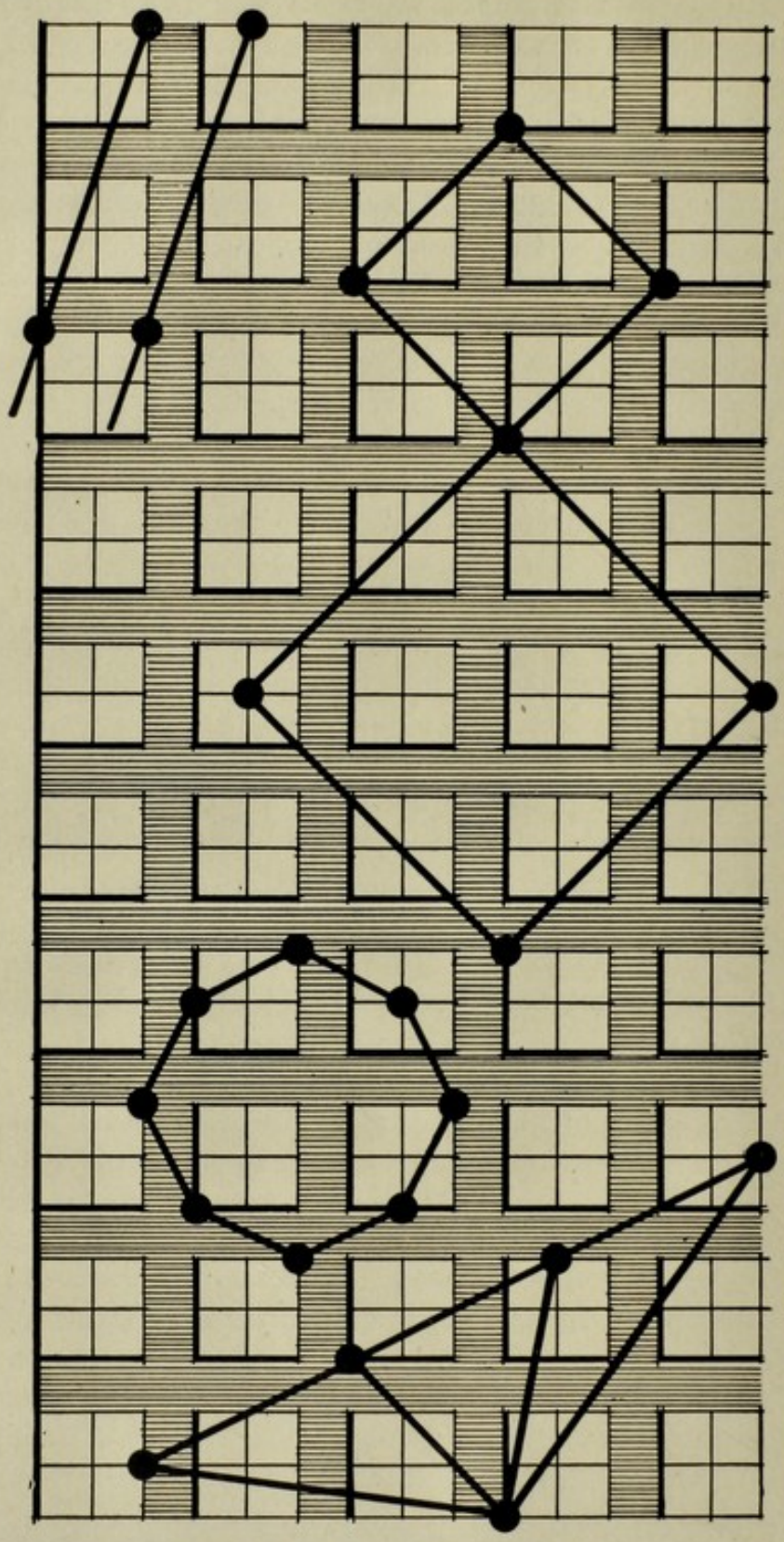
"2. The New York system is poorer in signs than the Braille, unless characters four points in length are used, and these are too long to be covered at once by the finger, which is inconvenient; hence, probably, the omission of many punctuation signs in the New York books, which produces inaccuracy and ambiguity.

"3. The correction of written or printed matter is very much more difficult in the New York than in the Braille system—a point of very great practical importance.

"4. As the letters in Braille are formed from each other by a simple rule, this system is more easily learnt than the New York, where there is no such aid to memory.

"5. As the different letters occur with varying frequency in different languages, it follows that, if the New York system were generally adopted, each language would have a different alphabet, and the difficulty of reading foreign languages would thereby be greatly increased.

"6. The Braille system is too firmly rooted in England ever to be changed; and it would be a great calamity to the blind to have two point systems, unless the new were greatly superior to the old. This objection applies with still greater force to the musical notation, which ought to be as universal among the blind as it is among the seeing. Great numbers of valuable musical works have already been published in Paris, London, Copenhagen, and elsewhere. These would be illegible by and useless to the pupils of an institution using the New York system for musical notation, the adoption of which could only be excused by great superiority, and it is by no means



Arithmetic Board Used for Geometrical Designs.

proved that the New York musical notation is even as good as the Braille."

Unhappily the battle of the types has continued unceasingly since the several systems were introduced. And now another Committee, representing the American Association of Workers for the Blind, is making a tour throughout the country and conducting further investigations and tests. "When the work is finished the ladies will have traveled about 10,000 miles and conducted experiments in 30 residential schools and 12 centers for adults, and will have had some of their sheets read by approximately one thousand blind people."

"But," the question has been asked, "will not Braille people continue to use Braille and New York Point people continue to use point?" The investigators think not. "If only the managers of the printing houses and the heads of institutions could be made to feel the need," says one of the investigators, "as those who go out from these institutions into the colleges and universities do, the inconvencience that they must suffer from having to learn a second or possibly a third system in order to get books that they can use, the problem would be an easy one. The majority of blind people themselves are willing and anxious to settle the question. We also believe that there is not a superintendent or printer in the country who can fail to see the advantages that would accrue from having all of the literature for the blind printed in one type."

One of the greatest advantages of the various point systems is the readiness with which they lend themselves to writing by the blind. A writing frame consists of a wooden frame of the size and shape of the frame of a child's slate. This is hinged and fits over a metal-grooved bed on which the paper designed to receive the impressions is placed. Extending across the frame is a brass guide punched with a double row of parallelograms of the height of three dots for the Braille and two dots for the New York Point. These spaces indicate the shape of the letters to be formed which are made by pressing a blunt pointed instrument, termed a style, into the paper, thereby making a depression on the one side and raising a little elevation on the other. These prominences are readily felt and distinguished by the finger of the reader. Many of the blind acquire such facility in deciphering these dotted forms that they read as rapidly and as frequently as those who see.

Several systems of shorthand for the use of the blind have been devised and are in general use, many persons becoming exceedingly expert in taking dictation, which they reproduce upon the typewriter

with a degree of accuracy and rapidity not exceeded by those who see.

The *Ziegler Magazine* is the only publication in raised print issued for the blind of this country. The magazine was founded in March, 1907, by Mrs. William Ziegler, of New York City. It is issued in two editions, one in New York Point and one in American Braille, the reader receiving the edition in the type he prefers. Nearly two-thirds read the New York Point edition.

Mrs. Ziegler spends about $20,000 a year on the magazine, maintaining it entirely at her own expense. About 8,000 copies are printed each month, but this does not represent the number of readers. For instance, there are nearly five thousand blind children attending the schools in the country, and a few hundred copies sent to these schools supply the wants of all the pupils. Again, many are inmates of homes for the blind and a few copies suffice for each of these homes. Again, many, after they read the magazine, pass it on to those in other countries. About three hundred readers send their magazine each month to persons in another English-speaking country. One girl in Australia, who receives her magazine each month from one reader, writes that she passes it along to seven other blind people in the United States and Canada who can read either of the types in which the magazine is printed. A free copy is also supplied to all the schools for the blind and libraries for the blind in English-speaking countries.

The magazine is published monthly and the matter it contains is about the same as that found in the ordinary magazines of the day. About one-fourth of the magazine is devoted to comments on current items, and this is a very popular feature, especially with those who have little opportunity to keep up with current topics in any other way. Another very popular department is entitled Experiences and Suggestions for Success. In this column letters from successful blind people are printed, and there are doubtless many engaged in various lines of work today who would not be so employed but for the help received through this department.

In addition to the work of the magazine, it buys at wholesale rates watches, typewriters, knitting yarns and wools, ribbons, etc., and supplies them to the blind of the United States at actual cost. The magazine has also for several years had charge of a department for the sale of goods made by the blind in the store of R. H. Macy & Co., New York City. Goods made by a blind person anywhere in the United States can be sent to the *Ziegler Magazine,* which in turn lists, tags and sends on to the department at Macy's, and when these

goods are sold the whole amount of the sale is remitted to the blind maker. Macy & Co. charge no commission for the sale. Practically the same plan has been adopted and carried out by Rothschild and Co., Chicago, Illinois.

All the work of assembling the sheets of the magazine is done by blind girls, fourteen of them giving about a week each month to this work. They receive $1.25 a day for their services, and their work is done as well as seeing girls could do it. These girls call it their week of happiness when they are at work. A piano is provided for them which they enjoy at the lunch hour. All the proofs of the plates are read by the blind.

American Printing House for the Blind.

After the American Printing House for the Blind in Louisville, Kentucky, the Perkins Institution and Massachusetts School for the Blind has been the most important agent in publishing books, music, etc., in tactile print. From a report submitted to the Massachusetts State Board of Education on October 1, 1910, and from a Library Report of 1912 the following facts have been gathered:

"The collection of embossed books at this institution, both in number and in variety, is large; 17,911 pieces or volumes, 1,373 titles. These have come from two main sources, the Howe Memorial Press, connected with the Perkins Institution, and the American

Printing House for the Blind at Louisville, Ky. The former is a foundation (by private endowment) for the purpose of providing the blind with reading; the latter, an institution subsidized by government to manufacture embossed books and to distribute them to schools for the blind in proportion to the number of their pupils. This American Printing House has furnished books to the Perkins Institution since 1871. Thence has come the main supply of school text-books. The Press of the Perkins Institution, though at work ever since 1833, has necessarily published fewer books and in less variety, limiting itself almost wholly to general literature. Moreover, until recently, it has put forth but one kind of print, the so-called Boston line-type, whereas the Louisville press has printed, first, in the same line-type, then largely in point-type. Line-type is the common Roman letters, enlarged and made palpable to the touch; but by no means all the blind, even of school age, have been able to read it. Because this was the case and because the system was unpractical for the blind to write in, the use of arbitrary characters, made up of points which are readily tangible to every normal blind person and writable by him, has gradually prevailed. Today no new books are printed anywhere in line-type.

This special reference library has been increased by 53 new books in English, French, German, Italian and Latin, making a total of 3,922 volumes. A large number of pamphlets, magazine and newspaper clippings have also been collected. Every quarter a list of the most important magazine and newspaper articles has been sent to the *Outlook for the Blind.*

It would seem probable that books in the so-called Moon type for the blind would always be in demand for the use and encouragement of those adult readers who are either too old to acquire a finer type or too lacking in health and courage to be willing to make the attempt to do so. Of these books there is an excellent supply, some 651 in all. They were purchased from the Moon Society for the Blind, Brighton, England, where such books are still made.

The slow and costly means of printing from movable type, prevailing for over half a century, has now been supplanted by appliances to punch metal plates directly from the press. By means of an appliance known as a stereotypemaker, devised and made in the state of Illinois, brass plates, bearing some 224 words each, can be made at an average cost of about 35 cents, and books reproduced in indefinite numbers and fastened in stiff covers, at a total cost of about one cent a page. Embossed books are, therefore, no longer the expensive luxuries they once were.

Last year a single operator, averaging two hours a day at this

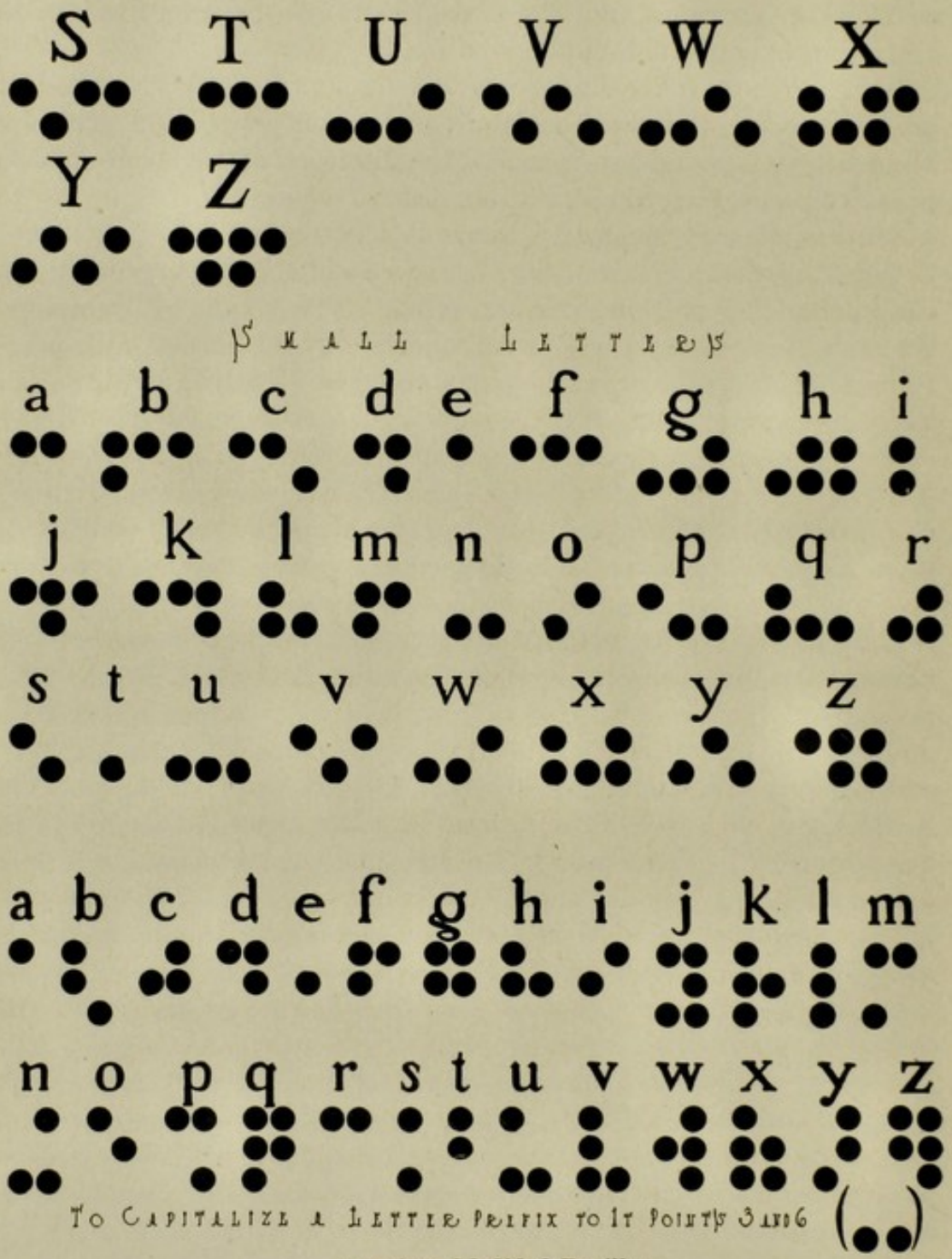
power stereotypemaker, produced 1,798 finished plates, which were fewer than usual. From these the Howe Memorial Press printed 107,144 pages and stapled most of them into books. Many have been sold and given away, and 721 placed in the Institution library; the rest remaining for future distribution.

Books embossed for finger reading expand usually from four to six times over the same matter as commonly printed. Those in Moon's type expand much more; the Bible to 58 big books. Comparatively speaking the few thousands of volumes belonging to the institution library demand enormous shelfroom; indeed, it would be hard to stack them, if all of them were called in. Everyone knows the quarto size of books for the blind. This size is still standard, though a few presses, the Howe Memorial Press included, now prefer to issue smaller and less cumbrous volumes. Both the readers and librarians prefer them so.

The books which have been put into raised type have been carefully chosen; those in the Boston line-type represent a particularly choice lot of literature, and blind people who have read and reread them have not failed to be influenced and affected by such a course of university extension education. However, very few so-called text-books are in this type. Most of these appear in the point books, having been prepared to meet the demand of schools for the blind throughout the country. Considering how fast ordinary text-books multiply and change, it is remarkable how comprehensive, excellent and modern the supply is which has already been embossed. This is due partly to boards of education of a few cities but mostly to the half-dozen institutions which, for fifteen or more years, have been plate-making at individual expense, some of them distributing the books as gifts or at actual cost, others sending the plates to the general printing house at Louisville, whence any one can order books made for them. General literature is also pretty well represented in point print. No country in the world has such a mass and variety of matter embossed from metal plates as America. The large collections in European countries are chiefly made up of books handwritten by people of the leisure class; and, while the variety is often splendid, the number of copies of each selection is necessarily very limited.

When the Howe Memorial Press ceased printing in line-type, which has been a type almost wholly limited to the blind who either had been or were at school, it undertook to meet the reading hunger of a much larger public, and issued in rapid succession short stories, essays, descriptions having contemporary interest, and poetry. This

mass and variety of reading is in American Braille, which is not difficult to learn to read and write. Printed lists of all the books in the Perkins Institution library, in the several embossed types, are



American Modified Braille.

sent to anyone on request; also embossed lists of fiction appearing in American Braille. As a result of such advertising, the calls for books have enormously increased. By special act of Congress, em-

bossed books are carried by mail free between libraries and readers. The same concession exists in Canada. Thus the Perkins Institution can and does send books to blind readers all over the continent north of Mexico. Six thousand and ninety-four were sent out last year.''

The most important publication in black print now issued in the interest of the sightless is the *Outlook for the Blind,* published quarterly, under the able editorship of Chas. F. F. Campbell of Columbus, Ohio. It was originally established in 1907 under the auspices of the Massachusetts Association for the Blind, but is now supported by voluntary contributions and by an annual subscription. The purpose of the magazine is to make it a medium of exchange between all workers for the blind, and its pages are open for the discussion of all subjects having a bearing on or reference to the work of the blind. Recently an Advisory Board has been formed consisting of representatives from State Schools and Institutions for the blind. Somewhat similar magazines are published in Great Britain and France.—(F. P. L.)

Alphozone. SUCCINYL PEROXIDE. A whitish powder, soluble in 30 parts of water, presented as a germicide and antiseptic and used as such both externally and internally.

F. B. Eaton relies upon this agent in most acute forms of conjunctival and corneal affections, including the various types of phlyctenular infection. He prefers one grain of alphozone to three fluid ounces of water, of which from 3 to 6 drops are to be put into the eye three times a day.

Homer E. Smith uses it as a collyrium in conjunctivitis of the catarrhal type, in the proportion of $\frac{1}{500}$.

Al-Qaisi, Qadi Fath ad-din Abul Abbas Ahmad b. al-qadi Gamal ad-din Abu Amr Utman. One of the latest and most famous of Egypto-Arabian ophthalmologists. His single known writing, entitled *Work Concerning the Result of Reflection about the Treatment of Ocular Diseases,* still extant, is simple, clear, and practical, but not to be compared for thoroughness with the works of such earlier Arabian writers as Ammar and Ali ben Isa.—(T. H. S.)

Al-Qasim b. Halifa. The father of the much more famous Arabian ophthalmologist, Usaibia, he was himself well known as an oculist at Damascus about the year 1200.—(T. H. S.)

Alquié, Alexis Jacques. This distinguished surgeon was born of indigent parents in 1812 at Perpignan, France. He received his medical degree, despite ill health and many other hardships, at the University of Montpellier in 1838 and, in 1851, was appointed to the chair of clinical surgery in the same institution. The most important

of his writings is the *Traité de Chirurgie Conservatrice et Moyens de réstreindre l'Utilité des Opérations,* which appeared at Montpellier in 1850, and in which, as a representative of the French conservative school, he strongly opposed the extirpation of the lachrymal gland for the relief of otherwise incurable epiphora and the section of ocular muscles in myopia. He died in 1864.—(T. H. S.)

Alsol. Burow's solution. This salt occurs in shining, colorless masses with a vinegar odor and an astringent taste. It is the proprietary name of a 50 per cent. solution of aluminum acetotartrate, and in ocular therapeutics is generally used in the form of compresses of 5 per cent. strength; one teaspoonful to a cup of boiled water. Alsol is said to have the advantage over boric acid and sublimate of not causing eczema of the lids when used as a local application. It is, therefore, especially valuable for compresses in blennorrhea neonatorum, in conjunctivitis, granular and scrofular ophthalmias, and, in warm solution, in chronic cases; also in hordeolosis, in corneal ulcers and iritis but in such case in solutions of $\frac{1}{500}$ and $\frac{1}{1000}$. It forms an acid solution with water but is insoluble in alcohol.

Alston, John. A Scotchman, treasurer of the Glasgow Blind Asylum who, about 1834, invented a form of raised Roman type for the use of the blind. See **Alphabet for the blind.**

Alt. (G.) Old, senile, age.

Alter. (G.) Age.

Alternating squint. See **Muscles, Ocular.**

Alternating strabismus. This condition is present when the deviation occurs alternately, or perhaps indifferently, in each eye. The visual acuity is generally equal in both eyes but the change of squint from one eye to the other is sometimes in the sense that the patient may continually use one eye for the distance and the other for near. On the other hand, many strabismics use sometimes one, sometimes the other organ for all purposes.

Duane's rule for the detection of this muscular and nervous anomaly cannot be improved upon. Using the cover- or screen-test and the excluded eye uncovered, if either both eyes move or, in spite of there being an evident deviation, both eyes remain steady, squint exists. In the latter case, if, when the left eye is uncovered, the eyes behave in the same way as they do when the right eye is uncovered (both alike moving or both alike remaining steady, no matter which eye is uncovered), the squint is alternating.

Coulter (*Ophthalmic Year Book,* 1908, p. 107) considers that the best course in dealing with permanent alternating squint, a matter

which has been unduly neglected and upon which the opinions of authors are contradictory, is to correct the deformity at once by operation; and then, in spite of the failure of previous orthoptic treatment, every effort should be made with the amblyoscope (q. v.) or steroscope to develop binocular vision. Between 12 and 16 years is the most suitable age for undertaking such treatment. See **Muscles, Ocular.**

Alternirendes Schielen. (G.) Alternating squint.
Alters. (G.) Senile, weakness of old age.
Altersabschleifung. (G.) Senile attrition; wearing away by friction.
Altersanlage. (G.) Senile predisposition.
Altersatrophie. (G.) Senile atrophy.
Altersbogen. (G.) Arcus senilis.
Altersbrand. (G.) Senile gangrene.
Alterschwund. (G.) Senile atrophy.
Altersdisposition. (G.) Senile predisposition, aptitude, tendency.
Altersemphysem. (G.) Senile emphysema.
Altersentartung. (G.) Senile degeneration.
Alterserscheinung. (G.) Senile phenomenon.
Alterserweiterung. (G.) Senile dilatation.
Altersfrische. (G.) Green old age.
Altersklasse. (G.) Class or order of age.
Alterskreis. (G.) Arcus senilis.
Alterslordose. (G.) Senile lordosis.
Altersmarasmus. (G.) Senile marasmus.
Altersnachweis. (G.) Age certificate.
Altersniere. (G.) Atrophic kidney of old age.
Altersring. (G.) Arcus senilis.
Altersschwach. (G.) Decrepit.
Altersschwäche. (G.) Decrepitude.
Alterssichtig. (G.) Presbyopic.
Alterssichtigkeit. (G.) Presbyopia.
Altersstaar. (G.) Senile cataract.
Altersstaarenstehung. (G.) The nascence or origin of a senile cataract.
Altersstaarformen. (G.) Senile cataract formation.
Altersstaarintranuclearer. (G.) An intranuclear senile cataract.
Altersstaar Kernstaar. (G.) A senile nuclear cataract.
Altersstaar klinisches Bild. (G.) Senile cataract, clinical presentation.
Altersstaar, Subcapsulärer. (G.) Subcapsular senile cataract.
Altersstufe. (G.) Stage or order of age.

Altersveränderung des Auges. (G.) Senile changes in the eye.

Altersverknöcherung. (G.) Ossification due to age.

Altersversorgungsanstalt. (G.) An institution for the care of the aged.

Alterszittern. (G.) Senile tremor.

Altheus. (L.), n.m. (Obs.). A physician or surgeon.

Althof, Herman. This distinguished German-American ophthalmologist, born at Horn, in the province of Lippe-Detmold, Germany, Aug. 8, 1835, came to America three times. His first arrival took place in 1847, when, with his father, he visited his brother, a resident of New York City. Returning to Germany, he first completed his academic education, after which he began his medical studies at Würzburg. Continuing these at Zurich, Vienna, and Prague he received his medical degree at Berlin in 1857. In the Prussian capital young Althof attracted the favorable attention of Alfred von Graefe, who offered him a position as one of his assistants. Refusing this position, however, Althof proceeded to Paris, where he studied ophthalmology exclusively and was a favorite of Desmarres.

In 1858 he came again to America, practising as an ophthalmologist in New York City.

At the end of two years, he returned to Europe, staying for a time with Heinrich Müller, in Würzburg, and, later, with Graefe again, in Berlin.

Returning once more, in 1861, to New York, he became connected with the German Dispensary, the German Hospital, and the New York Eye and Ear Infirmary.

He was one of the founders of the New York Ophthalmological society and of the American Ophthalmological Society, and was once the president of the former association.

His writings are few but important. They appeared, some in English, some in German. Among the latter were a number of *Klinische Notizen* (*Graefe's Archiv,* Bd. viii, Abthl. 1.). Among the former were *Canthoplasty:* a Clinical Study (*Trans. of the Am. Oph. Soc.,* vol. II, part 2.).

He was a gentle, kindly, and utterly unselfish man, yet, withal, very frank and sincere.

He died in New York of erysipelas, Jan. 14, 1877.—(T. H. S.)

Altiscope. An instrument consisting of an arrangement of lenses and mirrors in a telescope tube, extensible vertically, by means of which it is possible to look over objects intervening between the observer and the object seen. When the sections of the tube are extended, the view is received upon an upper mirror placed at an

angle of 45°, and reflected thence down the tube to the lower mirror, where it is seen by the observer.

Altitudinal hemianopsia. This is a term intended to indicate both superior and inferior hemianopsia, as opposed to the (lateral) homonymous or heteronymous varieties. Wilbrand (*Norris and Oliver,* Vol. II, p. 273) says that binocular superior or inferior hemianopsia theoretically is conceivable; but few cases, carefully studied, have appeared in literature. Uhthoff (*Beiträge zur Pathologie des Sehnerven*) reported inferior hemianopsia in a case of tabes dorsalis, in which he suspected the field defect was caused by symmetrical disease of the optic nerves.

Some writers claim that the loss of the upper or lower half of the field of vision, if not due to detachment of the retina or other lesion within the eye, may generally be regarded as a symptom of hysteria. On the other hand, it is sometimes present in genuine organic disease of the brain (e. g.,) it may result from a lesion of a limited area of the visual centers.

According to Peters (*Ophthalmology,* April, 1913, p. 339), who reports two examples of the disease, unilateral cases are rare, but more frequently observed than bilateral cases. In 1893 Russell (*Medical Times and Gazette,* Vol. II, p. 91) reported a case showing unilateral superior hemianopsia caused by a basilar bone tumor. It was associated with paralysis of the eye muscles. More recently, in 1893, Sailer reported a similar case, which he attributed to retrobulbar neuritis of rheumatic origin (*Medical News,* April 25, 1893), and in 1910 (*Annals of Ophthalmology,* April, Vol. XIX), Frederick Krause reported an instance of monocular altitudinal hemianopsia, due to ethmoidal disease.

Altmann'sche Methode. (G.) Altmann's method.

Altmann's method. This is a staining method mostly employed in the examination of the corneal tissues. See **Histology of the eye.**

Alttuberkulin. (G.) Old tuberculin.

Alum. ALUMEN. ALUMINII ET POTASSII SULPHAS. $KAl(SO_4)_2+12H_2O$. Common "potash" alum, although there are several other double sulphates with an aluminum base, especially the ammonium "alum." All the alums are manufactured in enormous quantities for commercial purposes from native minerals. They occur as colorless, inodorous octahedrons and cubes, with a sweetish astringent taste. Fused, it loses all its water of crystallization and is converted into a whitish mass. (See **Alum, Dried.**) The alums are very soluble in water but insoluble in alcohol.

Alum, Dried. ALUMEN EXSICCATUM. BURNT ALUM. $KAl(SO_4)_2$.

When 100 grms. of ordinary alum are exposed to a heat slightly under 400° F. (295° C.) it loses its water of crystallization and a dry, white, porous mass results. This, when dried, forms a mild escharotic and powerful astringent and, as such, has been used on granular masses and fungating wounds of the lids, globe and orbit.

Alum, Glycerite of. See **Glycerite of alum.**

Alumen. See **Alum.**

Alumen exsiccatum. See **Alum, Dried.**

Aluminated copper. See **Lapis divinus.**

Aluminii et potassii sulphas. See **Alum.**

Aluminum acetate. $Al_2(C_2H_3O_2)_2$. A gum-like mass with an acid reaction and an astringent taste.

In eye diseases it is commonly used as Burow's solution, a 7 to 8 per cent. solution of the acetate in water. This mixture is, in its turn, again diluted with five to twenty times its bulk of water before its employment as an astringent collyrium.

In cases of chronic dacryocystitis, with or without marked mucocele, the following constitutes an excellent form of lachrymal lavage with the Anel or similar syringe is a three per cent. solution in sterile, distilled water.

There is also a liquor alumini acetatis, a clear, colorless liquid, having an acid smell and reaction with an astringent, sweetish taste. See, also, **Lenicet.**

Aluminiumacetat. (G.) Acetate of aluminium.

Aluminum acetotartrate. This salt is found as colorless crystals, slowly soluble in water; insoluble in alcohol. It is occasionally used in chronic conjunctivitis in 0.20 to 0.50 solution, as well as a substitute for Burow's solution (q. v.). See **Alsol.**

Aluminum carbonate. $Al_2(CO_3)_2$. This salt is found as tasteless, chalk-white lumps, easily powdered. It is a mild styptic and astringent, and used as a dusting powder in chronic forms of conjunctivitis.

Aluminiumchlorid. (G.) Chloride of aluminium.

Aluminumnaphtholsulphonate. See **Alumnol.**

Alumnol. ALUMINUMNAPHTHOLSULPHONATE. A dry, colorless powder, easily soluble in water, less soluble in alcohol. It is an astringent and antiseptic and has been recommended as a collyrium, particularly in cases of gonococcus conjunctivitis, in 0.5 to 4 per cent. solutions. (See **Zinc acetate** and **Zincol.**)

Alypin. This agent, derived from glycerin, is closely related to stovaine (q. v.) and has been strongly recommended as a substitute for cocain as a local anesthetic.

Alypin is the proprietary name given to one of those numerous, complicated, organic compounds (mostly of German origin) that have in recent years flooded the market. In 4 per cent. solution it acts as a valuable and safe anesthetic for ophthalmic practice, as it has the same action as cocain without causing mydriasis, disturbance of accommodation, increase of tension, drying of the cornea or intoxication. It is a white, crystalline powder, soluble in water. We are indebted to Impens for its discovery.

Truc has compared the effects of both alypin and cocain of the same strength and is unable to find any appreciable difference, the toxic effect being less from alypin than cocain. With alypin there is no mydriasis, even with strong solutions. Tonus and accommodation are not changed by alypin. It is important that the solutions should be fresh, neutral; old or acid ones being irritating.

When this anesthetic is used in conjunction with silver nitrate, alypin nitrate is to be preferred to the alkaloid. Owing to the fact that alypin is incompatible with silver nitrate it is not well adapted for anesthetizing mucous membranes to which nitrate of silver is afterward to be applied, as it may to some extent neutralize the effect of the latter through chemical decomposition. Alypin nitrate overcomes this difficulty, and is therefore recommended in such cases. Its chemical characters, solubility, and strength of solutions correspond essentially to those of alypin.

Merck's Reports for 1906 quote the experience of Landolt that the anesthetic action of alypin is somewhat greater than that of cocaine, but comes on more slowly. As with the latter, the author has observed, after the instillation of drops of alypin, a transitory yet troublesome turbidity of the corneal surface with shedding of epithelium. An important point, however, is the fact that alypin is practically without influence on the pupil and on the accommodation. Kauffmann therefore recommends the use of alypin whenever dilatation of the pupil is to be avoided, and whenever the accommodation is to be preserved unimpaired; and again when the intraocular tension is raised, or when it would be dangerous to risk a rise of tension. It is also indicated, however, according to the author, when the tissue cells need special care, and when considerable changes or defects are present in the corneal epithelium, and when, further, there is no objection to hyperemia at the corneal border, or in the conjunctiva. To produce anesthesia for the removal of foreign bodies, a $\frac{3}{4}$ per cent. solution of alypin usually answers. The author gives the following as special indications for the use of alypin: Operations on the eye-ball, operations for uncom-

plicated lenticular cataract, operations for glaucoma, herpes, keratitis bullosa, defects due to injury, infective separation of the conjunctiva and abscess of the lachrymal sac.

Sydney Stephenson makes the following emphatic statement regarding it: That he had never seen a bad result from 2 per cent. alypin, despite the fact that from 1905 to August, 1908, it had displaced all other local anesthetics in his practice.

Sendral had good results with alypin anesthesia in operations for senile cataract and secondary cataract. In operations for chalazion where he both instilled alypin solution and also applied it subconjunctivally, he did not obtain complete immunity from pain, because the anesthesia was slow to extend into the tarsal tissues. In operations for squint, also, the anesthesia was incomplete.

Alzaharavius. A distinguished Arabian physician and ophthalmologist. See **Abul Kasim ben Abbas al-zarawi.**

Amacratic. Properly hamacratic. Same as amasthenic (q. v.).

Amacrine cells. This term is applied by Ramón y Cajal to a certain form of spongioblasts found within the plexiform layer of the retina. See **Histology of the eye.**

Amalgamiren. (G.) To amalgamate, to amalgamize.

Amalgamirung. (G.) Amalgamation.

Amanita. A genus of the mushroom family, mostly poisonous, whose ingestion occasionally produces ocular symptoms. Examples of oculotoxic disturbances are reported by several observers. G. Valenti gives the history of a man, 26 years of age, who exhibited signs of poisoning during the night after the day when the mushrooms were eaten. He was barely able to perceive light and the pupils were much dilated. The ophthalmoscope showed the papillæ to be "off" color, the arteries diminished in size and the veins relatively dilated. At the end of eight days vision began to improve and in two weeks the patient was able to read large type. At the end of a month vision had risen to about one-third, after which there was no further improvement. In this instance the toxic condition was due to a subacute, retrobulbar neuritis similar to that produced by tobacco-alcohol.

It not infrequently happens that when these poisonous fungi are mistaken for edible mushrooms and have been thoroughly cooked and seasoned, it is difficult for the ordinary observer to detect, by the sense of taste alone, the difference between the toxic and the non-toxic fungi; although their appearance when fresh, their method of growth and other indications, easily distinguish most poisonous plants from the innocent varieties.

The most lethal of this genus is *Amanita phalloides*, also known as *Amanita verna*. The symptoms are chiefly those relating to the size of the pupil which is often widely dilated. Diminution of the visual acuity, amounting now and then to blindness, has been reported. For example, several people who, one evening, ate a dish containing these mushrooms in milk, became sick at daybreak with slight and then with severe symptoms of gastro-intestinal irritation, exhaustion, increased pulse, and rise of temperature. The pupils at first reacted to light, but blindness eventually set in. Subcutaneous injection of atropin resulted in some improvement.

In another complicated case with Cheyne-Stokes respiration, mydriasis was present.

Pupillary contraction also occurs. In each of three cases of poisoning related by Lewin and Guillery the pupils varied; in one case they were normal, in the second the eyes were sunken, expressionless, and both were reduced to pin-points, while in the third they were contracted but unequal. The right was extremely contracted but the left was much dilated. In four days both became almost normal.

The pupils usually react promptly to light and accommodation, but in one case there was a slight sluggishness in the light reflex, and the action failed completely after repeating the test a number of times. In another case the patient, who had but slightly dilated pupils, complained of photophobia. See, also, **Toxic amblyopia** and **Amanita muscaria.**

Amanita muscaria. This fungus is one of the poisonous mushrooms, sometimes mistaken for an edible variety. It was from the Agaricus muscarius that the alkaloid *muscarin* was first obtained. From experiments with it on animals Lewin and Guillery found that while it is an energetic agent—acting as an antagonist of atropia—yet the poisonous species of Amanita must have other powerful agents combined with them. Both its local and general employment induces contraction of the pupil and spasm of accommodation. The local application to the eye of the cat causes an energetic contraction of the pupil, but after instillation of 0.5 per cent. solution of muscarin chlorid, or even after placing a crystal of the substance in a bird's eye, the action on the iris is nil. The explanation probably is that the iridic muscle in mammals is of the non-striated variety, but in birds is striated and more or less under the control of the will. In man larger amounts are required to produce contraction of the pupil. Even with 1.5 per cent. solution miosis is absent, though the refraction is changed. On the other hand, miosis may be well developed in an eye free of ciliary spasm. As a rule,

contraction of the pupil occurs later than spasm of accommodation and the miosis increases even when the near-point again begins to recede and lasts from three to twenty-four hours. A solution of atropin, strong enough to induce mydriasis and to overcome the contracted pupil, does not prevent the spasm of accommodation. For this stronger solutions are necessary when an additional dilatation of the pupil occurs. The pupil under the influence of muscarin reacts well to light.

When the effects of muscarin are produced by instillation, they occur in the form of an accommodation spasm associated with a rapid onset of false myopia. The accommodation spasm begins, as a rule, after five to ten minutes, reaches a maximum in fifteen to thirty minutes, and disappears in one to two and one-half hours. Thus the return to normal requires about twice as much time as its appearance. On subcutaneous administration the opposite is observed. Complete disappearance of the range of accommodation has not been accomplished with this agent, except by the employment of such strong solutions that marked irritation of the conjunctiva results. The action on the far-point is the first and most active; but a similar effect on the near-point cannot be produced. Physostigmin (eserin) acts more strongly on the pupil than on the accommodation, but with muscarin the reverse is the case, but when the effect of muscarin on the pupil appears it lasts longer than it does after eserin.

The subcutaneous injection of muscarin does not cause (for the reason before given) miosis in birds, but severe general intoxication may set in. In rabbits the effect is inconstant, while in cats a miosis appears in one to two minutes; after three to five there is an increased secretion of tears.

In man, subcutaneous injection of 0.005 grm. of muscarin induces an insignificant miosis and slow light reaction, while much smaller doses act on the salivary secretion and intestine; and 0.001 to 0.003 grm. causes accommodative spasm. Muscarin miosis is evidently the result of a peripheral stimulation of the sphincter mechanism.

The poisoning of people with amanita muscaria causes contraction of the pupils, as a rule. In a boy there were at first contracted pupils and lost reaction to light; later the pupils were markedly dilated. Frequently dilatation and loss of reaction occur, and even in fatal cases the pupils have remained normal in size from the beginning, reacting promptly to light and accommodation. Disturbances of vision have rarely been noticed. People who have eaten the amanita have visual hallucinations and generally see

objects enormously enlarged. Although such persons are able to walk without staggering yet objects appear unsurmountably large. Writers relate a joke sometimes played on the unfortunate of laying a small obstacle, a cane, for example, in his path. The poisoned patient stands still, examines the cane, and finally jumps over it! In such cases of megalopsia it has been noticed of the size of the pupils that at first they are dilated, later contracted.

Amanita phalloides. For an account of the ocular symptoms in poisoning from this fungus, see **Amanita.**

Amanite. (F.) The generally poisonous fungus, **Amanita** (q. v.).

Amarant. (G.) Amaranthus.

Amaranth. (G.) Amaranthus.

Amasthenic. In *optics*, a term applied to a lens photographically perfect, or which unites all the chemical rays into one focus. Also amacratic.—(C. F. P.)

Amaurose. (G.) Amarosis.

Amaurosi parziale fugace. (It.). Scintillating scotoma.

Amaurosi uremica. (It.). Blindness due to uremic poisoning.

Amaurosis. The distinction commonly made between *amblyopia* and *amaurosis* lies in the degree of blindness in each instance. In the former case the defect of vision is not as marked as in the latter. Amaurosis conveys the idea of complete blindness, or a defect in the eyesight closely approaching it.

This expression was formerly employed to indicate a clinical entity and to constitute a diagnosis *per se*, but it is now obsolete in that sense, since in most forms of amaurosis (blindness) the tissue alterations and the character of the various disorders producing the loss of eye-sight are now known to vary and in many instances to be entirely distinct from one another.

Amaurosis, Epileptiform. Attacks of partial or total blindness in epilepsy experienced by the still conscious patient, corresponding to concentric contractions of the field of vision and the arterial and ciliary spasm so often elicited on examination. The perimeter is consequently of great value in the diagnosis of this disease and in cases of suspected malingering. Dilation of the retinal veins has been observed during the seizures, and to this condition has been given the name retinal epilepsy.

Amaurosis exanthematica. Blindness attending or following eruptive diseases.

Amaurosis ex hemorrhagia. AMAUROSIS EX HYPEROPSIA. A serious form of blindness occurring after various hemorrhages, especially hema-

temesis and other bleedings from the intestinal tract. The amaurosis is often permanent and results from anemia and atrophy of the optic nerve. See **Amblyopia from hemorrhage.**

Amaurosis ex hyperopsia. See **Amaurosis ex hemorrhagia.** Blindness following excessive bleeding.

Amaurosis from mercuric methyde. See **Toxic Amblyopia.**

Amaurosis from uremia. Unless there are alterations in the retina or optic nerve accompanying this symptom—temporary blindness in persons suffering from chronic or acute renal disease and similar conditions—the prognosis is quite favorable. The attacks of blindness rarely last longer than from 12 to 24 hours and a return to normal vision is the rule. During the period of recovery, temporary defects in the visual field have been noticed. The treatment should be directed to the underlying diseases. Sometimes, as in the uremia of pregnancy and scarlet fever, this can be cured in which case the amaurosis eventually disappears.

Amaurosis in malaria. See **Malaria, Eye disease from.**

Amaurosis in scarlatina. See **Scarlatina, Ocular Symptoms of.**

Amaurosis, Narcotic. Blindness following the use of narcotics.

Amaurosis partialis fugax. TEICHOPSIA. SCINTILLATING SCOTOMA. MIGRAINE. SICK HEADACHE. Attacks of this disease have certain clinical affiliations with epilepsy but are not to be regarded as indicative of disease of the eye, although ocular disturbances form an important part of the symptom-complex. Apart from the scintillations, a "fortification" scotoma is the most common experience. This irregular, cloud-like appearance, usually edged with colors, shows itself in some part of the visual field and gradually spreads until the patient is blind. This is followed in its turn by severe, unilateral headache, lasting for a few hours or for a whole day, to be apparently relieved by vomiting. The attacks of migraine become less frequent or less violent after 45. until they generally disappear, with advancing years. The elasticity of the vascular walls diminishes with age, thus interfering with that spasm of the cerebrocortical vessels upon which the disease probably depends. As in epilepsy, treatment (especially the prescription of glasses) directed to the eye occasionally relieves or cures this troublesome affection, but it is not to be relied upon.

Amaurosis pellagrosa. (L.). Blindness due to pellagra (q. v.).

Amaurosis, Progressive. Blindness resulting from a progressive atrophy of the optic nerve-endings.

Amaurosis, Quinine. See **Toxic amblyopia.**

Amaurosis, Rachialgic. Blindness due to disease of the spinal cord.

Amaurosis, Simulated. Feigned blindness, or ocular malingering.

Amaurosis, Spinal. Atrophy of the optic nerve due to lesions of the cord, such as lateral or multiple sclerosis.

Amaurosis, Sympathetic. Permanent or temporary blindness of one eye due to the transmission of disease from the fellow eye. See **Sympathetic ophthalmia.**

Amaurosis, Trifacial. Blindness due to irritation or disease of the trigeminus nerve.

Amaurosis venerea. Blindness due to syphilis.

Amaurotic cat's-eye. An obsolete term formerly applied to various intraocular conditions observed through the pupil, especially to glioma of the retina, vitreous deposits, exudative choroiditis, etc.

Amaurotic family idiocy. ARRESTED CEREBRAL DEVELOPMENT. INFANTILE CERERRAL DEGENERATION. AGENESIS CORTICALIS. A rare disease characterized by the gradual onset of paresis or paralysis, mental impairment leading to absolute idiocy, defective vision terminating in absolute blindness, marked marasmus and death invariably before the third year of life. No form of treatment has had the least effect in these cases. Since it is wholly untenable that the disease is of syphilitic origin, the routine administration of mercury and iodides is not justified, and need not be advised. Kingdon tried pituitary gland and cerebrine without effect. On the assumption that the disease may result from the elaboration of some toxin by the mother, Kingdon and Russel suggest that the children in the family be hand and not breast fed. In the presence of a hopeless disease this may prove worth while.—[D. H.].

Cases of this condition are reported by Buchanan, Cohen and Dupuy-Dutemps, the latter case being the first recognized in France. All these were of Jewish parentage, as have been all but six of the instances so far reported, numbering now over 80. In Cohen's case the deviation from health was noticed at 5 months and death occurred at 17 months. In the other cases special weakness was noticed at the age of three months. They were still living at 11 and 15 months; but an older brother of the patient of Dupuy-Dutemps had died at 2½ years, apparently of the same disease. In Cohen's case the microscopic examination showed no true edema of the retina, but supported the view that the disease was essentially a degeneration of the ganglion cells. There was also beginning atrophy of the optic nerve. (*Ophthalmic Year-Book*, 1908, p. 228).

Amaurotic idiocy. See **Amaurotic family idiocy.**

Amaurotisch. (G.) Amaurotic.

Amaurotische Pupillenstaare. (G.) Amaurotic pupil cataract.

Amaurotisches Katzeauge. (G.). Amaurotic cat's eye. Pseudoglioma.

Amaxophobie. (G.) Amaxophobia

Amber glass. Material for the manufacture of protective lenses, coquilles, etc., intended to defend the eye, especially from the violet and ultraviolet rays of light. The protection thus afforded, even by light shades of amber glass, is very marked. In the various forms of intraocular disease of which photophobia is a symptom, or when normal eyes are exposed to glare or dazzling light, brilliant reflections, etc., this color is probably the most satisfactory one that can be prescribed. Instead of the yellow-red (amber), a green-yellow euphos glass (q. v.) is preferred by some authorities.

Ambidexterity. The ability to use either hand equally well, especially in operative surgery. Seldom will an operator acquire the same skill for the left hand that he possesses in the right, and the advantages of ambidexterity in ophthalmic operations have usually been greatly over-rated. The right-handed operator will always realize that when it comes to certainty, quickness and delicacy of action his right hand is the more reliable, no matter how much training he may give the left, and it is a duty he owes to himself and to the patient to operate in a manner which holds out the best hope of success under any circumstances which may arise.

It may be true that the person who has been trained from childhood to use one hand as much as the other may learn to operate as well with one hand as the other, but this will not hold good with the average person who has been single-handed up to the time that his operative experience begins. To him the best results under all conditions will come from the hand that is used to the most exacting work, and whose natural function has been increased by appropriate training. It sounds very well for an operator to say that he makes his corneal section in cataract extraction with the right hand when operating upon the right eye, and with the left hand when operating upon the left eye, and the practice may look well to an audience, but the operators are exceedingly few in number who can use one hand as well as the other, and it is a sacrifice of some of the chances for the highest type of success when the operator fails to use the hand which he knows is the one with which he can do best under any and all conditions.

Many operators are apparently ambidexterous and operate successfully and skillfully with the left hand, but it may be seriously questioned if such operators in an emergency could be depended

upon to do as expert work with the left hand as the right, and one never knows when an emergency may arise which will tax to the utmost the suppleness, promptness and delicacy of action sometimes required of an operator, and it is then that it is the height of absurdity to claim that the left hand can be depended upon to the same extent as the right, which from birth has been trained to do all the exacting work.—[E. C. E.]

Ambiopia. Double vision. See **Diplopia.**

Ambliopia alcoolica. (It.). Blindness from the ingestion of alcoholic liquors.

Ambliopia congenita. (It.). Congenital amblyopia.

Ambliopia da anopsia. (It.) Amblyopia from non-use of the eye.

Ambliopia isterica. (It.). Hysterical amblyopia.

Ambliopia nicotinica. (It.) Tobacco amblyopia.

Ambliopia notturna. (It.). Hemeralopia.

Ambliopia tossica. (It.). Toxic amblyopia.

Amblyopia. The term amblyopia, like amaurosis, formerly defined a clinical diagnosis and entity, but modern methods of examination have relegated it to the ophthalmic limbo, although it is still employed, by consent, to indicate some definite and some ill-defined organic lesions. As his knowledge of pathology increases the ophthalmologist should use the word less and finally discard it as a relic of the pre-ophthalmoscopic era.

Amblyopia, Alcoholic. See **Alcoholic amblyopia;** also, **Toxic amblyopia.**

Amblyopia amaurotica. (L.). Obsolete term intended to express total loss of vision from optic or central disease.

Amblyopia and heterotropia. See **Amblyopia ex anopsia.**

Amblyopia, Arsenical. See **Arsenical amblyopia; Atoxyl; Salvarsan; Toxic amblyopia.**

Amblyopia, Astigmatic. Astigmatism is sometimes accompanied by a conus at the optic disk, a white, sickle-like figure which corresponds to a widening of the sclerotic ring at the lower edge of the optic nerve. Abnormalities in both the lens and cornea may also be discovered on examination. In other words, some forms of this refractive anomaly are accompanied by organic changes in the eye, so that it is not to be wondered at that in high degrees of astigmatism, even after correction of the anomaly of refraction, the visual acuity never reaches normal. Such a defect of vision may properly be termed *amblyopia astigmatica.*

Amblyopia, Cachectic. Defective vision due to the absorption of the products of some chronic, wasting or malignant disease. Two cases

of this form of chronic intoxication associated with complete blindness not being caused by alcohol or tobacco are reported by Tojoda, who states that in the first case there was a suddenly developed central amaurosis imposed on a partial retrobulbar neuritis of long standing, probably the result of chronic nephritis, cirrhosis of the liver and empyema of the gall bladder. The second case was a toxic amblyopia to which a rapidly developing complete amaurosis was added, due to cachexia from carcinoma. Similar cases of blindness due to carcinoma cachexia have been reported by Deutschmann and Miura. Microscopically, the nerves showed typical interstitial neuritis, with ascending and descending atrophy. In the first case the lesion began 8 to 10 mm. behind the optic nerve entrance, showing that the process started in the nerve itself, and not primarily in retina or the papilla. (*The Ophthalmic Year Book*, 1908, p. 236.)

Amblyopia, Central. By this term is specifically meant the disease that Leber *(Graefe-Saemisch Handbuch)* described as hereditary optic neuritis or atrophy—*neuritis optica hereditaria.*

It also indicates any symptom-complex depending on a lesion of the central area of the retina, i. e., the fovea, or macular region, or of the nerve bundles that supply this region, e. g., in tobacco-alcohol intoxication, retrobulbar neuritis, etc.

In Leber's cases the male members of one family were affected about their twentieth year. Diminution of the visual acuity, due to a central scotoma, developed in the course of a few weeks; and recovery was rare. Ophthalmoscopic examination revealed, first, an optic neuritis and, later, atrophy of the optic nerve. Considering these objective findings the disease thus described by Leber should not be called an amblyopia.

Amblyopia crapulosa. (L.). Alcoholic amblyopia.

Amblyopia, Crossed. This symptom was probably first mentioned by Charcot, although Gowers and other have since accepted the definition, viz.: a marked visual defect with a very contracted field of vision in the eye opposite the central cerebral defect (in the angular gyrus or internal capsule), associated with a perimetric contraction in the eye on the side of the central disease. The objection to this hypothesis is that it assumes a double crossing of the optic fibres as well as two distinct centres—one for unilateral and the other for bilateral vision.

Amblyopia ex anopsia. ARGAMBLYOPIA. Defective vision from lack of education or use of the visual apparatus, or of some portion of it. When one eye is excluded from the visual act this inability may be due to an opacity in the dioptric media, as in congenital cataract,

pupillary membrane, leucoma or nebula of the cornea, etc. More often it is congenital and due to some form of strabismus. Sometimes strabismic eyes that possess fair vision early in life may lose the power of fixation after long-continued non-use.

Treatment of this form of amblyopia is the removal at as early a stage as possible of the obstacles to good central vision and the subsequent exercise of the affected eye. In cases of strabismus that anomaly should be relieved either by operation or the prescription of glasses, or by both means.

There has been much controversy as to whether blindness or very poor vision from non-use or lack of education of an eye really occurs. A case reported by G. H. Mathewson, for example, gives proof that one does meet with eyes which do not see because they have not been trained to do so.

A boy, 13 years of age, was brought with a badly damaged eye, having been struck a violent blow by a large stone. Both the boy and the mother stated that the vision in the eye which was damaged had never been good. On examination, the injured eyeball was found to be ruptured and disorganized, with absolutely no vision. The damaged eye was enucleated one week later, and after an uneventful convalescence vision in the patient's remaining eye was ability to count fingers at 12 feet, and with the addition of a plus 4 sphere it improved to 6/xxxvi. He was unable to read even very coarse print with the glass. Refraction under homatropine showed his refraction to be about the same as without a mydriatic and consequently his full correction was prescribed. Five weeks later when he was brought back it was found that his vision was 6/ix and he could read the finest print with ease.

Although the term itself has frequently been loosely applied, especially in connection with the amblyopia (usually unilateral) of the various forms of strabismus, yet there seems to be no reason why congenital lesions of the nerve centres, or even of the nerve tissues themselves, as yet undiscovered by laboratory investigation, may not explain the irremediable or but slightly improvable forms of *amblyopia ex anopsia.* This condition, on the other hand, entirely differs from that giving rise to "defects of function" (whatever that may imply) which are capable of considerable improvement or complete cure after the neglected eye has been converted into a functionating organ. A better classification of these forms of amblyopia from non-use based on careful and extended examination, is much needed.—(Ed.)

Amblyopia, Feigned. See **Malingering.**

Amblyopia from botulism or ptomaine poisoning. See **Toxic amblyopia.**

Amblyopia from dental disease. In a number of well-known cases through irritation of the branches of the nerves supplied to the teeth, decided defects in vision have been produced.

Amblyopia from drugs and allied agents. See **Toxic amblyopia.**

Amblyopia from excessive light. See **Day-blindness, Functional.**

Amblyopia from hemorrhage. Temporary or permanent reduction in visual acuity due to loss of blood from one or several organs, was noted at a remote period in medical history. The affection, which is found more often after than before the fortieth year, is of unusual occurrence; it is rarely seen in healthy subjects who have been accidentally wounded (e. g., soldiers in battle); and, as a rule, it involves both eyes in about the same degree.

The careful study of this subject which was made by Fries,[1] in 1876, after searching the literature of the preceding 235 years, has furnished the following statistics:—Of 106 cases of visual disturbance following hemorrhage, 36 per cent. were from the stomach; 25 per cent. from the uterus; 7 per cent. from the nose; 5 per cent. from accidental wounds; 25 per cent. from intentional loss of blood —venesection, leeching, or cupping; and 1 per cent. from pulmonary and urethral bleeding. Carlini[2] states that these percentages have not been changed by cases reported since 1876.

The age of the recorded patients has ranged from 2 to 77 years. When the condition is bilateral, rarely is one eye entirely blind and the other only slightly affected. In only 10 to 15 per cent. of cases is one eye alone involved (Groenouw).[3] Blindness following gastric hemorrhage is twice as frequent in men as in women (Pergens).[4]

That extensive hemorrhage, *per se*, is not a factor in the production of amblyopia is undisputed. Thus, in the Franco-Prussian war de Wecker and Knies did not observe a single case of amaurosis following wounds, and only 5 of the 106 cases tabulated by Fries can be attributed to pure traumatism. Nor is there any relation between the extent of the hemorrhage and the gravity of the ocular symptoms. Hence it must follow that, in cases of visual disturbance following hemorrhage, a pre-existing factor or condition is of supreme etiologic importance.

The case reported by Stirling[5] may be cited as typical of predisposing conditions. A boy, aged 6 years, a victim of hemophilia, suffered a transient complete blindness sequent to a profuse hemorrhage following the extraction of a tooth.

Disorders of vision following hemorrhage occur, almost without exception, only in persons who previously were not healthy.

Loss of vision from hemorrhage may come quickly or slowly. In 25 per cent. of cases the loss of sight appeared either during, or immediately following the hemorrhage; in 20 per cent. within the first 12 hours; in more than 50 per cent. the blindness appeared within 3 weeks—and in most of these between 3 and 6 days after the loss of blood (Groenouw). As regards blindness following gastric hemorrhage, the statistics of Pergens, based on 43 cases, show the following: immediate loss of vision, in 21 per cent; loss within the first 24 hours, in 9 per cent.; later, but within the first week, 51 per cent.; in the second week, 14 per cent.; and in the third week, 5 per cent.

Amblyopia from intentional blood-letting comes, as a rule, within a few hours; whereas that following accidental hemorrhage appears after several days.

The patient may suffer severe hemorrhage without visual disturbance, only to have his vision much reduced or entirely lost after a recurrence of the bleeding. In repeated hemorrhages vision may become less after each attack, while improvement or entire restoration is noticed during the intervals.

If a severe hemorrhage has caused unconsciousness, the patient, on awakening, will notice the blindness, or may think that he is in the dark; i. e., that it is night-time. Cerebral symptoms—syncope, cardiac palpitation, headache, pain in the back of the neck, or at the base of the skull—are often present.

Following less severe bleedings, and having recovered from the resulting anemia, the patient may think himself entirely well when, suddenly, there is a loss of vision.

The external appearance of the eyes is not far removed from the normal. In complete blindness the pupils will be dilated and irresponsive to light. In unilateral cases, the pupil of the blind eye will contract synergistic with that of the normal eye. This is in accord with the well known facts that in unilateral blindness due to disease of the optic nerve or retina, the pupil of the affected side will be dilated provided the other (normal) eye is covered; while light striking the seeing eye will cause both pupils to contract.

The ophthalmoscopic findings in cases of amblyopia from hemorrhage may be: 1—entirely negative; 2—slightly positive; or, (3) of marked degree. In only a few instances has the ophthalmoscopic examination been made within a few hours after the advent of the blindness (cases of Litten,[6] Schweigger,[7] Hirschberg,[8] and Horst-

mann).[9] In these patients the optic nerve head presented a washed appearance, with very slight or not any swelling; and the area surrounding the nerve showed a faint opacity, extending to the macula lutea and diminishing toward the periphery of the retina. Small, brilliant spots and minute hemorrhages were seen in the retina.

While in the majority of cases ophthalmoscopic signs are either negative, or are present as slight neuro-retinal changes, there remains the small number in which the fundus changes are markedly prominent. The cases of Groenouw,[3] Ulrich,[10] Stirling,[5] and Theobald,[11] may be cited as examples. Such severe cases will show the nerve-head of chalky whiteness; the contour indistinct; the retinal arteries narrowed and the veins—by contrast—of normal size. Hemorrhages may be present in the retina.

The changes mentioned above may be permanent, or there may be an improvement in some of them. Thus, for example, Groenouw [3] cites a case in which, after an interval of three months, the blurred disc had regained its contour; the attenuated vessels were of normal calibre; visual acuity and the visual field had become normal—but the chalky whiteness of the nerve-head remained.

The ophthalmoscopic findings do not correspond with the degree of loss of vision. With pronounced fundus changes good visual acuity may be present, and vice versa.

In those patients who have retained vision of an amount sufficient to permit an examination of the fields, the perimetric findings have shown great variations. The narrowing may be slight and concentric, or so great that only a small island remains. Often the field is irregular and it may assume a hemianopic form, or, only one quandrant may be missing. In a case cited by Uhthoff [12] the nasal half of the field was preserved, the color-fields for blue and red were much contracted, and in the blind temporal half of the retina two small islands were functionating. A normal peripheral field with a central scotoma was observed by Mandelstamm.[13]

In general terms, the field is contracted but its form is not characteristic.

Few photometric examinations have been made in the class of cases under consideration. Pergens [4] found the light-sense abolished.

Only three post-mortem examinations have been made:—the first one by Hirschberg, in 1882; the second by Ziegler,[14] in 1888; and the third by Raehlmann,[15] in 1889. The findings of Hirschberg and Raehlmann are of little value, since their cases belong to the latter stages of the disease. Ziegler's case, which was studied 23 days after the advent of amblyopia, is important.

Hirschberg's specimens were studied 3½ years after the onset of blindness. The right eye was totally blind, and its sections showed a complete atrophy of the optic nerve. The left eye had presented, ophthalmoscopically, a neuro-retinitis and had regained vision of 20/40. In it a circumscribed atrophy of the outer layers of the optic nerve was found.

Ziegler's studies showed a fatty degeneration of the optic nerve and retina, the process reaching its acme in the nerve fibres adjacent to the lamina cribrosa.

Raehlmann's patient was a female, aged 23 years, who became blind on the second day after a severe hemorrhage and died eight weeks later from edema of the brain. Microscopic examination disclosed a marked narrowing of the lumina of the retinal arteries from endarteritis fibrosa; and the veins presented a similar process. In some areas the arteries were obliterated. The retina was edematous.

It would be unprofitable to enter into a discussion of the numerous theories which have been advanced in explanation of this form of blindness. As Carlini[2] has said: "only the hypothesis based on the accurate clinical observation of each case can be of true value."

A few of the hypotheses which have been considered seriously are: hemorrhage into the optic-nerve sheath (von Graefe,[16] Leber);[17] stasis in the retinal veins (Ulrich);[10] thrombosis of the central retinal artery (Theobald);[11] inflammation of the optic nerve with subsequent atrophy (Horstmann, and Hirschberg); a lesion, probably an edema, of the visual centres (Samelsohn);[18] anemia of the brain.

Amblyopia from hemorrhage is a serious condition which calls for a guarded prognosis. There seems not to be any relation between the amount of blood lost and the degree of possible improvement in vision; nor has the date of the appearance of blindness any bearing on the prognosis. Recovery is possible even after perception of light has been abolished for several days, provided the pupillary reaction to light is retained. In the more favorable cases the duration of the amblyopia will vary from a few minutes to many hours. In the majority of patients the improvement, if it comes at all, is noticed not immediately but after several days, weeks, or even months (Groenouw).[3] As has been mentioned above, the ophthalmoscopic findings do not furnish a basis on which to predicate the prognosis.

The degree of the impairment of vision, existing early in the history of these cases shows great variations. Singer,[19] who collected 198 cases from the literature (including 106 noted previously by

Fries),[1] reports 58.8 per cent. of complete blindness; 32.4 per cent. of partial blindness; and 8.8 per cent. in which blindness was complete in one eye and partial in the other.

The ultimate results, as given by Singer, were: no improvement, in 45.9 per cent.; improvement in 39.1 per cent.; complete recovery in 13.5 per cent.; with subsequent failure in 1.5 per cent. These statistics practically confirm the statement of Groenouw,[3] that, "In almost one-half of all cases vision does not improve; in about one-third there is improvement; and in about one-fifth complete restoration of central vision, with—in many cases—defects in the visual field, is to be expected."

In amblyopia following gastric hemorrhage, the percentage of cures is small. Pergens[4] has collected 50 such cases which ended as follows: 6 per cent. died; 36 per cent. were blind in both eyes; 18 per cent. were blind in one eye; 18 per cent. suffered a marked reduction in visual acuity in both eyes; 14 per cent. obtained useful vision; and in 8 per cent. there was a complete cure.

The treatment of amblyopia following hemorrhage must be conducted along broad and general lines—bleeding should be checked, rest enforced, a nutritious diet supplied, and iron and strychnia be administered. Local treatment of the eyes is not required, and such radical procedures as paracentesis of the anterior chamber and iridectomy should not be considered. (J. M. B.)

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Zentmayer (*Ophthalmic Record*, Aug., 1912) expresses the opinion that these cases are of comparatively rare occurrence. In a very considerable percentage there is marked contraction of the superior and inferior halves of the fields, simulating hemianopsia; true homonymous hemianopsia, central scotoma and peripheral contraction are also seen. There may be no ophthalmoscopic changes, or there may be optic atrophy, neuritis and papilledema. The prognosis is grave. These symptoms most frequently follow hemorrhage from the stomach and bowels, and uterine hemorrhage. The condition of the patient at the time of hemorrhage is an important factor. The pathogenesis is varied. Probably in a majority of cases it is due to degeneration. Treatment should be prophylactic. Hypodermoclysis and intravenous injection of blood-serum are advised.

Commenting on this paper Hiram Woods says that the essayist properly insists upon carefully noting all conditions present and shows how this leads to the use of modern laboratory methods of diagnosis, and examination of the patient by trained specialists in all departments of medicine. This is necessary because blindness from distant hemorrhage is very rare, and profuse hemorrhage very frequent; consequently there must be something beside the hemorrhage. Toxemia is to be considered, because (1) toxic symptoms are noted in all the troubles producing the hemorrhagic duodenal ulcer, uterine disease, etc.; (2) toxemia is common in the disorders for which venesection is done, and venesection has been followed by blindness; (3) the variety of blindness observed is such as we see in toxic conditions—central scotoma, field scotoma, hemianopsia, etc. It is not claimed that this is entirely satisfactory, but it is suggestive. Even in cases of blindness following hemorrhage from tooth extraction, when the individual was thought to be in normal condition, there is still no explanation of the reason for the hemorrhage. We know very little about the causes of profuse bleeding after such slight injuries; but its occurrence certainly means that something is wrong, that the individual cannot be given a clean bill of health.

Regarding the pathology of the blindness, the essayist quotes

Gowers and DeLapersonne to the effect that the pathogenesis is not the same in all cases; Wildebrand and Sanger—that we know nothing definitely about it. He also lays stress upon the work done on animals by Holden. This demonstrated atrophy of the ganglion cells of the retina; but Holden himself is not satisfied with the evident failure of this to explain all cases. Weeks gives as the only explanation "degeneration of the ganglion cells, primarily because of interference with their nutrition," and says it is to-day fully recognized that this is the cause of blindness. Diagnosis of this degeneration is impossible. Atrophy of the retina, on the other hand, affords evidence in narrowing of the vessels, their conversion into white strands, etc. Fuchs gives, as causes, protracted inflammation, embolism, thrombosis. In such cases the nervehead itself shows secondary atrophy. It is worthy of note that Fuchs does not mention profuse distant hemorrhage as a cause of *retinal* anemia or atrophy. In other words, Fuchs puts the primary ocular manifestation of the distant hemorrhage in the nerve. Since the optic nerve is affected by intracranial lesions, cortical, basal, nuclear, etc., we are often forced to wait for focal symptoms before we can explain a papillitis or atrophy. When they come we may see visual defects characteristic of toxemia or of one of several focal troubles. If we assume degeneration of the retinal ganglion cells as the cause, we can, of course, explain the secondary nerve atrophy, thread-like vessels, etc. But we do not explain the clinical character of the blindness in a number of the reported cases. In this connection the views of von Graefe, Carlini, Leber and others, as embodied in the paper, reinforced, as they seem to be, by Fuchs' classification, point to intracranial or optic nerve lesion as the starting point. Twenty-four cases are appended from the literature to the paper. The ophthalmoscopic findings are not given in 3 cases, and in one they were normal, but in the other 20 there was definite nerve lesion-papillitis, postneuritic atrophy and simple atrophy. This, to his mind, strengthens the essayist's hypothesis that retinal ischemia, with degeneration of the retinal cells, may account for cases showing peripheral contraction, and possibly some of the cases of central scotoma; but that retro-bulbar neuritis, or neuritis with secondary atrophy, due to a variety of intracranial lesions, more thoroughly explain clinical findings.

Another hypothesis is possible, and it corresponds somewhat closely with the theory of cell degeneration from ischemia—the only explanation based on animal experimentation. There is no reason why the cortical cells should not suffer from ischemia as well as the

retinal. Case histories indicate that in a certain number the nerve lesion is observed late.

Samelsohn's explanation of optic neuritis is given by the essayist. With a refilling of the cerebral vessels the fluid is forced into the lymph spaces—causing an optic neuritis, with an increase in the interstitial tissue and pressure on the central vessels, and finally optic atrophy. This order of pathological changes might explain the hemiopic cases on the theory of ischemia. Some vision was spared because the secondary atrophy was slight, while the cortical cells were killed by lack of nutrition. Again, degeneration of retinal cells would be explained by cutting off of nutrition through pressure on the vessels during the atrophic process in the nerve.—(Ed.)

Amblyopia from poisons. See **Toxic amblyopia.**

Amblyopia, Functional. See **Amblyopia, Hysterical.**

Amblyopia, Hereditary. See **Amblyopia, Central.**

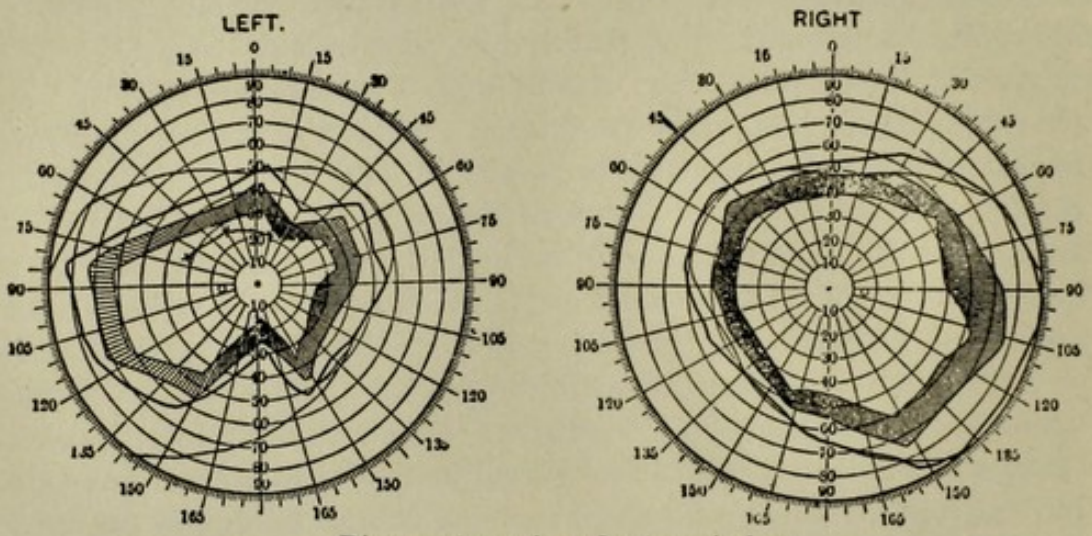
Amblyopia, Hysterical. The functional amblyopia, retinal anesthesia, neurasthenic, or nervous asthenopia of the hysterical individual may be so marked that the patient has to be led about the room, or, more usually, it may pass unnoticed by the patient. It is not improper to regard the visual defect as due to an anesthesia of the perceptive elements of the retina in correspondence with that loss or perversion of sensation exhibited by the skin and mucous membrane in other phases of hysteria. This visual defect is almost always present, and when the central acuity of sight, as determined by test-types, is nearly or quite normal it will be found on careful inquiry that peripheral vision, measured by the perimeter, is uniformly affected.

The peculiarity of an hysterical field is, that while in every other disease where peripheral limitations occur, the color field is affected in greater proportion than the field for white, in hysterical amblyopia the field is less affected for colors than for white. Even where the field for white is still the largest it can usually be shown (where there is no perimetric defect) that the visual field for red is larger than that for blue, and these measurements should always be taken in doubtful cases. This reversal of the order and extent of the fields for white and colors is, when present, positive evidence of the existence of hysteria; it cannot be simulated, and is caused by no other ocular disorder. It is readily determined and possesses a diagnostic value equal to the anesthesia of the glottis and pharynx so frequently referred to as pathognomonic of this neurosis.

Although contracture and spasm of almost every member of the oculo-muscular system have been observed in hysteria, many of

these are differentiated from true paresis and insufficiencies with some difficulty. A few, however, are so evidently functional disorders, and their detection is so comparatively easy, that we do not hesitate to refer to them as hysterical stigmata with which every one should be acquainted.

Even before the days of modern ophthalmology it was noticed that spasm of the orbicular muscles was frequently associated with amaurosis and amblyopia, although there was no apparent structural disease of the ocular apparatus. Such a state of affairs should make us suspect, and further examine the patient for, hysteria. All such forms of spasm of the orbicularis—winking or blinking,



Ring scotoma in a hysteropic boy.

tonic, clonic, transitory or permanent, unilateral or bilateral—are probably hysteric. If central or peripheral excitants competent to produce the spasm can be excluded and if other hysterical stigmata be present the possibility becomes a certainty.

Monocular polyopia or diplopia is often noticed in hysteropes although this symptom will have to be developed in the majority of cases because the patient is unconscious of it as such.

It commonly appears to him as part of his visual defect. Tests should be made both in a lighted and darkened room. One eye being covered, a white match is held vertically three or four inches in front of the uncovered eye. The patient is then asked to observe whether the object appears double, as it is slowly moved from its first position to a point three feet away. In most cases the match will present a double image when held quite near the face; the images approach one another and become fused as they are removed, to

separate again, more and more, until the metre distance is reached. The match is again from this point gradually brought close to the eye when the same phenomenon, but in reverse order, will be manifested.

The second eye is similarly examined and finally the room is darkened and a further (control) test is made with a candle flame. Sometimes three or more images (polyopia) are observed, and it is usually possible to exclude one or more of these by carefully interposing a card so as to cover various segments of the pupillary area during the examination.

Hysterical photophobia, not necessarily associated with spasm of the lid muscles, is a common experience in hysteria and, when present at all, may be so marked as to give rise to a suspicion of organic disease. The absence of all signs of vascular congestion is usually sufficient to exclude the latter. The patient often asserts that the light hurts the eyes even when these organs are covered with a heavy bandage, an exaggeration that should excite the suspicions of any one conversant with the hysterical character.

Pseudo-paralytic ptosis is another purely hysterical stigma. This rather unusual symptom, unlike organic paralysis, is almost always accompanied by other signs of hysteria, especially reflex photophobia and blepharospasm. The eye closes quickly when the hysterical lid is raised; slowly in true paralysis. In unilateral hysterical ptosis, as Charcot observed, the eyebrow is lower on the healthy side; higher in true paralysis.—(Ed.)

Amblyopia, Hystero-traumatic. See **Hysterical amblyopia.**

Amblyopia, Malarial. According to deSchweinitz (*Diseases of the Eye*, p. 649), in addition to the amblyopia in malarial cachexia with lesions apparent in the fundus, one sees cases without such lesions, due to a special action of the malarial poison upon the optic nerve and retina. These appear in the form of a transient loss of vision, or as complete blindness, lasting from several hours to some days or even months. The affection disappears under antiperiodic treatment. In most of the instances ophthalmoscopic findings are negative, or the descriptions are included in vague terms applied to the retina and optic nerve—"congestion," "hyperemia," and "redder than normal." The affection may be unilateral or bilateral.

Amblyopia of the visual field. See **Anesthesia retinæ.**

Amblyopia, Peripheral. The term is occasionally employed to indicate a rapid fatigue of the peripheral parts of the retina, as in hysterical or asthenopic amblyopia, but Sammuelsohn, in 1892,

applied it to a disorder induced by lead intoxication (q. v), which is characterized by a peripheral defect in the visual field.

Amblyopia, post-marital. Amblyopia due to sexual excess; also called BURN'S AMAUROSIS.

Amblyopia, Pretended. MALINGERING. When the patient desires to escape troublesome duties, to excite sympathy, to draw sick benefits, or to obtain damages from corporations, he may resort to a pretense of partial or total blindness in one or both eyes. Numerous plans have been devised to expose this deception, and these will be fully described under **Legal relations to ophthalmology.** Meantime, it may be stated that one of the best tests is that devised by Priestley Smith and Edward Jackson: A lighted candle is placed in front of the patient; hold a six degree prism before one eye. If there is vision is both eyes, the one behind the prism will move inward, and on removing the prism, will move outward, the other eye remaining in the fixed position.

Amblyopia, Reflex. Partial or total blindness due to irritation or other causes in distant portions of the body.

Clinical reports contain many descriptions of diminution of visual acuteness caused by irritation of sensory nerves, especially of the branches of the trigeminus, *dental amblyopia,* for example. Priestley Smith advances the hypothesis that the irritation is transferred to the sympathetic nerve which leads to the contraction of the choroidal blood-vessels and thus to interference with the chorioretinal functions.

Amblyopia, Sympathetic. See **Amblyopia, Reflex.**

Amblyopia, Thyroid. In this connection Raimondi's case of double amblyopia with perineuritis attributed to absorption of thyroid gland is of interest. His patient was a woman who had taken tablets of thyroid gland for the purpose of reducing her weight. At the expiration of three weeks, with a reduction of vision to 1-10, central scotomas appeared in the center of each visual field, while the discs were discolored, as they are in tobacco-alcohol amblyopia. The abuse of these agents, however, was eliminated, as were also syphilis, albuminuria and diabetes. The author attributes the visual disturbances in his patient to a disturbance of general nutrition, originated by the thyroid, and not to a direct action of the drug on the optic nerve. After a month of treatment with quinine and arsenic there was complete recovery.

Amblyopia, Tobacco. Toxic amblyopia from tobacco alone is evidence of idiosyncrasy against that poison and is a very rare condition, mainly because of the fact that the patient who indulges to excess

in tobacco usually drinks alcohol, so that we generally find the ocular defects due to this mixed cause. The various questions connected with the relations of these two intoxicants to the eye symptoms of *Toxic amblyopia* will be discussed under that heading; it will perhaps suffice to say here that amblyopia from tobacco alone differs in no essential from that set up by alcohol alone, or by alcohol plus tobacco, either in symptoms, the character of optic nerve lesion, or in its treatment.

Amblyopia, Toxic. TOBACCO-ALCOHOL AMBLYOPIA. AMBLYOPIA FROM DRUGS AND ALLIED AGENTS. QUININE AMAUROSIS. TOXIC RETROBULBAR-NEURITIS. INTOXICATION AMBLYOPIA. TOBACCO AMBLYOPIA. AMBLYOPIA FROM BOTULISM OR PTOMAINE POISONING.

Included in this category are numerous agents, among which, in addition to those just referred to, may be mentioned methyl or wood alcohol, bisulphide of carbon, salicylic acid, malefern, mercurial preparations, naphthalin, santonine, gelsemium, benzine, aniline dyes, iodoform, thyroidin, lead salts, the venom of snakes, tea, coffee, chocolate, oil of wintergreen, ergot, phosphorus, carbolic acid, cocaine, strychnia and arsenical preparations.

Although the general and ocular symptoms set up by these various forms of toxic amblyopia differ greatly, yet their treatment is much the same in many if not in most of them. By far the larger number of cases occur from chronic poisoning by alcohol, tobacco, quinine, Columbian spirits and various preparations made from this form of methyl alcohol.

The drug or toxic agent should be discontinued and eliminated from the system. The patient should be put upon a proper diet and should strictly conform to all the requirements of personal hygiene. As a rule, pilocarpine sweat baths with or without the exhibition of potassium iodide should be used in the early stages, especially if there is any hyperemia of the optic disc or engorgement of the vessels. Later strychnia, both by the mouth and hypodermically, should be given in full doses.

The diagnosis, prognosis and treatment of tobacco-alcohol amblyopia are so important that they are introduced into this brief review of the subject which is intended only to introduce the major heading. (See **Toxic amblyopia**), that will be fully considered later on.

Both eyes are affected, the patient complaining of foggy or misty vision. He almost always applies for glasses to assist his failing sight and, as the disease is entirely painless and presents no external sign, he rarely suspects the true cause of his visual defect. The

acuity is lowered to at least $\frac{2}{5}$ or $\frac{2}{7}$ of normal, and the reading of fine print is difficult or impossible with any glass.

There are also to be noted a well marked tobacco, or ethereal, odor to the breath, a general atonic condition, some insomnia, anorexia, and there may be dull frontal pain.

This condition is due to a central color (relative) scotoma, especially for red and green. The examination to determine this sign may be made with the perimeter or with a strand of red and green wool. Double a single thread between the thumb and finger of the right hand, holding it so that only a quarter of an inch of the loop projects and is seen. Cover the patient's left eye with a bandage and ask him to look steadily at the pupil of the examiner's right eye at a distance of two feet. Now, interpose the small loop of red wool in the common line of vision at a point a few inches in front of the examiner's eye. In alcohol-tobacco amblyopia the patient will not then recognize the loop as red, or it will appear redder when removed an inch or two to the right, left, up or down from the line of sight, than it does when placed directly in front of the pupil. The same result will be obtained from the green wool, but probably not from white, blue or yellow, unless the disease is far advanced and the visual acuity has fallen below $\frac{1}{10}$.

Taken in time a perfect recovery generally follows (1) total and immediate abstinence from tobacco and alcohol; (2) good food, fresh air, sufficient sleep, tri-weekly Turkish baths; (3) the administration of medicinal doses of iron and strychnia by the mouth, for which the following is an efficient formula:

℞

Quinin. sulphat.		gr. v,
Tincturæ ferri chlor.		
Acid. phosphoric dil.	āā	f. ʒvi,
Liq. strychniæ.		f. ʒi,
Syr. simp.		f. ℥viii.

A teaspoonful in water before meals; (4) the hypodermic injection of increasing doses of strychnia daily or every other day.

Probably the temporary improvement in vision from nitrite of amyl inhalations indicates the employment of some form of Bier's congestion cure in those cases of intoxication in which the lesion is an optic nerve atrophy and this remedy might well be used as soon as anemia of the nerve head is discovered. In addition to the "hyperemia" treatment full doses of digitalis might be employed to stimulate the heart's action and insure a larger blood supply to the starved nerve fibres.

The diagnosis once correctly made this routine treatment can be prescribed with the assurance that, if faithfully followed, a cure may be confidently expected in from one to three months.

The treatment of methyl alcohol amaurosis and amblyopia is quite unsatisfactory. Some cases improve under free catharsis from jalap, calomel and salines, combined with diaphoresis from hypodermics of pilocarpin. This treatment, however, must be given during the first few days of the acute inflammatory stage if any beneficial results are to be expected. When atrophy begins to show itself strychnine is given hypodermically in increasing doses until the point of tolerance is reached. Potassium iodide has also been used, but it must be remembered that the prognosis is very bad when signs of atrophy begin to appear. In most cases the affection goes on until complete blindness results, regardless of treatment.

The treatment of lead amblyopia is sometimes more satisfactory.

Wirsing reports the case of a woman, aged 30, who took, instead of bicarbonate of soda, a teaspoonful of red lead oxide with some water. After about two weeks, symptoms of lead intoxication developed: colic, headache, tinnitus, palpitations of the heart, profuse perspiration, vomiting, vertigo. About two months after the accident her memory failed and visual disturbances set in with diplopia and micropsia. Then she became drowsy and could not recognize anybody.

Examination of the eyes six weeks after admission to the hospital, revealed: V. R.= 5/v, V. L.= 5/vi. Left mydriasis, reaction of both pupils sluggish, paresis of left superior oblique, contraction of left visual field about 15° to 20°, color perception normal, optic neuritis, with commencing atrophy, in left eye.

Under pilocarpin-instillations, warm baths and iodide of potassium a rapid improvement took place in the general condition as well as the eye symptoms, and the paresis of the left trochlearis was eventually cured.

For a complete treatise on the whole subject see **Toxic amblyopia.**—(Ed.).

Amblyopia, Traumatic. In the absence of a lesion that will account for the blindness, one has a right to suspect hysteria in cases of injury, associated with complete or partial blindness; and the stigmata of that disorder (see **Amblyopia, Hysterical**) should be searched for.

Amblyopiatrics. The therapy of amblyopia.

Amblyopie. (G.) Dimness of vision, or double vision.

Amblyopie, Angeborene. (G.) Congenital amblyopia.

Amblyopie durch Nichtgebrauch. (G.) Amblyopia on account of non-usage of vision; dimness of vision or double vision on account of non-usage of the eyes. See **Amblyopia ex anopsia.**

Amblyopie, Hereditäre. (G.) Hereditary amblyopia.

Amblyopie, Hysterische. (G.) Hysterical amblyopia.

Amblyopie, Nächtliche. (G.) Hemeralopia.

Amblyopie, Peripherische. (G.) Peripheral amblyopia.

Amblyopie, Reflectorische. (G.) Reflex amblyopia.

Amblyopie, Reizende. (G.) (Obs.) Asthenopia from hyperesthesia of the genital organs.

Amblyopie, Sympathische. (G.) Sympathetic amblyopia.

Amblyopie, Tägliche. (G.) Nyctalopia.

Amblyopie, Toxische. (G.) Toxic amblyopia.

Amblyopie, Transitorische. (G.) Transitory amblyopia migraine.

Amblyopie, Traumatische. (G.) Traumatic amblyopia.

Amblyopsa, Amblyopsia. Synonyms of amblyopia. Defective vision, due neither to ametropia (q. v.) nor to visible organic lesion of the ocular tissues. See **Amblyopia.**

Amblyoscope, The. This instrument was devised for the purpose of determining the presence or absence of binocular vision, as well as to exercise and educate those eyes not possessing the ability to acquire the fusion faculty without extrinsic assistance.

It was invented by Claud Worth and, although several modifications of the original have been made, the instrument in use to-day is much the same as the first model. It consists of two L-shaped tubes, attached at their apex by a movable joint, so as to admit of being converged and diverged through a considerable arc. (See the figure.) At one end of each tube is placed a convex lens of the proper focal distance, so that no accommodation is necessary by the eye focusing on the picture at the opposite end of the tube. These pictures are mounted on translucent celluloid and are held in receptacles which admit of their being easily changed. At the bent portion of each tube is placed a mirror which enables the patient looking through the eye-piece to see the picture with the corresponding eye.

Black has contributed an improvement which allows one of the tubes to be raised or lowered, giving a more perfect adaptation to eyes which are not on an exact level. An added feature is one suggested by Duane, which consists of having a graduated arc fitted to the two tubes which shows always the exact amount of deviation. de Schweinitz has devised an arrangement by which prisms to correct vertical deviations may be inserted.

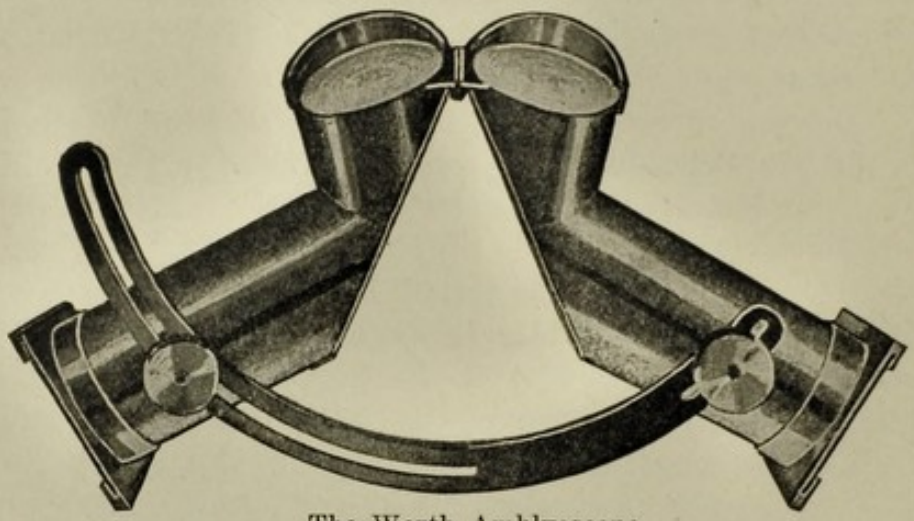
The great advantage of the amblyoscope lies in its arrangement for illuminating the pictures. The latter being mounted on translucent celluloid, the light is allowed to shine through them, the illumination usually being furnished by two small electric lights, one at the back of each picture. By the use of a rheostat it is possible to accentuate one picture by making its light burn brighter and to make the opposite picture less prominent by dimming its light. By this method the picture seen by the amblyopic eye is made to stand out prominently and the patient finds it much harder to disregard this image. He therefore more readily fuses the two pictures.

The amblyoscope finds its greatest use in the treatment of concomitant strabismus of children.

The following directions for the use of the amblyoscope, were written for de Schweinitz's *Diseases of the Eye,* by H. Maxwell Langdon, who has devoted much attention and study to this instrument.

The child's vision should be tested, if types or other signs cannot be utilized, with small, white ivory balls, each with a diameter varying from ½ inch to 1½ inches. Each eye is tried separately, and the child is required to pick up the ball, which is rolled with a twisting movement. If this test reveals that one eye is amblyopic and possesses one-sixth or less of visual acuity, some form of blinder exercise should be instituted to improve the defective visual acuity. Preceding the exercises with the amblyoscope, the angle of strabismus should be measured according to the methods elsewhere described, the refractive error having been carefully and fully corrected, and the glasses being in position, and during all of these exercises the glasses must be worn. Amblyoscope training should be begun as soon as the child is old enough to look at ordinary pictures and to talk about them, because deviation yields far more readily to these exercises in young children than in older ones, and, moreover, after the sixth year it is usually practically impossible to make any satisfactory impression upon the defective fusion-faculty. A child of three years is well able to take part in these exercises, especially if they are so conducted that they represent to him a game in which he may readily be interested. Usually one or two sittings a week, each occupying half an hour, are sufficient. The child should be seated on a chair between the surgeon's knees, and the angle of the tubes approximated to the angle of strabismus. Next, the illumination, which may consist of two electric-light bulbs, two lamps, or two candles, equally distant from each tube, are arranged, and an object-slide is placed in each holder. These object-slides should

consist of pictures familiar to young children, but the ones used at first should be quite dissimilar; for example, the picture of a bird and the picture of a cage. The child is now required to look into the tubes, and is asked what he sees. If one eye is amblyopic to any considerable degree, it is probable that the image of the object before the better or fixing eye will be the only one which is visible. Hence, the illumination must be altered before the other object-slide can be seen by diminishing the light before the fixing or better eye, and increasing that before the amblyopic or squinting eye, continu-



The Worth Amblyoscope.

ing with this regulation of lights until both objects are visible and can be described by the child. This alteration in the lights can be accomplished in various ways; for example, by changing the distance of the lights, as Worth suggests, or by adapting to the amblyoscope, as the writer has done, a revolving wheel, which contains smoked lenses of different densities, and which can be turned before the non-amblyopic eye. Each object should be seen clearly, and the exercise should be varied with several pairs of object-slides. Next, the child is required to place one hand on each of the surgeon's knees and to tap that knee on the side on which the picture of the bird is seen. If the angle of the tubes is rapidly altered a position will be found where the slightest movement of the tubes causes the picture of the bird to pass directly through from one side of the picture of the cage to the other. But, after continuing the exercises, the bird apparently will go directly into the cage, indicating that the child is acquiring a certain amount of fusing power. If one object is above the other, this vertical deviation must be overcome by means of prisms suitably placed in the grooved slides back of the focussing lenses. As soon as the child can easily merge

the two objects, more difficult tasks are set, with slides demanding accurate and complete fusion, and by gradually widening the angle of the tube, a range of fusion which varies from 5° to 15° may be acquired by the patient.

Finally, a series of stereoscopic pictures, intended to teach the child the sense of perspective, are employed. During these exercises, by which the fusion-faculty is stimulated and developed, the strabismus may do one of three things: it may disappear after a few days of training; it may gradually lessen; or it may not alter at all, and operative procedures are required to produce parallelism of the visual axes.

Amboceptoren. (G.) Amboceptors.

Ambozeptor. (G.) Amboceptor.

Ambrosia. This interesting classical eye-patient, dead these twenty-two centuries, has recorded her own case on a marble votive-tablet to the following effect: "Ambrosia, of Athens, blind in one eye. She came to the god [Asklepias] seeking help. Walking about in the sanctuary, she ridiculed many of the histories of healings, declaring it to be incredible and impossible that the lame and the blind should have been cured merely by means of a dream. But, in her own temple-sleep, she beheld a face. Apparently the god came to her and said that he would make her well again; that, however, she should install in the temple a silver pig, as a memorial of her folly. After these words the god grazed the diseased eye with a knife, and instilled a healing remedy. As it became day, Ambrosia departed from the temple wholly sound."—(T. H. S.)

Ambrosia artimisifolia. See **Pollantin.**

Ambulanz. (G.) Ambulance.

Ambulatorische. (G.) Ambulatory.

Ambulatorische Behandlung. (G.) Out-patient treatment; also the treatment of poisoning by making the patient walk about.

Ambulatorische Klinik. (G.) Out-patient department.

Ambulatorische Praxis. (G.) Out-patient practice.

Ameba coli. (L.) See **Amœba coli.**

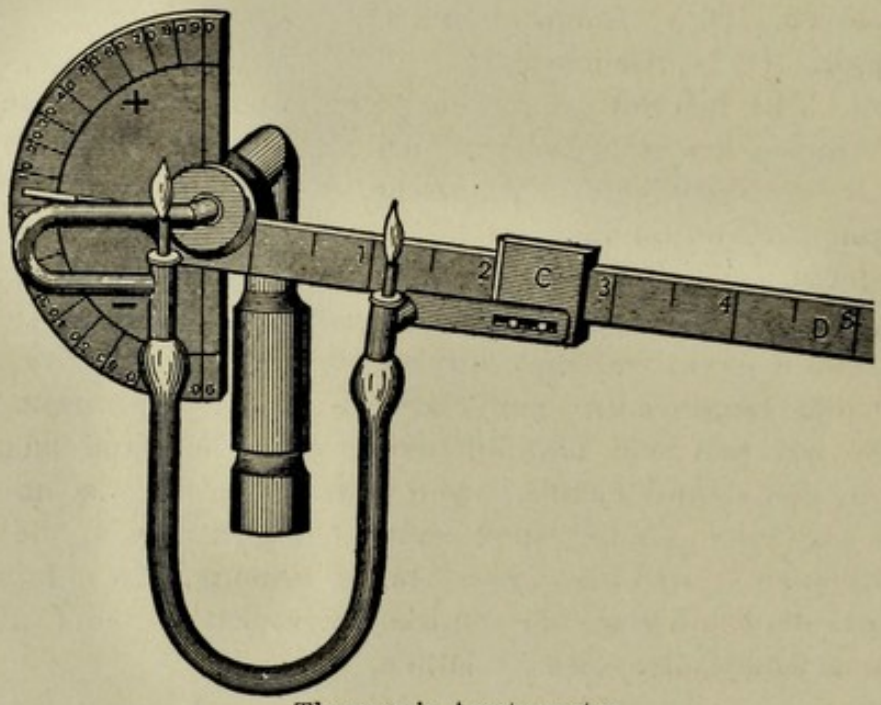
Ameisensäure. (G.) Formic acid.

Amethyst glass. When certain kinds of white glass are exposed for many years to the sun's rays they assume a light purplish (amethyst) color, and are then useful in the manufacture of tinted lenses and other forms of eye protectives. The amethyst color in the glass (due to chemical changes in its constituents) is also produced in a short time artificially, as it were, and is doubtless quite as efficient for the purpose as the variety first described.

Amethystviolett. (G.) Amethyst violet.

Ametrometer. An instrument for measuring ametropia, or errors of refraction.

Ametrometer, Thomson's. This instrument has two small gas-flames about five millimeters in diameter, one stationary and the other movable on a metal arm, which can be changed or revolved to any meridian. Each eye is tested separately at a distance of twenty feet, preferably under a cycloplegic. The method of the test is to move one flame along the metal arm until the two lights appear to fuse. The scale, as marked on the arm, gives the approximate



Thomson's Ametrometer.

strength of lens necessary to correct the ametropia. By raising or lowering the arm any meridian may be tested. It is a most ingenious test, but not in common use. (Thorington.)

Ametropia, Adjunct treatment of. See **Adjunct treatment of ametropia.**

Ametropia, or abnormal refraction. When the eye is in a state of rest, parallel rays of light come to a focus not on but at some point behind or in front of the retina and instead of presenting a clear image of the object looked at, vision is blurred and indistinct and the eye has to exert its accommodative power to see clearly, thereby causing fatigue and other symptoms of discomfort, setting up a condition known as asthenopia.

Ametropia is divided into 1. Hypermetropia, 2. Myopia, 3. Astig-

matism, which Edward Jackson prefers to call astigmia. In the first, when the eye is at rest, parallel rays of light from distant objects come to a focus at some point behind the retina, while divergent rays from near objects focus at a point still farther back of the retina.

In other words, the hypermetropic eye is an eye that is smaller than it ought to be—an undeveloped eye.

In an emmetropic eye it is understood that no accommodative effort is required to see distant objects distinctly and the accommodation is but slightly called upon when we wish to do near work. In far sight such is not the case, as the course of the rays of light entering the eye must be altered by an increased effort of accommodation before they focus exactly on the retina and give distinct vision for distant as well as for near objects. A greater effort is required for the latter than for the former. The accommodation being constantly called upon the ciliary muscle is in a continual state of contraction and becomes hypertrophied. Such a condition of affairs may lead to symptoms of discomfort not only in the eye, but in the structures surrounding it.

A slight amount of farsightedness may not cause any unpleasant symptoms, especially in youth when the general health is good and the eyes are not used for much near work. Children at birth are usually hypermetropic; this condition generally becomes less marked and may, as it often does, pass into a state of normal refraction.

The persistent and excessive demand made upon the accommodation for the purpose of giving clear and distinct vision frequently produces a sort of cramp of the ciliary muscle, causing pain and congestion in and around the eyes and inability to use them for any length of time for near work.

This is especially true of a farsighted eye, because a part of the accommodative power having already been used up in obtaining clear vision when looking in the distance, there is much less to fall back upon, and a greater effort is required to see clearly when the eyes are called upon to do prolonged reading, sewing, bookkeeping, etc. The vision soon becomes blurred and the eyes have to be rested before the work can be continued.

If much near work is persisted in complaint is made of pain, fatigue, a sensation of weight, frontal headache, and other symptoms of discomfort about the eyes, a complex of symptoms commonly called eyestrain (q. v.). The conjunctiva becomes congested and frequently the margins of the lids are red and inflamed. Soon there

is a feeling of sand in the eyes, with burning and smarting of the lids and eyeballs and an increased secretion of tears.

Where the strain is kept up for some time styes and other affections of the lids are frequently met with. When this strain is not relieved by appropriate treatment the effort even to see distant objects distinctly also causes marked discomfort until eventually the patient is no longer able to use his eyes for any purpose, even for a few moments, with comfort. This condition is known as accommodative asthenopia.

A farsighted eye, as has just been noted, is a small eye and this abnormal state is due in the majority of instances to shortening of the antero-posterior diameter of the eyeball, to which is given the name axial hypermetropia. Less frequently it depend upon some deficiency in the curvature of the cornea or lens, (curvature hypermetropia) or upon the absence of the lens (aphakia). It is almost invariably a congenital and rarely an acquired condition.

For the correction of farsightedness it is necessary that parallel rays of light should be brought to a focus on the retina without the aid of the accommodation. This is accomplished by means of a convex lens in front of the eye, of sufficient strength to make the rays as they enter the eye, more convergent. The greater the amount of hypermetropia the stronger the convex lens must be.

When there is spasm of the ciliary muscle (and this condition is more or less present in a large percentage of the cases) a variable amount of the error is masked and in some cases the cramp of the muscle is so great that the eye presents a condition of false myopia, due to such strenuous efforts of the accommodation (in the endeavor to focus the rays on the retina) that it is overdone and the rays apparently focus in front of the retina.

In determining the true or total amount of farsightedness, as well as of the other forms of ametropia, the power of accommodation should be relaxed and the ciliary muscle paralyzed by the use of one of the many cycloplegics at our disposal, e. g.: One per cent. atropia.

One drop into each eye three times daily for two days; or by a mixture containing hydrobromate of homatropine and hydrochlorate of cocaine, of each, 4 grains in half a fluid ounce of distilled water.

One drop into each eye every 10 minutes for one hour. In suitable cases full, but transient, cycloplegia occurs in an hour and a half after the first drop.

Better still is the use, every twenty minutes for an hour, of a

gelatin disc containing each $\frac{1}{50}$ grain of homatropine and cocaine alkaloids. (See **Cycloplegics.**)

F. A. Morrison prefers the following mixture, instead of a solution or the gelatine discs, for the purpose of insuring prolonged contact of the cycloplegic with the eye-ball.

℞

Cocain. hydrochlor.	
Homatropin. hydrobrom. āā	gr. iss
Pulv. acaciæ	5ii

A little to be placed on the eye-ball, or in the sac, near the outer canthus. Keep the eye closed.

F. B. Eaton prefers hyoscin gelatine disks, $\frac{1}{1000}$ to $\frac{1}{500}$ gr. each, to atropin or any other cycloplegic.

When gelatine lamellæ with hyoscin (gr. $\frac{1}{2000}$) are employed and a single disc put into the sac five minutes after the instillation of a single drop of a 2 per cent. solution of cocaine hydrochloride and homatropine hydrochloride one obtains the maximum cycloplegia with the minimum expenditure of time, provided the patient can afford to have ciliary rest for seventy-two hours. An important consideration in this procedure is that the cocaine benumbs the conjunctiva and cornea, and one does not experience the foreign body sensations and other discomforts arising from the introduction of discs into the conjunctival sac.

D. M. Griffith finds that the most marked cycloplegic effects can be obtained from small doses of atropine combined with dionin. He also believes that the addition of dionin inhibits the toxic effects of the atropine. He generally uses this formula: One grain of atropin sulphate, and five grains of dionin in two fluid drams of distilled water.

Two drops in each eye three times a day for four days.

Alexander Randall prefers hyoscyamine (2 grains to the fluid ounce) as a cycloplegic. He has found it prompt and vigorous, holding the ciliary muscle firmly in its grasp for 72 hours, meantime giving complete, enforced rest. The cycloplegic effects practically disappear in 150 hours after the initial instillation.

Other ophthalmologists prefer one grain of hyoscin hydrobromate to the fluid ounce of distilled water, of which one drop is to be put into each eye thrice daily for two days.

Wendel Reber uses homatropin semi-occasionally, and atropin infrequently. For a number of years past he has used a $\frac{1}{10}$ per cent. solution of hyoscin hydrobromate, containing also $\frac{1}{3}$ per cent. cocaine. In about one case in fifty there is rather marked

flushing of the face, quickening of the pulse and some slight vertigo, but not more than is sometimes seen with homatropin. Not once was pronounced "toxemia" noticed. Compression of the canaliculi immediately after instillation will prevent even the slightest constitutional reaction. The solution is instilled once or twice the evening before, and twice the morning of the examination. For office use cocaine solution, 2 per cent., warmed, which is instilled, and the hyoscin dropped in, also warm, twice at intervals of a half hour. An hour later the testing may begin. Accommodation is sufficiently re-established for ordinary purposes at the end of 48 to 60 hours. It is not wise to attempt to hasten this by instilling eserin, as the benefit of the rest under a mydriatic is thus forfeited. The ideal would be to completely paralyze accommodation and put the internal ocular structures at perfect rest by atropin prior to testing the refraction, but this is often impracticable.

Alexander Duane believes that a cycloplegic should be employed for determining the refraction in practically all cases, not glaucomatous, below 48 years of age and in some cases above this limit.

Homatropine in 2 per cent. solution, provided it is used with ordinary precaution, is a safe cycloplegic, and if properly used is effective in the vast majority of cases.

It should be repeatedly instilled and the examination made not less than an hour after the first instillation nor until a test of the accommodation has shown that the latter is as completely abolished as possible.

The cases in which homatropin proves inefficient are few. They are marked by varying vision and varying acceptances, discrepancies between the subjective tests and the skiascopic findings, and the persistence of an undue amount of accommodation (more than one D) even after prolonged action and repeated instillations.

In such cases atropin should be used.

Macklin prefers atroscine to other cycloplegics for determining refractive errors, and uses it as a one per cent. solution in castor oil. He says it acts as a rapid and powerful mydriatic and cycloplegic, is as potent and reliable as atropine sulphate, while the power of accommodation returns in five days. Of course, with homatropine the ciliary paresis ceases in 24 hours, which is undoubtedly a great advantage in many cases, yet homatropine has disadvantages which must be apparent to all who use it. Mydriasis with atroscine begins in ten minutes and is complete in twenty. Cycloplegia begins in ten minutes and is complete in about fifty.—(Ed.)

See, also, **Refraction and accommodation of the eye; Physiological optics.**

Ametropie. (G.) Ametropia.

Ametropisch. (G.) Ametropic.

Ametropometer. An instrument for determining the character and the degree of ametropia or refractive anomalies.

This instrument, which is founded on Scheiner's experiment, (q. v.) has been perfected by Fromaget. He employs a lantern giving an especially brilliant light, and before each of the holes of the Scheiner disk places a colored glass, one red the other green. The luminous opening of the lantern is rectangular in form, its width being variable. The plate carrying this luminous opening is capable of rotation to any meridian.

The principal meridians of astigmia are ascertained by placing before the eye a disk with pin-hole openings arranged in the form of a cross. Each of these openings gives an elongated image; and when the cross is turned so that one arm takes the direction of greatest elongation, it indicates the meridian of greatest ametropia. The slit aperature of the lantern is then turned to one of the principal meridians and the line joining the pin-hole openings of the Scheiner disk is placed perpendicular to it. Until the ametropia of this meridian is corrected, a red and a green image of the light are seen, homonymous for myopia and crossed for hyperopia. Lenses are placed before the eye until these two images fuse into a single rectangle light. The lense doing this corrects the ametropia of that meridian.

To measure hyperopia or myopia without astigmia, the lantern aperture may be placed in any meridian and the two images brought together by lenses. Even for astigmia only spherical lenses are required, and Fromaget has employed for the purpose the lens disk of Kalt's ophthalmoscope.

This is a good subjective method for children, illiterates and those who do not possess, or will not acknowledge, good acuteness of vision. But like others based on the Scheiner experiment it really measures the refraction of only two points in each principal meridian. If the error of refraction were capable of complete correction by a spherical or sphero-cylindrical lens, the method would be theoretically and practically perfect. But the fact is, that in all eyes we find aberration and astigmia. The actual refraction of the eye does not conform to the theory, and for that reason such methods must always be inferior to those, like skiascopy and the

trial lenses, which deal to some extent with the refraction in all parts of the pupil. (*Ophthalmic Year Book*, 1904, pp. 15, 16.)

Amianthinopsy. Violet-blindness, or inability to distinguish violet shades.

Amidin. See **Holocaine.**

Amidon. See **Starch.**

Aminoalcohol. See **Arterenol.**

Ammar. Full name, Abul Qasim Ammar b. Ali-al-Mausili. He is one of the most distinguished, and by far the most original, of the Arabian oculists. Ammar * was born at Mosul, in Mesopotamia, in the latter half of the 10th century. He made a number of pilgrimages, both for the purpose of study and for that of practising ophthalmology, dwelt for a time in Irak, and finally settled for the practise of his profession in Egypt. In this land it was, during the reign of the Sultan Hakim (996-1020 A. D.) that Ammar composed his highly original book, and, possibly, invented his suction method for the extraction of cataract. At all events, the suction method is undoubtedly Ammar's and his great treatise, entitled "*Book of the Selection of Eye-Diseases,*" is the most important work on ophthalmology now extant from the Middle Ages, with the single exception of the "*Memorandum Book for Oculists*" of Ammar's great contemporary, Ali ben Isa.

The most decidedly interesting passage in the book is that relating to the suction-operation for cataract. Having made an incision in the conjunctiva 2/3 of a barleycorn behind the corneal limbus, and, after that, a puncture in the sclera with a little knife, exactly as if preparing for a reclination, Ammar proceeds to introduce through the opening, instead of the solid needle (the kind employed in reclination) a hollow affair of his own devising "until it is felt to be within a void space." Then he continues: "But the handling [of the instrument] is [now] different [i. e., from the handling of the solid instrument employed in reclination]. As soon as the needle has reached the interior of the eye, thrust the cata-

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* Practically all we know of Ammar (as of many another—great or small—Arabian) we owe to the industry of Hirschberg. In many of the biographical and historical articles of this work, similar acknowledgment is made of our obligation to this brilliant, as well as indefatigable, Teutonic investigator, but it is absolutely impossible to make appropriate acknowledgment on every otherwise proper occasion, and it therefore must, in default of a better method, suffice to acknowledge at this opportunity that Hirschberg is well-nigh the creator of the History of Ophthalmology.

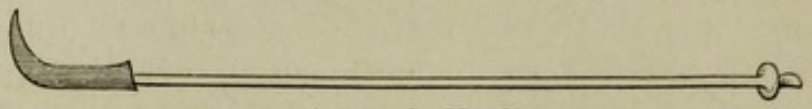
Hirsch, Magnus (especially for antiquity), Sichel, Pansier, Leclerc, Klein, Anagnostakis, and others have also done good work in this field, and to them we are also indebted.

ract down, in the customary fashion. When now the cataract goes down, and the half of the pupil is clear, and to thee the needle in the interior of the eye becomes visible—it is indeed not visible to thee before the pupil gets clear—then notice on which of the three sides of the needle the eye of the needle lies. Cause this side to ride upon the cataract. Then command the assistant that he suck vigorously. Then look! the cataract has a thick body, and around it is a membrane like that encompassing the white of an egg. When now the assistant sucks, and the cataract hangs on the eye of the needle; then command him to suck hard: thou thyself, however, watch the cataract with thine eyes; and when the cataract has arrived inside the needle, then draw the needle out, while the assistant keeps on sucking till the needle is out of the eye. Then has the cataract come out with it. After this it is not necessary that the patient lie down. One has only to bind up the eye, for seven days, until the place of operation is fast healed. The assistant must, however, take care at the time of suction that nothing of the membrane returns into the eye—for then would the eye become staring; and that the needle does not act upon the egg-white [aqueous] humor, nor, at the time of the sucking, draws in much thereof—for then the eye would shrivel."

"After the operation, the patient must guard against light and clearness, till forty days are passed; and against coitus, and against vomiting and against weeping and against constipation. This belongs to the healing of the operation. Had I leisure, I would treat this matter more in detail."

In another place Ammar describes the needle with which he performed his suction operation. In view, however, of the fact that, in describing the hollow needle, he assumes on the part of the reader an understanding of the solid needle, we first subjoin his description of the latter instrument: "This is the picture of the needle, in order that the inquirer may learn it. Its length measures 1½ handbreadths, without the point, with which the operation is carried out. The length of the point [operative extremity] which enters into the eye, should be as large as the nail-part of the thumb. A ring should be placed on the needle, which separates its body from its point. Let the end of the point be triangular, in order first that the place of puncture be given a triangular form, and therefore the wound heal more quickly; and in order second, when the point has pressed in, that it will always be possible, that one of the three sides, whichever one it may be, may fall upon the cataract and depress it, without the necessity for troubling oneself to give the

needle a turn.'' Now, then, follows the description of the hollow instrument: ''The form of the hollow needle is, necessarily, exactly the same as that of the solid instrument; only the hollow instrument should be thicker. The hollow extends from the one end to the other. The place with which the cataract is sucked should be a (lateral) perforation on one of the three surfaces. This is the picture of the hollow needle. It is prepared of copper or of gold.''



Ammar's Needle.

The necessity, or at least the advantage, of having the needle made of copper or of gold, arose (as explained by another Arabian, Salah ad-din) from the fact that needles manufactured of these substances were, by reason of their color, much more plainly visible against the pupillary blackness and the cataractous whiteness than if made of other metals.

Long before Ammar's time, certain attempts had undoubtedly been made (e. g., by the ancient Greek, Antyllus) to remove soft cataracts by suction. These endeavors, however, had been hesitating, and half-hearted, as well as awkward and probably without success. All had been performed (so far as that word is applicable) by the corneal route, and the escape of aqueous humor had been looked upon, both in antiquity and in the Middle Ages, as an irreparable disaster. Further, the attempts at suction had, in these early instances, been made by means of a glass tube. Ammar avoided ''the aqueous calamity'' by entering the eye by way of the sclera, and then, as above related, had removed the cataract by suction through a hollow needle of his own invention.

Ammar's suction procedure was a more important matter in his land and day than would appear to us on first consideration. Cataracts were frequent there and then, and, in the great majority of instances, were soft. However, the operation did not by any means receive the recognition which it so manifestly merited. Favored sufficiently by the operators of the Orient, it nevertheless did not secure in Western Islam more than a bare recognition. Thus, in Spain, it was really never adopted to any considerable degree. In Christendom the excellent little procedure fared even worse. Merely mentioned by Guy de Chauliac and one or two other authorities of the Christian Middle Ages, it was laid aside for centuries (almost a millenary) until, 1846. In that year, the procedure was revived by Blanchet.—(T. H. S.)

Amme. (G.) A wet-nurse.

Ammenbrust. (G.) A wet-nurse's breast.

Ammenmilch. (G.) A wet-nurse's milk.

Ammensprache. (G.) A nurse's language.

Ammeter. A galvanometer that measures the value of an electric current in ampères.

Ammon, Filaments of. A name given to certain histological elements of the ciliary body. It has been known since the days of Galen that at the border of the ora serrata are found certain striations resembling hairs. These are really minute capillaries arranged meridianally along with faint folds of the surface. See **Histology of the eye.**

Ammon, Frederich August von. This immortal ophthalmologist—son of the famous theologian, Professor Christopher Friederich von

Frederich August von Ammon.

Ammon—was born at Göttingen, Germany, Sep. 10, 1799. In 1813 he accompanied his father to Dresden, and from 1814-18 he attended the Schulpforte, leaving this institution to begin the study of medicine at Leipzig. Later, he continued his professional studies at Göttingen, where he was intimately associated with Blumenbach, Langenbeck, Sr., Himly, and other celebrated instructors. When he had studied at Leipzig only a year and a half, he received the prize of the George-Augustus University for his work on the "*Semeiology of Sleeping and Waking.*" Aug. 25, 1821, he graduated, presenting as his Dissertation "*The History of Ophthalmo-Paracentesis.*"

After a brief sojourn in Paris and another in Southern Germany,

von Ammon settled (1822) in Dresden, where he devoted especial attention to surgery and ophthalmology.

In 1824 he was appointed physician to the Dresden Institute for the Education of Blind Children—a position in which he displayed extraordinary ability. In 1828 he was made Professor of General Pathology, Materia Medica, and Clinical Medicine and Surgery in the Medico-Chirurgical Academy at Dresden. He had an extensive practice, especially in diseases of the eye, and seemed to be absolutely tireless in his work.

The universal testimony is that, as a man, von Ammon was distinguished above all things by conscientiousness. Nothing that he did was done badly, or, to all appearances, in haste. The sole exception, perhaps, in this regard, is his literary work. In this, marks of haste do now and then appear.

His services to surgery in general are very great, much greater, however, are those to ophthalmology. He is said to have written 65 important articles, and his books, 7 in number, are valuable without exception. He was also the cause of much original and highly excellent work being performed by others—chiefly, of course by his own associates and pupils. Among these latter may be mentioned, Gescheidt, Lechla, Bech, Wimmer, Warnatz, Schön, Klemmer, Beger, Froebelius, and Zeis.

Ammon's most original work was done in relation to iritis, strabismus, symblepharon, and congenital ocular defects and malformations. His work on *Iritis* is so thorough and so carefully based on anatomical and pathological considerations as to make all previous investigations into the nature of this disease appear elementary. His treatise on *Ocular Defects and Malformations* was not, contrary to what has been suggested "the first upon this subject;" but it was certainly the best upon this subject, and, at the present day, it has not been superseded entirely. Aside from the "posterior scleral protruberance of Ammon," which, presumably, will always continue to bear the name of its distinguished discoverer, what ophthalmologist, without thinking of this brilliant investigator, can call to mind such ocular malformations as epicanthus, the very name of which he invented, blepharo-ptosis, coloboma of the iris and of the lens, ankyloblepharon, blepharophimosis, and microphthalmus?

von Ammon's books (it is simply out of the question to attempt a list of his articles) are as follows:

1. *Ophthalmoparacenteseos historia.* Spec. medico-histor. quo commentatur in varias hujus operat. ad cataract. sanand. methodos

hucusque institutas et in instrumenta hunc in usum inventa. Cum tab, aer. incisa. Gottingae 1821.

2. *Kurze Geschichte der Augenheilkunde in Sachsen.* Eine med.-hist. Skizze bei Eröffnung der neuen Erziehungs-und Arbeits-Anstalt für Blinde in Dresden. Leipzig 1824.

3. *Brunnendiätetik oder Anweisung zum zweckmässigen Gebrauche der natürlichen und künstlichen Gesundbrunnen und Mineralbäder* (Dresden 1825, 1828, 1835, 1841, 1854; Polish edition, 1827).

4. *Die ersten Mutterpflichten und die erste Kindespflege zur Belehrung junger Frauen und Mütter* (Dresden 1827, 1835, 1839, and so on even to the 13th edition).

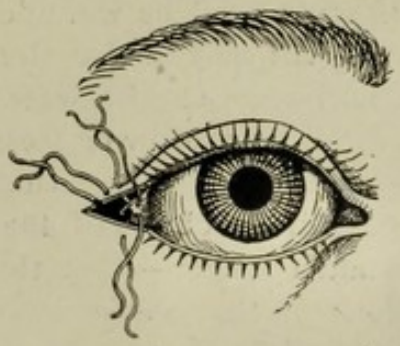
5. *Quaestio anatomico-physiol.* de genesi et usu maculae luteae in retina oculi humani obviae. Acced. tab. in aes incisa. Vinariae 1830.

6. *De Iritide.* ... Lips. 1838.

7. *Klinische Darstellungen der Krankheiten und Bildungsfehler des menschlichen Auges, der Augenlider und der Thränenwerkzeuge nach eignen Beobachtungen und Untersuchungen.* Hierzu 55 Tafeln mit 965 ophthalmoklinischen Abbildungen. Berlin 1847, Fol.

von Ammon died May 18, 1861, in consequence of prostatic hypertrophy.—(T. H. S.)

v. Ammon-Agnew cantholysis, The. Agnew's cantholysis is a modification of the operation devised by von Ammon in 1839. It is the simplest method and the one chiefly in vogue among American surgeons.



Agnew's Cantholysis, or Modification of the von Ammon Canthoplasty.

The instruments employed are large and small straight, blunt scissors, mouse-tooth forceps, needle-holder, and two or three fine curved needles. General anesthesia is resorted to only when absolutely necessary. Local anesthetics help slightly. The patient lies on the table.

The canthotomy. The outer commissure is held moderately open by the left thumb and index finger; one blade of the large scissors is slid into the outer cul-de-sac as far as it will readily go, its

edge exactly beneath the angle of the lids and in line with the closed palpebral fissure. The other blade is closed down until it touches the skin, a good grip is taken on the handles, so that the blades will not "buckle," and with one firm snip the cut is made. The skin incision should be from one to one and a half centimeters long, according to the demands of the case; the conjunctival cut should reach to the bottom of the cul-de-sac. Although the cut is usually made in a perfectly horizontal direction, in many individuals the scar conforms better to the natural topography of the outer canthus if it be given a somewhat downward inclination.

One should bear in mind that a part of the accessory lachrymal gland lies in this region and strive not to injure it wantonly.

There will be some bleeding, but it usually ceases spontaneously.

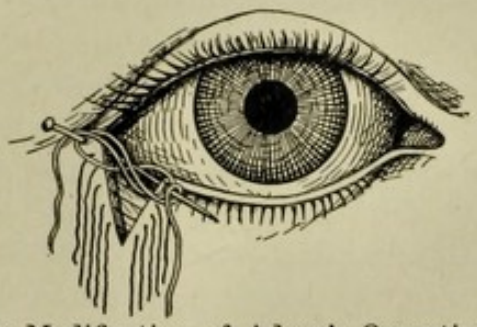
Division of the external canthal ligament. The free border of the upper lid is grasped by the left thumb and index, pushed slightly up to open the spaces between the severed skin and conjunctiva, and the small scissors, closed, are put into the upper opening to feel for the ligament. The lid is now pulled forward toward the nose, so as to make the ligament taut, when the scissors are opened slightly, the blades are pushed up astride the ligament about midway of its length, and it also is cut with a single snip, and at right angles to the primary incision. Some authors state that the conjunctiva is unavoidably incised in dividing the ligament; such is not the case, for with delicate scissors and a little care, neither the skin nor the conjunctiva need be wounded. If the snip is successful the lid at once gives way under thumb and finger. If it fails to yield, another and more careful effort must be made. The same procedure is repeated on the lower section of the ligament.

Placing and tying the sutures. An assistant opens wide the extended commissure. It will be observed that the cut in the skin is longer—often very much longer—than that in the conjunctiva. Now, all the descriptions of the operation that I have ever read, and all the many cuts that I have seen illustrative of it, teach that the angle of the conjunctival opening should be joined to that of the skin. This is precisely what Agnew insisted should not be done, and with substantial reasons; for, because of the inequality in the length of angles alluded to, thus to unite them means the obliteration of the external cul-de-sac; not only this, but it also means undue stretching of the conjunctiva to force it to meet the skin at this point, hence, the formation of an unseemly bridle or band that is particularly noticeable and restricting when the globe is in adduction. Instead, therefore, following Agnew, after picking

up the conjunctival angle with the needle, it is carried outward as far as it will go without any stretching and is joined to the upper lip of the incision. See the figure.

Another suture is placed to unite the lower skin and mucous lips, and sometimes a third to perform the same office above, and the operation is finished—unless, perchance, one chooses to put in a fourth or superficial suture to close the small skin angle thus left unclosed. Care must be exercised not to include the canthal ligament in suturing. As each suture is put in, if it be not tied at once, the two ends of thread are laid together on the temple where an assistant places a finger on them to insure keeping each pair to itself. They are tied with the canthus stretched open, in order to see that they are true, and not tied too tight lest they cut out of the conjunctiva.—(C. H. B.)

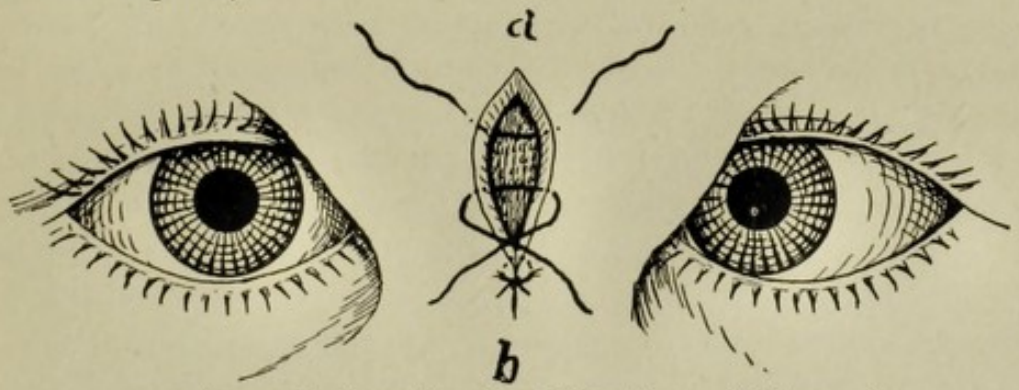
v. **Ammon's operation for ectropion.** This operation (see figure) strives to remove a part of the free border of the lid and still leave



von Ammon's Modification of Adam's Operation for Ectropion.

the remainder intact. To this end a gore is cut from the entire thickness of the lid from the outer canthus, and the wound closed with pin and sutures.—(C. H. B.)

v. **Ammon's operation for epicanthus.** The fact that by pinching up a vertical fold of skin on the nose the deformity will disappear suggested the operation, called by von Ammon "rhinorraphy." (See the figure.)



von Ammon's Operation for Epicanthus. (Rhinorraphy.)

He pinched up a fold of skin on the bridge of the nose sufficient to uncover the inner canthus, marked out the line of incision with ink and then excised an oval piece of skin. von Ammon brought the lips of the wound together with surgical pins around which were placed figure-of-eight sutures, but in place of these the wound can be directly closed with silk or silk-worm-gut sutures. The resulting scar is a linear one and not very noticeable if healing by primary union follows.—(W. H. W.)

Ammon's posterior scleral protuberance. A variety of posterior ectasia of the sclera.

Ammoniacum, Oculo-toxic symptoms from. It has for more than a century been known that certain resinous substances, especially ammoniacum and galbanum, produce disturbances of vision if they are used internally for a long time. After the employment of these therapeutic agents in pill form for several months, some patients have developed a complete and incurable amaurosis.

The disease develops slowly and the dimness of sight is the first toxic symptom of which patients complain. The pupil is dilated and its motility is impaired. Two short case histories *(Encyklopädie der Augenheilkunde)* are typical of this form of intoxication. A man, after taking daily about 8 grams of galbanum in emulsion for some time, complained of a peculiar dimness or cloudiness of vision, which almost approached blindness. The symptoms disappeared on stopping the medicine. A woman, after taking galbanum resin, became almost completely blind; on stopping its use she recovered. In a third patient the same result was noticed, whether the resin was taken in emulsion or in pills. This patient also saw "stars and fiery spots" before the eyes.

We are unable to throw much light upon the action of these substances, except that it is similar to some ethereal oils that are depressants of the central nervous system, and that the resinous acid anhydrides which have similar effects belong to this group of resinoids. There is no evidence, as has been suggested, that these substances are carried in the circulation in solution or as an emulsion and deposited in insoluable form in the eye or optic nerve and thus produce visual disturbances for a longer or shorter time.

Ammonia, Oculo-toxic symptoms from. Ammonia, like other alkalies, forms soluble albuminates and destroys living tissues. Its great volatility assists it to penetrate loosely-arranged cellular tissue, as well as to spread over its surface. After burns of the eyeball by the gas or gaseous solutions a peculiar false membrane forms, of

the same character but less pronounced than that produced by other corrosives.

Some idea of the reaction in ammonia burns can be obtained from attempts to clear up leucomata in a cocainized eye with ammonia. The application destroys the epithelium over the scar and it becomes a sort of colorless pulp which afterwards becomes opalescent. The leucomatous area is included in the destroyed area. The application produces swelling of the lids, chemosis of the conjunctiva, photophobia, and blepharospasm.

Ammoniak. (G.) Ammonia, ammonium, ammoniacum.

Ammoniakgas. (G.) Ammonia gas.

Ammoniated copper. See **Cuprum ammoniatum.**

Ammoniated mercury. See **Mercury, White precipitate of.**

Ammonium acetate, Solution of. Spirits of Mindererus. This solution contains (U. S.) not less than 7 per cent. of the salt. It is a colorless, faintly acid liquid, and is occasionally employed as a collyrium with tincture of opium in subacute and chronic forms of simple conjunctivitis.

Ammonium, Acid tartrate of. See **Ammonium bitartrate.**

Ammonium bitartrate. Acid tartrate of ammonium. $NH_4HC_4H_4O_6$. This salt occurs as white crystals, soluble in water; mostly used as a baking powder.

Guillery and zur Nedden advise the employment of 5 to 10 per cent. solutions of this salt, neutralized by the addition of liquor ammoniæ, in removing opacities of the cornea produced by lime burns. The solution is applied in an eye-cup three times daily. A little cocaine may be used in conjunction with the treatment, although the pain is not severe. To be effective the treatment must be applied early before the deposits take on the form of the carbonate.

For recurrent attacks of styes Lanvole finds the following mixture of decided value: Ammonium chloride, one gram; precipitated sulphur, 3 grms.; spirits of camph., 20 grms.; rose water, 50 grms.

The lids are to be regularly bathed with this wash two or three times daily for several weeks.

Ammonium chloride. Sal ammoniac. NH_4Cl. This well-known salt, now mostly derived from the so-called coalgas liquor, when pure, is a white, granular, crystalline powder, soluble in 2 parts of water and 50 of alcohol. It has a cooling but strongly saline taste.

Ammonium chloride is rarely used in ocular therapy, and then generally in conjunction with other remedies as a mild astringent, as in the following collyrium:

℞

Sulphur. sublimat.	3.0 (gr. xlvj)
Ammonii chloridi	1.0 (gr. xv)
Aquæ rosæ	50.0 (f℥j,f℥v)
Spiritus camphoræ	10.0 (f℥iiss)

In filamentary keratitis a 2 per cent. solution of this salt is said to be beneficial as a collyrium.

Pick has used, in an eye cup, a 2 to 5 per cent. solution for corneal opacities.

Ammoniumchlorid. (G.) Chlorid of ammonia.

Ammonium ichthyol. See **Ichthyol.**

Ammonium ichthyolate. See **Ichthyol.**

Ammonium ichthyolsulphonate. See **Ichthyol.**

Ammoniummolybdate (G.) Ammonia molybdate, ammonium molybdate.

Ammoniumpersulfat. (G.) Persulphate of ammonia.

Ammoniumpikrat. (G.) Picrate of ammonia.

Ammoniumsäuere. (G.) Acid of ammonium.

Ammoniumsulfat. (G.) Sulphate of ammonia.

Ammoniumvanadinat. (G.) Ammonium vanadinate.

Ammonshorn. (G.) Hippocampus major; cornu ammonis.

Amnesia, Visual. Another term for this central disease is "mind-blindness." The patient sees an object correctly but has no memory of it. By closing the eyes it may be recognized by touch or by the other senses. This symptom is present when the lesion is in the centre for visual memory or in the path connecting the centre for vision with the centre for visual memory. In these higher visual centres both eyes are represented in each hemisphere. They are situated in the angular gyri of the parietal lobes, and communicate with each other through the callosal crossway. A lesion in this region does not cause hemianopsia.

In *amnesic color-blindness* (q. v.) the patient cannot name the color of an object, although he distinguishes color and can perform color-tests perfectly.—(J. M. B.)

Amnestia optica. (G.) Mind-blindness. See **Amnesia, Visual.**

Amnestic color-blindness. This condition consists, as stated by Wilbrand, (*System of Diseases of the Eye*, Vol. 2, p. 301) in the patient's not being able to name, or in his naming wrongly, colors that are held before his eyes. When examining with the perimeter, this circumstance might easily lead to the assumption that an alteration of the color-sense is present. Such patients are merely not in condition to find spontaneously the word which belongs to the color

set before their eyes. If bundles of colored wools are placed before them, and they are set to sort the colors which belong together, they do it without hesitation or fault, thus proving that the color-sense is normal and that the disturbance is one that belongs to the aphasic symptom-complex. Wilbrand has described such cases.

Amöbe. (G.) Amoeba.

Amœba coli. (L.) Bacterium or bacillus coli. The bacillus of dysentery. See **Bacteriology of the eye.**

Amorphie. (G.) Malformation.

Amorphisch. (G.) Amorphic.

Amorphismus. (G.) Amorphism.

Amotio retinæ. See **Retina, Detachment of the.**

Amperage. The number of ampères (electrical units) that pass through a given circuit.

Amphibia, Oculo-toxic symptoms from poisonous. In the epidermis of toads there are both mucous and poison glands. The latter are found only on the animal's back and legs, but the mucous glands are scattered over the entire body.

An alkaline toxin, *phrynin,* was easily isolated from the poison-gland secretion, while from the skin of *Bufo vulgaris,* an acid, amorphous principle called *bufotalin,* five parts of which are soluble in 2,000 parts of water. In addition to these two is a similar but weaker agent, *bufonin.* Bufotalin is very irritating locally and, when absorbed, as after subcutaneous injection, acts like digitalis; it sets up salivation, vomiting and diarrhea.

Fresh toad poison causes an active inflammation of the lids. They become swollen, while phlyctenules may form and a purulent conjunctivitis set in.

Some toads, especially one from Guatemala, are said to inject a stream of corrosive fluid into the faces of those handling them. This liquid causes pain when it enters the eyes. *Bufo ictericus* is said to secrete the poisonous fluid (which produces cardiac paralysis in animals) in the glands of the neck. However, the consistency of the poison, which is present in the epidermis of the toad, speaks against the possibility of its being expelled the necessary distance to reach the eyes. As for the origin and character of the expelled fluid it may, in some instances, be a poisonous urine or secretion of the oral glands.

According to Lewin and Guillery, a watery solution of bufotalin placed in the eye causes conjunctivitis. A more noticeable result is a persistent, local anesthesia of the cornea and conjunctiva, when the toad poison in solution of 1 to 100 is placed in the human con-

junctival sac. The anesthesia begins in about 15 minutes and lasts about 5 hours; even after 24 hours the sensitiveness of the cornea is still reduced. This anesthesia, as well as the inflammatory changes set up by it, agree very well with its digitalis-like action, empirically known for almost two hundred years. It seems to be a law that digitalis-like substances, with few exceptions, act as irritants and anesthetics when applied to the conjunctiva.

There are a few other creditable reports of the injurious effect of toad poison on the eye. For example, P. Frank saw a very rapid and severe swelling of the eyelids in a young girl, who, while cutting grass, grasped a toad and then rubbed her hand over her eye.

Amphibians, Eyes of. Amphibia, as the name implies, are capable of life both beneath and above water. These terraqueous vertebrates exhibit two stages of development—the larval, in which they are aquatic and breathe with gills—and the adult form with lungs. Their eyeballs are small and structurally resemble the eyes of fishes. (See **Fishes, Eyes of.**) However, the tapetum (q. v.), the argentea (q. v.), the campanula of Haller (q. v.), the processus falciformis (q. v.) and the so-called "choroid gland," well represented in piscian species, are lacking in amphibian eyes.

The globe itself is nearly round and the cornea is decidedly convex. The pupil is generally circular, although in a few instances —Bombinator, for example—it is triangular. The crystalline lens is large, and more convex on its inner than on its outer surface. Amphibia accommodate chiefly by movement of the lens towards and away from the cornea and probably not by altering the shape of the crystalline. This action is brought about by the ciliary muscle. In the frog and other amphibian species there is a protractor lentis muscle that aids this movement, and it may be the homologue of the retractor of the lens in fishes.

Ciliary processes are seen in several amphibian species, while the iris has well-developed muscles. Hyaline cartilage—often pigmented—is found in the scleral coat although, unlike the sclerotic of birds, these are never ossified. It serves the same purpose as the bony plates in the bird's sclera.

The visual apparatus of this vertebrate class is arranged for seeing—not very distinctly, however—both in air and under water. See, also, **Comparative ophthalmology.**—(Ed.)

Amphiblestroid apoplexy. (Obs.) Retinal apoplexy or hemorrhage.

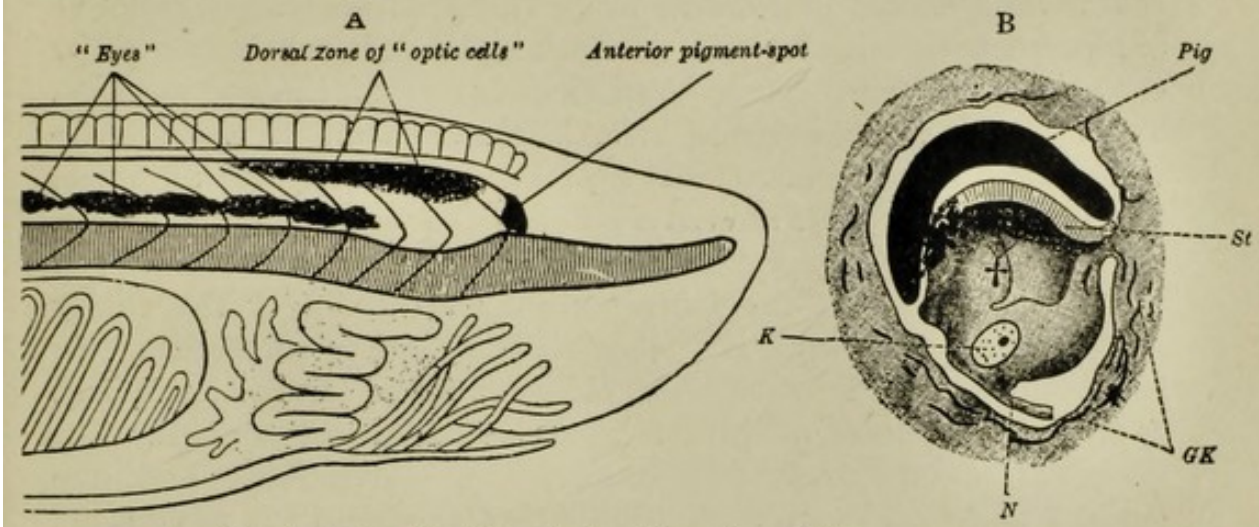
Amphiblestroiditis. (G.) Inflammation of the retina.

Amphicelous, or amphicoelous. Concave on both sides or ends; biconcave.

Amphidiplopia. (G.) That condition in which each eye exhibits double vision.

Amphikranie. (G.) Bilateral headache.

Amphioxus, Eyes of. Amphioxus (lancelet) is a genus of invertebrate animals that are destitute of eyes in the sense that these organs occur in vertebrates. They have, in addition to an unpaired pigment-spot in the front wall of the cerebral vesicle (which is supposed to serve as a light-perceiving organ), a series of simple,



A.—The Anterior Portion of *Amphioxus lancelatus*. (Modified from H. Joseph.)
B.—One of the Eye-Like Organs in A. (After H. Joseph.)
GK, capsule, with neuroglia elements; *K*, nucleus of optic cell; *N*, its nerve process, and †, its granular border; *Pig*, pigment-cell, showing three layers; *St*, striated border of optic cell.

cup-like structures, somewhat resembling the eyes of flat worms, situated on either side of the spinal cord. (See the figures.) These structures are arranged in groups, corresponding to the myomeres, and gradually becoming less numerous in passing backwards to the tail. Each of these bodies is described as consisting of a single optic cell with a nerve fibre, and is partly surrounded by a pigment cell. More dorsally, above the oral region, somewhat similar, but pigmentless, bodies have been observed.—(Wiederscheim).

Ampiezza dell'accommodazione. (It.) Amplitude or amount of accommodative effort of which the eye is capable, from its far to its near point.

Amplitude of accommodation. The amount of accommodative effort of which the eye is capable, from its far point (punctum remotum)

to its near point, or punctum proximum. It is often referred to as the field or range of accommodation. "It is expressed by the formula $\frac{I}{P} - \frac{I}{R}$, in which P represents the near point and the R the far point; and may be taken as the difference in refractive power of lenses of which the foci are respectively P and R. The binocular range of a. is the a. from the farthest point (r_2) to the nearest point (p_2), for both eyes at once. The relative range of accommodation is the range over which we have control at a given convergence of the visual lines. It represents the degree in which accommodation is independent of convergence. The positive-relative range of a. represents the amount of a. of which a person is capable nearer or closer than the point of convergence of the visual lines of the eyes. The negative relative range of a. is that amount of convergence which is required in order that a person may clearly see an object lying beyond the point of convergence of the visual lines."—Foster.

This condition is dependent upon alterations in the curvature of the lens, the age of the individual, the condition of the ciliary muscle, etc. Hess calls it "latent ciliary muscle contraction" in contra-distinction to "manifest ciliary muscle contraction," i. e., that which produces alterations in the curvature of the lens. The range of accommodation is measured by determining both the "near" and "far" point of vision. By "far point" is understood the distance from the eye at which an object is placed to be distinctly seen with the least curvature of the lens. The "near" point is the distance at which an object can be seen distinctly with the greatest curvature of the lens. In practice, fine print (Jaeger I or the corresponding Snellen type) is used to determine the near-point. These tablets are brought near to the eye until the print appears blurred. The size of the object and the width of the pupil are important factors to be considered, and as the above method deals with a narrow visual field only, not the real near-point but a "pseudo" near-point is obtained, which, in general, is nearer to the eye than the true punctum proximum.

To determine the positive near-point, it is, however, best to employ some method depending upon the Scheiner experiment. Looking with one eye at a small point of light through two small holes close together in a disc, the point fixed will be seen double if the eye is not sharply focussed; single if it is. With the least error in focussing two points will be seen instead of one. Again, if a pointed object is gradually brought near to the eye, it is not

difficult to say at what point the object begins to be seen double with strong accommodation, and the "near-point" is positively found. The optometers of Porterfield-Young, Stampfer and others are constructed on the base of this experiment. The two small holes are replaced by two fine parallel slits.

Recently, it has been asserted that the range of accommodation in hypermetropia is greater and in myopia less than in emmetropia, and this was explained by the difference in action of the ciliary muscles. If this assumption were correct the different range of accommodation in ametropia could be explained only by differences in the crystalline lens of each form of refraction. As a matter of fact, however, the range of accommodation is essentially the same in all.

As is well known, the increasing hardness of the lens as age advances prevents the action of the ciliary muscle. The near-point consequently recedes (and the amplitude of accommodation diminishes) from the eye, whereas, up to the age of fifty, the far-point does not change. The accommodation at the age of ten is about 14 D, at twenty about 10 D, at thirty about 7 D, at forty about 4½ D, at fifty about 2½ D. As soon as the near-point has so far moved away from the eye that reading at 30 cm. distance is impossible, visual disturbances, known as presbyopia, appear. Such disturbances are not due to a functional weakening of the ciliary muscles but merely to an increasing density of the lenticular substance; and no efforts (however strong) on the part of the ciliary muscle can increase the curve of the lens past a certain point.

This state of affairs distinguishes presbyopia from the hypermetropia of youth. In the latter instance increased ciliary contraction is followed by increased curvature of the lens and approach of the near-point of distinct vision. It also explains why (emmetropic) presbyopes do not suffer from asthenopic symptoms and why they have no dynamic convergence. With advancing age the manifest range of accommodation decreases while the latent increases correspondingly. When the lens has become so hard that form changes are entirely lost, the entire amplitude of accommodation becomes latent.

See **Physiological optics; Refraction and accommodation.**

Amplitude of fusion. This expression indicates the extent to which fusion of the images of the two eyes (and binocular vision) are maintained during extreme variations of the angle of convergence in the amblyoscope, or similar instrument. The number of degrees covering the arc thus described is the measure of the amplitude of

fusion, which may also be regarded as the extent to which the fusion faculty has been developed.

Amplitude of vibration. In *physics,* the length of the perpendicular between the summit of a wave and the line of its propagation. The perpendicular is located midway between the nodes (q. v.).

Ampullæ. These containers are small, specially constructed glass bottles for liquids likely to be injured by contact with the air or light. Generally they are opened by breaking their slim neck at a file mark in the glass.

Amtsarzt. (G.) District physician.

Amtsphysikus. (G.) A physician connected in a jurisdiction of a state.

Amylalkohol. (G.) Amylic alcohol.

Amylnitrit. (G.) Nitrite of amyl.

Amyl nitrite. AMYLO-NITROUS ETHER. AMYL NITRIS $C_5H_{11}NO_2$. Ethereal, yellowish liquid, of a pungent aromatic taste and a peculiar fruity odor; very volatile and inflammable. It is never used locally in eye diseases, but is generally inhaled as a cardiac stimulant. Small doses stimulate the heart muscle, increasing the force and rapidity of the heart, while overdoses produce the opposite effect. It also increases the amount of urine and sometimes sets up a temporary glycosuria. Pearls made of very thin glass are on the market, each containing a dose—2 to 5 minims (0.20-0.30 cc.)—of the drug. One of these is crushed in a piece of gauze or handkerchief and slowly inhaled. Flushing of the face, slight tinnitus, and even vertigo accompany the rush of blood to the head, which it is the purpose of the drug to accomplish.

It is used in tobacco-alcohol amblyopia partly as a remedy and partly to determine whether a temporary improvement in vision will follow the improved supply of blood to the starved optic nerve. If this occurs the prognosis is decidedly more favorable than when no such improvement follows. It is also used in quinine amblyopia and in forms of optic atrophy as an adjunct to other treatment; also as a heart stimulant in cocaine poisoning.

Amyloform. This condensation product of the action of formaldehyde on starch is a white, odorless powder eminently adapted as an antiseptic application to the ocular structure in lieu of iodoform.

Amyloid degeneration of the external eye. This tissue alteration is a local one, unconnected with general disease. Its etiology is unknown, and its occurrence is rare, except, perhaps, in countries

like India, Egypt and the Russian Baltic provinces where trachoma is common. It is most frequently met with between the ages of 20 and 25, and both sexes are equally affected. Usually only one eye is affected and the course of the disease is a very chronic one. In the conjunctiva it is generally found about the region of the fornix and superior arcus tarseus (q. v.). Hence the process extends to other parts of the conjunctiva, but it rarely attacks the eyeball or deep tissues of the eyelid. The thickened mucous membrane later on forms heavy folds which may project more or less into the conjunctival sac. Their surface is smooth and of a yellow color. At this stage of the disease hemorrhages into the parenchyma of the swollen tissue may occur. The upper eyelid is now drawn down, and on account of the gradually increasing extent of the swelling, the lids are more and more pushed away from the eyeball till they seem puffed out—almost globular. The lid, however, remains normal. Beneath the epidermis hard, knotty elevations appear, which have sometimes smooth, sometimes uneven surfaces, so that eversion of the upper eyelid is difficult or impossible. Subjective disturbances are almost entirely absent in the beginning while later on patients complain of the disfigurement and of defects in vision.

The process, localized at first in the conjunctiva proper finally invades the submucosa and may even extend into the deeper tissues.

Pathologically, we find the formation of peculiar granulation tissue (adenoid cells according to some authors), intercellular connective tissue bundles and fibrillæ. Mast-cells are encountered occasionally. The amyloid substance is deposited in these tissues and may appear in irregular, isolated areas or in large interconnecting masses. Some of the single areas are enveloped by an endothelial layer. Usually, the bloodvessels are also strongly affected, showing thick walls and narrowed or obliterated lumina. In progressive cases all the palpebral glands and muscles undergo degenerative changes. Lime salts may also be deposited in the diseased tissues and ossification of the amyloid tumors may result.

It is the common idea that the amyloid substance is deposited in the connective-tissue network of the granulations and their bloodvessels, and that cellular elements are secondarily affected by pressure atrophy.

The symptoms are characteristic, although in the early stage they might be mistaken for the signs of diffuse trachoma. Absence of follicles and pannus aid the diagnosis. The prognosis is ordinarily favorable unless the process has already spread very much.

In this case the prognosis will be doubtful because after operative measures adhesions may occur between the globe and the eyelids. Effective therapy consists in excision of the tumors with the greatest possible preservation of the mucous membrane. Repeated and partial excision of the larger of the tumors is to be recommended, since the other swellings may disappear spontaneously after the operation. Relapses may also occur after operation.

Amyloid degeneration of the cornea is thought to be a colloid or hyalin change, and outside of the color reactions (with iodine and iodic acid) has little in common with amyloid degeneration of the eyelids (q. v.). It occurs in eyes suffering from leucoma, staphyloma or irido-corneal scars, or is seen in eyes blind from glaucoma or irido-chorioiditis, (ribbon-shaped keratitis). The histological changes take place in the superficial layers of the corneal (scar) tissue, and may extend into the epithelium. The degeneration consists of a highly refractive, glossy substance which appears in the form of very small granules, or droplets, or in larger, irregular masses, often complicated by calcification. Opinions differ as to the origin of this substance. Some investigators connect it with a degeneration of the cells of the cornea or of more recent young scar-tissue in it. The substance itself is insoluble in alcohol, ether and chloroform, is not attacked by inorganic acids and concentrated alkalies, and often gives the color-reactions (iodine and its compounds) characteristic of the amyloid or hyaline substance. Clinically, the affected parts of the cornea show a marked yellowish tinge.—*(Encyklopädie der Augenheilkunde.)*

Amyloid disease of the conjunctiva. According to Fox (*Diseases of the Eye*, p. 132), this is a rare affection of the conjunctiva, characterized by amyloid infilration of that structure. It is most frequent in young adults, and is often first noticed by the drooping of one or both lids. Redness, hemorrhages, and protrusion may become marked, and often render the eye useless. The condition is not unlike trachoma in appearance, but differs from that disease in that it is yellow, waxy, and transparent. The cause is unknown. The treatment consists of excision.

Hyaloid degeneration of the conjunctiva has also been observed, but is usually considered a forerunner of amyloid changes.

Amyloide degeneration der Bindehaut. (G.) Amyloid degeneration of the conjunctiva.

Amyloide degeneration von Hornhautnarben. (G.) Amyloid degeneration of scars of the cornea.

Amyloidentartung. (G.) Amyloid degeneration.

Amyloidentartung der Bindehaut. (G.) Amyloid conjunctival degeneration.

Amyloidentartung der Conjunctiva. (G.) Amyloid degeneration of the conjunctiva.

Amyloidentartung der Conjunctiva des Tarsus. (G.) Amyloid degeneration of the conjunctiva of the tarsus.

Amyloidentartung der Hornhaut. (G.) Amyloid degeneration of the cornea.

Amyloidentartung innerer Organe. (G.) Amyloid degeneration of the internal organs.

Amylo-nitrous ether. See **Amyl nitrite.**

Amylum. See **Starch.**

Amyotrophische. (G.) Amyotrophic.

Amyotrophische lateralsklerose. (G.) Amyotrophic lateral sclerosis.

Anabolic change. A term used in describing Hering's theory or explanation of color perception. The theory assumes that different colors affect different color-substances in the retina. Red light, for example, induces a catabolic change (Dissimilirung) in the red-green substance, producing a sensation of red. Green light, on the other hand, brings about a constructive or *anabolic* change (Assimilirung) in the same substance, thereby producing a color sensation of green. See **Color sense.**

Anacamptic. Causing a reflection, as of light or sound.

Anacamptics. That part of optics which treats of reflection. Same as catoptrics (q. v.).

Anacamptometer. An instrument for measuring the reflexes.

Anaclasis. A refraction or reflection of sound or light.

Anaclastic, adj. In *optics,* pertaining to or produced by the refraction of light; refracted. *Anaclastic curves,* the apparent curves at the bottom of a vessel of water, caused by the refraction of light. *Anaclastic glass* or vial, a glass with a narrow mouth and a wide convex bottom of such thinness that when a little air is sucked out it springs inward with a smart crackling sound, and when air is blown in it springs outward into its former shape with a like noise. —(C. F. P.)

Anaclastics, n. Plural of anaclastic. That part of optics which treats of the refraction of light. Same as dioptrics.

Anaërobe Kulturen. (G.) Anaerobic cultures; a micro-organism capable of living without free oxygen or which is destroyed by it.

Anaëroben. (G.) Micro-organisms capable of living without free oxygen or which are destroyed by it.

Anæsthesia. See **Anesthesia.**

Anaesthesie der Bindehaut. (G.) Anesthesia of the conjunctiva.

Anaesthesie der Hornhaut. (G.) Anesthesia of the cornea.

Anaesthesie der Lidhaut. (G.) Anesthesia of the palpebral skin.

Anaesthetica. (G.) Anesthetic.

Anagenesis. A term used in connection with the photo-chemistry of the retina to indicate a certain form of regeneration of the previously bleached or exhausted color-elements of the retina. See, also, **Rhodogenesis** and **Neogenesis.**

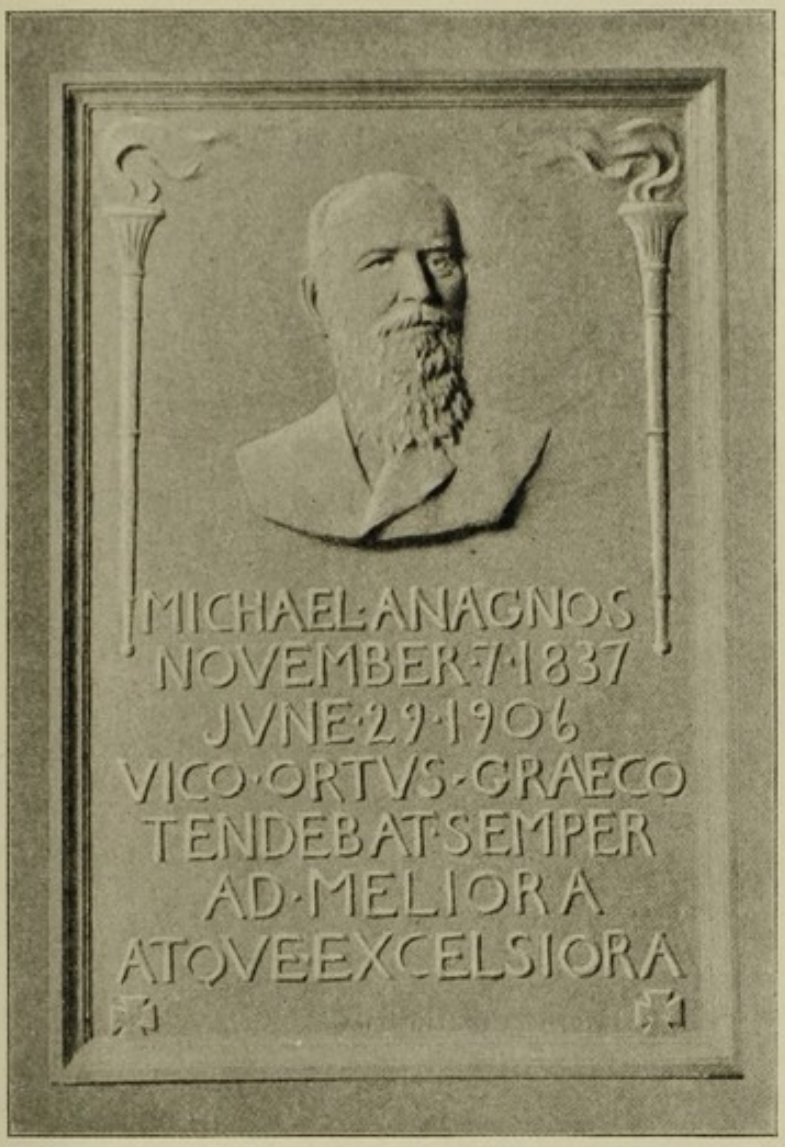
Anaglyph. An experimental figure, composed of two superimposed designs, one drawn in red and the other in blue. If this be observed through a red glass, only the blue lines are visible, and *vice versa.* If, however, a red glass be placed in front of one eye and a blue glass in front of the other, a stereoscopic effect is obtained. Changing the glasses gives a reversal of the relief, if the anaglyph be drawn in such a manner as to permit of this interpretation.

Anagnos, Michael. This well-known philanthropist was for many years Superintendent of the Perkins Institution for the Blind. He was born in Epirus, Greece, in 1837. At eighteen he entered the University of Athens and devoted himself especially to the study of philosophy and languages. Later he studied law, which he followed for three years. He was shortly afterward drawn into the political movement of the time having for its aim the freeing of the Greek provinces from the domination of Turkey. His activities and vigorous articles against the political policy of the then reigning King Otto caused his imprisonment. After the dethroning of King Otto and the establishment of a liberal government under King George, he resumed his journalistic pen. He took an active part in the agitation in Greece during 1867, when the Cretans rose against their Turkish oppressors, and assisted the struggle on the part of the Greek people to unite in one nation all their compatriots,—an effort that excited the general sympathy of the world.

Dr. S. G. Howe, who had made several previous visits to Athens, was at this time in Greece, bringing with him money and encouragement from American sympathizers. There he met the young patriot and between these men a warm friendship soon developed.

Urged by Howe, Anagnos accompanied the former to America. He soon became deeply interested in the work for the blind and was appointed secretary of the Perkins Institution for the Blind. Later, he married the eldest daughter of Dr. Howe, Julia Romano, and in 1876, on Howe's death, he became in his turn Director of this, one of the oldest and most important of the Institutions for the blind in America. His wife was his never-failing inspiration and support.

Following the remarkable experimental work in the training of the blind deaf as exemplified in the case of Laura Bridgeman, Anagnos received and trained in the Institution at South Boston, four



Michael Anagnos.

children who could neither see, hear, nor speak. Of these the most remarkable was Helen Keller (q. v.).

Anagnos gave great attention to the building up of a library both of the oldest and most important of the Institutions for the Blind This has been continued and enlarged by his successor, E. E. Allen, and it is now one of the most complete to be found anywhere in the world.

Anagnos wrote a number of valuable papers on the Education of the Blind.—(F. P. L.)

Anagnostakis, Andreas. This distinguished modern Greek oculist was born in Crete in 1826 and died in Athens in 1897. He studied at the Universities of Athens, Berlin, and Paris, receiving his degree in 1849 at the last-named institution. Returning to Athens for the practice of ophthalmology, he was appointed Director of the Ophthalmiatric Institute in 1854, and Professor of Ophthalmology at the Athens University in 1856. In 1877 he became University Rector. From 1854 until his death he was one of the collaborators of the *Annales d'Oculistique,* and, from 1850 to 1860, was one of the editors of the *Journal Médical d'Athénes.*

His numerous writings, some published in modern Greek, are especially, though not alone, valuable for the history of ophthalmology. Among the most important are: *Remarques pratiques sur le Traitement Chirurgical de l'Entropion et du Trichiasis* (1857); *De l'Ophthalmologie en Gréce et en Egypte* (Bruxelles, 1858); *Mélanges Ophthalmologiques* (Athenes, 1861); *Contributions à l'Histoire de la Chirurgie Oculaire chez les Anciens* (1872); *Encore deux Mots sur l'Extraction de la Cataracte chez les Anciens* (1878).

Many of his statements concerning the ophthalmology of the ancients, though long believed in absolutely, have been overthrown by the later investigations of Hirschberg.—(T. H. S.)

Anagnostakis' operation for entropion. Anagnostakis (*Annales d'Oculistique* 1857, XXXIII, p. 5) was probably the first to call attention to the principle contained in the Hotz operation, viz., attaching the cilia border to the upper margin of the tarsus by means of a skin flap.

He made the incision nearer (about 3 mm.) the lid border, by which the everting effect is considerably increased, and also excised the muscle fibers from the anterior surface of the tarsus. With sutures he then united the lower skin flap to the upper border of the tarsus.—(W. H. W.)

Analgesine. See **Antipyrine.**

Analyse. (G.) Analysis.

Analysiren. (G.) To analyze; analyzer, analyst.

Analysis, spectrum. Determination of the composition of a luminous body by observation of its afferent light-rays with the spectroscope. See **Spectrum analysis.**

Analytik. (G.) Analytics.

Analytisch. (G.) Analytic.

Anämie. (G.) Anemia.

Anämie nach Blutverlusten. (G.) Anemia following a hemorrhage.

Anämie, Perniciöse. (G.) Pernicious anemia.

Anämie perniziöse. (G.) Pernicious anemia.

Anämie Retinitis. (G.) Retinitis from anemia.

Anämie und Chlorose. (G.) Anemia and chlorosis.

Anamnese. (G.) The history of a case.

Anamnesis. The clinical history of a case as obtained from the patient himself, from his relatives or from others. It is sometimes written *anamnesia.*

Anamorphism. Same as anamorphosis (q. v.).

Anamorphoscope. An optical toy consisting of a vertical cylindric mirror which gives a correct image of a distorted picture drawn at the base on a plane at right angles to the axis of the mirror. See **Anamorphosis.**

Anamorphose, v. t. To represent by anamorphosis; to distort into a monstrous projection.

Anamorphosis, n. In perspective, a method of drawing which gives a distorted image of the object represented when it is viewed directly or nearly so, but a natural image when it is viewed from a certain point, is reflected by a curved mirror, or is seen through a polyhedron.—(C. F. P.)

Irregular or anomalous development. In a gradual change of biologic form in successive members of a group.

Anamorphosy, n. Same as anamorphosis (q. v.).

Anamorphous, adj. Distorted; out of shape.

Anamorphosis, Catoptric. The correction of a distorted image by the employment of a cylindrical mirror.

Anaphoria. A form of heterophoria (q. v.) in which there is an upward tendency of the eyes and visual axes.

Anaphylaxis. (Gr., against protection). This term is used to denote a condition of hypersensitiveness of an animal to certain substances. Among the earlier observations on anaphylaxis were those of Theobald Smith, who noted in testing antitoxin by injecting the serum into guinea-pigs, that animals which had previously received an injection, suffered after the second injection from a rather characteristic train of symptoms. Within a few seconds or minutes after the injection of the second dose, the animals begin to sneeze, become restless and breathe more rapidly. Convulsions may occur with the passage of urine and feces, and respiration ceases. Post mortem, the lungs remain in permanent distension. The smaller bronchi are contracted and many of the alveolar walls are ruptured. Multiple hemorrhages are found in the lungs and in other tissues of the body. These symptoms of anaphylactic shock vary in different animals. The guinea-pig has been used in most of the expe-

rimental work as it has been found more sensitive to anaphylactic shock than are other laboratory animals. The amount of albumen required to sensitize a guinea-pig may be extremely small, one millionth of a gram of pure albumen being sufficient to sensitize a guinea-pig so that death follows a second injection of a larger amount.

A definite interval must elapse between the first and second injections. This interval is usually from seven to ten days. In a sensitized animal, the rapidity with which the symptoms follow the second injection and the severity of these symptoms varies with the mode of injection. The intravenous injection is followed within a few seconds by characteristic and severe symptoms. When the intraperitoneal or subcutaneous methods are employed, a somewhat longer time elapses before the symptoms appear.

If the serum from a sensitized animal is introduced into a normal animal, the symptoms of anaphylaxis appear in the second animal on the introduction of the substance used to sensitize the first animal.

This condition is known as passive anaphylaxis.

The condition of anaphylaxis is specific, that is, an animal sensitized to horse serum shows anaphylactic shock on a second injection of horse serum but not after an injection of bovine serum.

In addition to the serums and other substances derived from animal sources, the proteins obtained from various plants and bacterial products may be used to sensitize animals.

The phenomena of anaphylaxis are of great importance from a medical point of view. In man, certain cases of severe reactions following the injection of sera such as diphtheria antitoxin have been noted. In some instances where these symptoms have followed the first injection of serum, it has been assumed that the individual had been sensitized through the ingestion of horse meat. In other cases such an explanation has not been tenable and many of the instances of anaphylaxis of this sort remain without adequate explanation. In a number of individuals in whom severe reactions have been noted, there has been a history of previous asthmatic tendency.

The phenomena of "serum disease" which are frequently seen after the injection of diphtheria antitoxin are regarded as a form of anaphylaxis. The urticaria appears usually on the eighth to the tenth day and it is believed that the reaction is due to the presence of a portion of the serum which has remained unchanged in the body and which produces the reaction as soon as sufficient

time has elapsed for the formation of antibodies. In persons who have received horse serum in previous years, the giving of a second dose may cause no immediate symptoms but the serum disease appears at a considerably earlier date, perhaps the fourth or fifth day or earlier. This an accelerated reaction is ascribed to the increased facility with which the body forms antibodies to the serum. The serum disease is not due to the antitoxic property of the serum; it follows as well the injection of normal horse serum. In giving antitoxin, it is important to inquire as to previous injections and whether the individual is subject to asthma. If such is the case then a very small dose, a few drops, of serum should be given first, and if no serious reaction occurs the full dose may be given in a few hours. The fear of anaphylactic shock should not be allowed to outweigh positive indications for antitoxin in a case of diphtheria.

Many of the familiar reactions used in the diagnosis of disease such as the tuberculin reaction, including the Calmette reaction in the eye and the cutaneous reactions to various other bacterial products are clearly of anaphylactic nature. In the incubation period of several of the exanthemata, such as measles, a marked similarity to the phenomena of serum disease and anaphylactic shock in animals may be traced. Hay fever has been regarded as an anaphylactic reaction on the part of the sensitized individual to the pollens of certain plants. Sympathetic ophthalmia and eclampsia have also been explained on the basis of anaphylaxis.—(E. E. I.). See, also, **Allergy,** under which caption will be found additional information on this subject. Also **Ocular anaphylaxis.**

Anastomoses of the retinal vessels. CILIO-RETINAL VESSELS. The reëstablishment of the retinal circulation by the communication sometimes existing between the ciliary and retinal circulation, or by the development of anastomosing branches, after obstruction of the central retinal artery is a not uncommon occurrence. A case in point is reported by Gonin. Three months after the obstruction occurred, there were found small vessels emerging near the margin of the disk and forming a series of loops, or network about it, commencing with the branches of the central retinal artery. These branches were thread-like, or had quite disappeared from the disk; but beyond the junction of the anastomotic vessels they presented their normal appearance and approached the normal size.

Gonin regards it as probable that these anastomotic vessels have resulted from the development of fine communications, which usually

exist in and about the head of the optic nerve before the central artery has been obstructed. This seems to him more probable than the supposition that these vessels were anomalous and peculiar to this particular case; or that they existed fully developed and ready to take up the circulation as soon as the obstruction of the main trunk occurred; for in spite of the anastomotic vessels the eye became and remained entirely blind.

Anatom. (G.) Anatomist.

Anatomiren. (G.) To dissect.

Anatomisch. (G.) Anatomical, anatomically.

Anatomy, Microscopical, of the eye. See **Histology of the eye.**

Anatomy of the eye, Comparative. See **Comparative ophthalmology.**

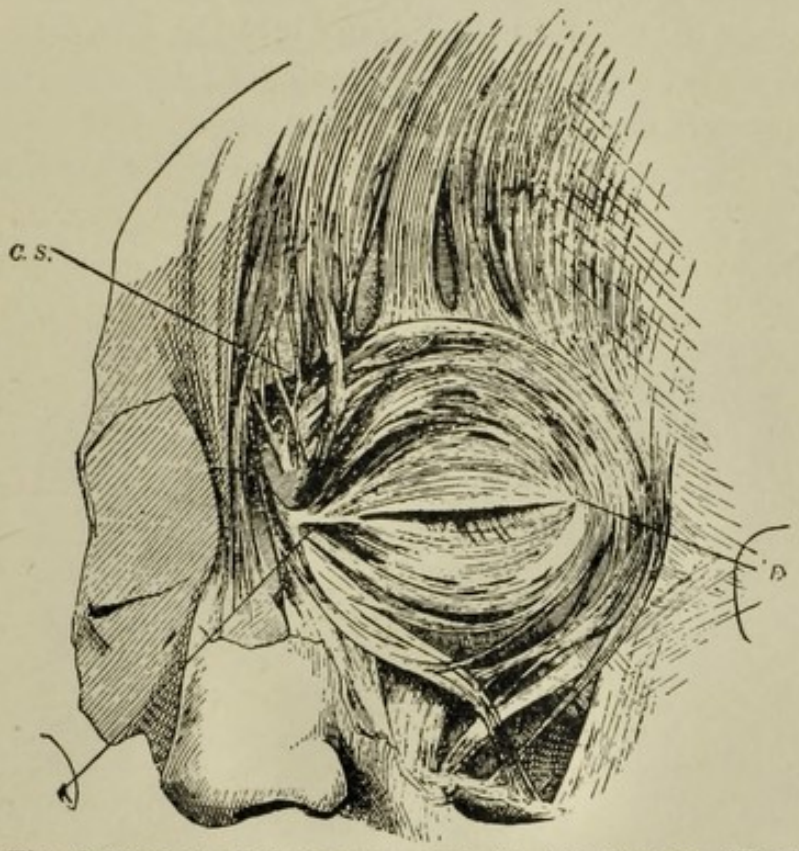
Anatomy (gross) of the human eye and of its appendages. In the following pages both the histology, or microscopical anatomy, of the ocular apparatus and of its physiology will be incompletely consid-

Eyelids Naturally Open, Horizontal Plane Passes Through the Inner Canthus.

ered; a few details of the latter will be given. As is well known there is no strict line of demarcation between the two subjects; and the same may, in another sense, be said of the macroscopical anatomy and the physiology (q. v.) of the same organs, though no attempt is made in this section to cover the latter subject which will, with the histology (q. v.) be elsewhere described.

The **eyelids** [*palpebra superior; palpebra inferior*] which cover and protect the eyeball, are formed from upper and lower folds of embryonic skin. Their margins become joined at the third month of fetal life by union of the conjunctival epithelium. Shortly before birth rupture of this union occurs and the lids become separated from each other. In many animals this separation does not take place until several days after birth.

The *skin* of the eyelids is of the thinnest found covering the human body; it becomes quite thick, however, as it nears the eyebrow—a thickened, arched eminence of skin surmounting the upper margin of the orbit, and covered by closely-placed, thick, short hairs growing mostly in a lateral direction. It is very loosely attached about the margins of the orbit, but close to the free margin of the lid the attachment is very firm. Very delicate, short hairs cover the surface.



The Orbicularis Palpebrarum and its Attachments (Henle).

The *upper lid* extends as far as the eyebrow. In this location are attached the orbicularis palpebrarum, corrugator supercilii, and occipito-frontalis muscles; the function of the latter muscle being to raise the eyebrow well on the forehead, of the former to depress the eyebrow and protect the eye, to a certain extent, against the entrance of light or harmful agents.

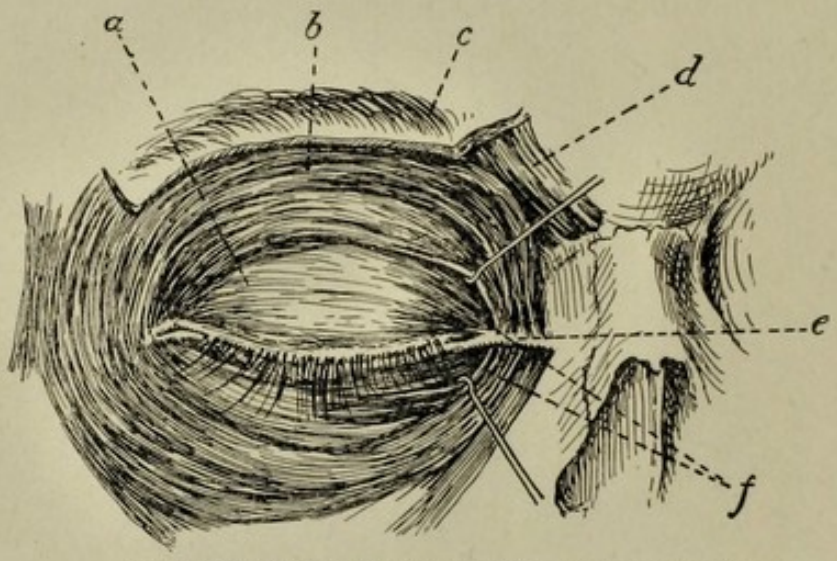
The *lower lid* has no well-defined boundary, being directly continuous with the skin of the cheek.

On the upper lid a deep furrow in the skin, running from one canthus to the other with its convexity upward, indicates the upper border of the upper tarsus, and the chief insertion of the levator palpebræ superioris; it is called the *sulcus orbito-palpebralis su-*

perior. As age advances the fold of tissue above often overlaps the groove beneath it. This furrow forms a landmark for the surgeon in operations on the lid.

A somewhat similar groove—the *sulcus infra-palpebralis*—is seen on the lower lid. Beginning a little to the nasal side of the inner canthus, it extends downward and laterally, and terminates about the middle of the lid just above the infra-orbital margin. As age advances it becomes deeper, and may be continued on up to the outer canthus.

In addition to the integument, the lids are made up of areolar, muscular, glandular, and connective tissue (the tarsal plates), and a lining mucous membrane—the conjunctiva.



Muscles of the Right Eyelids (from front).

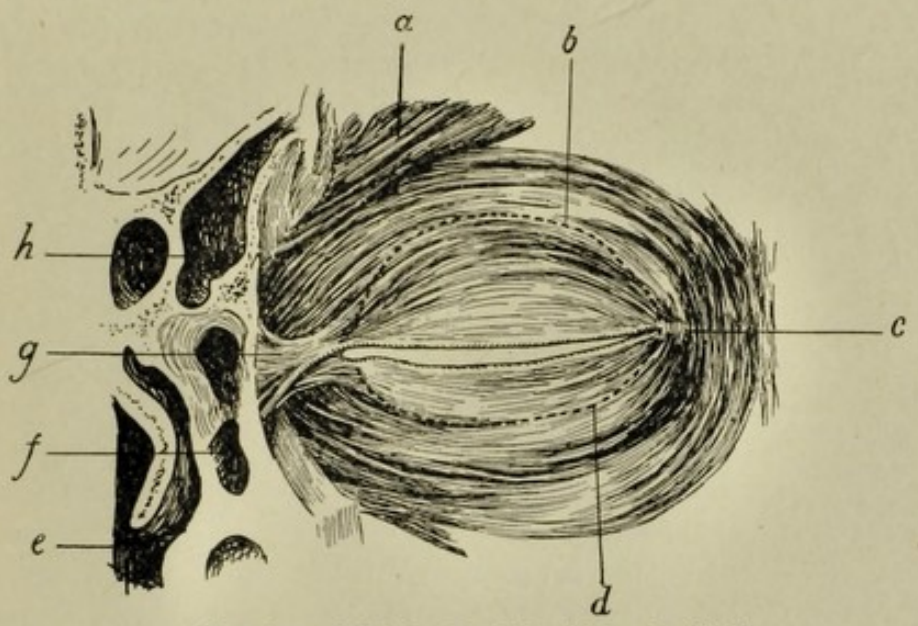
a. Palpebral portion of the orbicularis muscle; b. Orbital portion of the orbicularis muscle; c. Eyebrow; d. Corrugator muscle; e. Medial palpebral ligament; f. Lachrymal portion of the orbicularis muscle.

The upper lid is the larger of the two, and is the more freely moveable.

Between the lids is the lid-fissure, or palpebral opening, following the curve of the lid-margins. It averages about 30 mm. in length, is more curved above than below, and exposes nearly the entire cornea and a portion of the sclera equal to one-fifth of the globar surface. It is longer in childhood than in adult life, and shortest in old age. The palpebral fissure terminates in an inner and an outer canthus, or angle. The latter is the lower of the two, and has a sharper angle. If the lids are put on the stretch, there will be seen at the outer canthus a delicate fold of skin called the outer commisure, which connects the upper with the lower lid.

The inner canthus presents an outline somewhat similar to a horseshoe, at the free ends of which are situated the puncta lachrymalia; these are directed a little backward, and are closely applied to the eyeball. Here, also, is found a small, pink body—the lachrymal caruncle—which is set down in the concavity of the "horseshoe" against the eyeball; it is composed of skin and conjunctiva.

The width of the lid-fissure varies greatly in different individuals. Usually, when looking directly forward, the upper portion of the cornea is covered for about 1.5 mm. by the upper lid, while the lower portion remains exposed. The narrow, free margins of the lids are closely in apposition when the lids are closed. An oily secretion from the Meibomian glands prevents an overflow of tears, except when they are formed greatly in excess of the normal.



Muscles of Right Eyelids (from behind).

a. Corrugator muscle; b. Upper border of superior tarsus (dotted line); c. Lateral palpebral raphe; d. Lower border of inferior tarsus (dotted line); e. Cavity of nose; f. Ethmoidal cells; g. Lachrymal portion of the orbicularis muscle; h. Frontal sinus.

The *cilia,* or eyelashes, which project in two or three rows from the margin of the upper lid, curving slightly upward, are larger, longer, and more numerous than those of the lower lid, which arise from its anterior margin and grow downward and forward. In both lids they are longest in the middle; toward the nasal side they reach only to the recess in which the caruncle is placed.

The chief muscle of the lids is the *orbicularis palpebrarum,* a powerful voluntary sphincter, consisting of an orbital, a palpebral, and a lachrymal portion. It is a thin, flat muscle which lies immediately under the skin, spreading out and mingling its fibres with the

muscles of the brow (corrugator supercilii), forehead, and cheek; its fibres are also attached to the tarsus and to the lachrymal apparatus. It has its origin at the inner canthus from a short, firm, fibrous band, which is attached to the nasal process of the superior maxilla—the ligamentum palpebræ mediale; at the extreme inner angle of the inner canthus this ligament becomes divided into two parts, one being attached to the upper and one to the lower tarsal plate. At the outer canthus is the raphé palpehralis lateralis, which connects the ends of the tarsal plates to the orbital margin. A small slip of the orbicularis is distributed to the upper lid margin between the eyelashes and the conjunctiva, where it receives the name "muscle of Riolan." By the action, consequently, of different parts of the orbicular muscle and its direct connections, the lids may be partly and gently closed (without wrinkling the skin); or they may be tightly squeezed together, with wrinkling of the surrounding skin, or accompanied by contortions of the face and forehead.

The levator palpebræ superioris acts in opposition to the orbicularis, and elevates the upper lid. (This muscle will be considered in detail under a subsequent heading.) The under lid sinks slightly by virtue of its own weight.

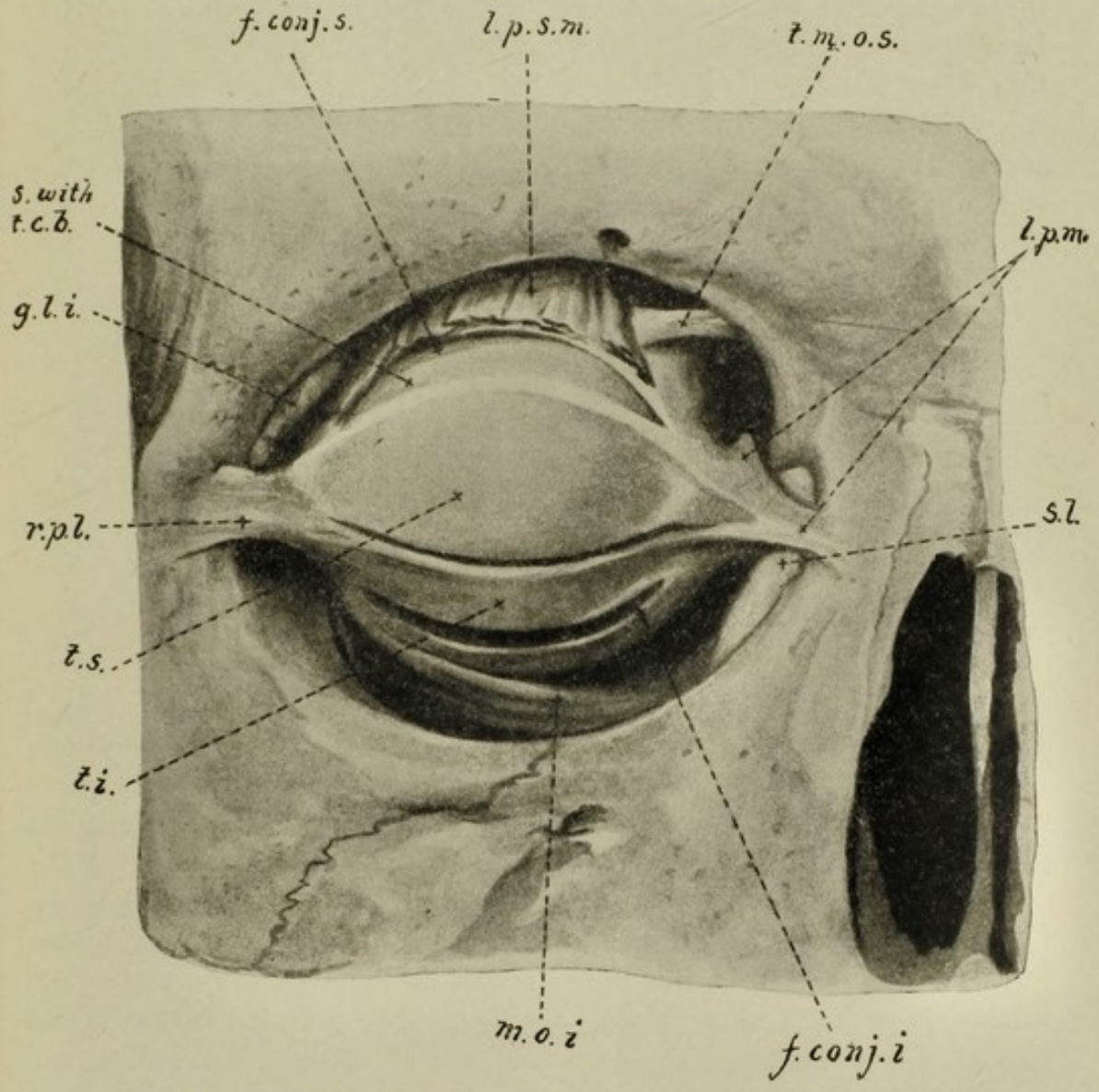
The lids are well supplied with blood—most richly at the free lid-margin. The chief source of supply is from the superior and inferior palpebral branches of the ophthalmic artery on the nasal side, and from the lateral palpebral branches of the lachrymal branch of the ophthalmic on the temporal side; together, these vessels anastomose and form the *arcus tarseus superior* and *arcus tarseus inferior*. In addition, the lids are supplied by branches of the orbital and transverse facial branches of the temporal, the anterior temporal branch of the temporal, and by the angular branch of the facial. All of these vessels anastomose freely on the surface of the lids.

The veins are more numerous and larger than the arteries, and are tributary, in part, to the veins of the face, in part to the vena ophthalmica. They form a thick plexus underneath the conjunctiva of the superior and inferior fornices. In their course to the orbit they pass through the fibres of the orbicularis.

The lids are rich in lymphatics, which are connected with the vessels covering the face, with the parotid system, and perhaps with the submaxillary glands. Some infections of the conjunctiva are, for this reason, accompanied by soreness and swelling of the preauricular gland.

The sensory supply to the upper lid tissues is from the first division of the fifth nerve, through the supra-orbital and supra-troch-

lear branches of the nasal; and through the lachrymal, the latter at the outer angle. The lower lid is supplied by the infra-orbital. The facial is the motor nerve of the orbicularis; while the oculo-motorius controls the levator palpebræ superioris. Fibres of the fifth supply the muscles of Mueller, which will be considered later on. Close to the palpebral border the nerves form a rich marginal plexus.



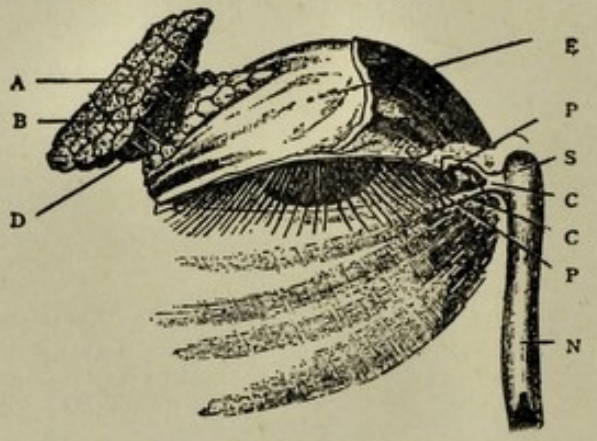
Lid Plates of the Right Eye Dissected out. Viewed from in Front. (After Spalteholz.)

The insertion of the m. levator palpebræ superior has been removed, and the conjunctival sac has been opened from in front, above and below the lid plates.

s. with t.c.b., sclera with tunica conjunctivæ; g.l.i., glandula lachrymalis inferior; r.p.l., raphe palpebralis lateralis; t.s., tarsus superior; t.i., tarsus inferior; f.conj.s., fornix conjunctivæ superior; l.p.s.m., levator palpebræ superior; t.m.o.s., tendo m. obliqui superior; l.p.m., ligament, palpebræ median.; s.l., saccus lachrymalis; m.o.i., m. obliqus inferior.; f.conj.i., fornix conjunctivæ inferior.

In addition to the hair and sebaceous follicles found in dermal tissue everywhere, there are to be seen at the lid-margins the so-called glands of Moll, which are modified sweat-glands.

Underneath the conjunctiva, and imbedded in perpendicular grooves in the substance of the tarsus, are the acinous Meibomian glands, which are identical in structure with the sebaceous glands. Of these glands there are, in the upper lid, some thirty or forty, placed parallel to one another; in the lower lid there are about twenty-five. The longest glands are in the center of the upper lid; they become gradually shorter as they approach the ends of the tarsus. These tubules open on the intermarginal space, and secrete the fatty substance that lubricates the lid-margins. They are well developed in infants, hence the large amount of yellow secretion in their eyes. By everting the lids, particularly the lower, they

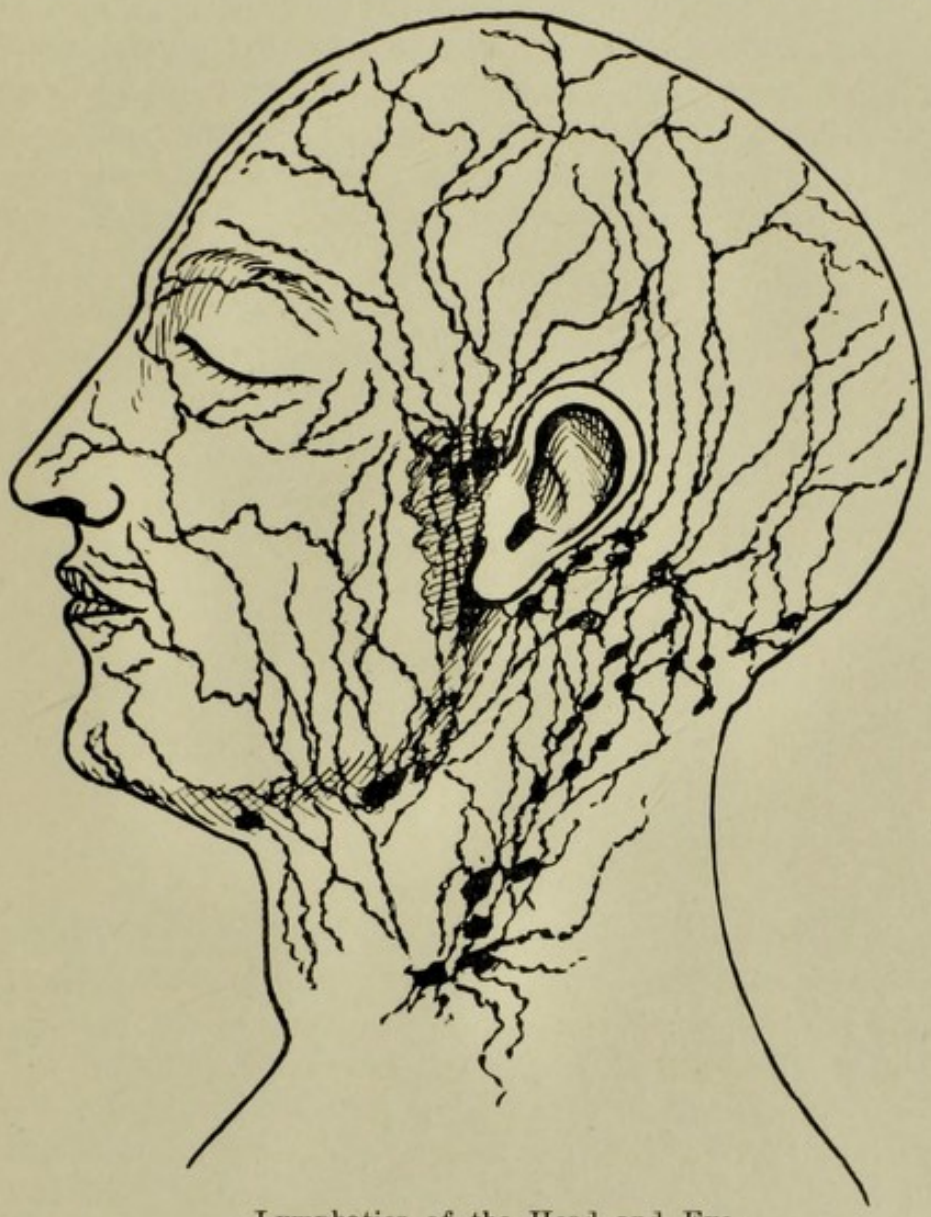


The Lachrymal Gland and its Relations.
a, superior portion of gland; b, inferior portion; d, lachrymal ducts; e, upper eyelid, skin partially removed; p, p, puncta; c, c, canaliculi; s, lachrymal sac; n, nasal duct.

can be seen through the conjunctiva as faint parallel streaks beginning at the lid-margin and running at right angles to it.

The *tarsus,* or tarsal cartilage (improperly so-called, since it exhibits no cartilage cells), is a thin, fibrous, connective-tissue plate; of these there are two: that in the upper lid is quite large, while that in the lower lid is considerably smaller. Two margins of the tarsal cartilage are designated, viz.: an upper, or convex, margin, and a lower, or free, margin; there are also two surfaces, an anterior and a posterior. These plates are highest at the center and taper off toward the ends. The tarsus gives form to the upper lid; and, when both lids are closed, forms a shield for the eyeball. They are attached to the frontal process of the superior maxilla by the tendo oculi, or ligamentum palpebræ mediale, and are united to the margins of the orbit by the tarso-orbital fascia. The levator palpebræ superioris is attached to this fascia and to the upper edge of the tarsal plate.

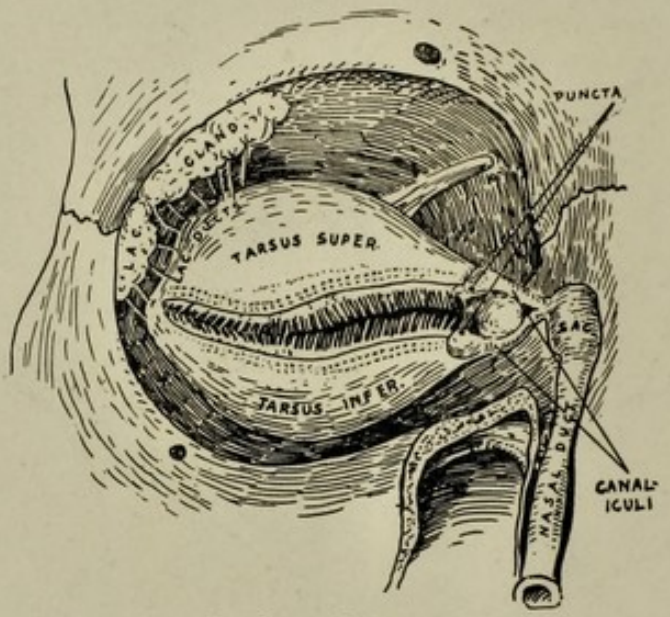
Opening on the conjunctival surface are the *glands of Waldeyer,* acino-tubular structures, secreting a modified mucus. A constant mucous secretion from the various conjunctival and other glands, moistens and lubricates the anterior ocular structures. The cornea, particularly, is kept clean and bright from this source, aided by the



Lymphatics of the Head and Eye.

approximation of the lid-edges in winking. This closing of the lids acts like a "window-scraper;" it gently removes all deleterious matter from the front of the eyeball, and pushes it toward the lachrymal puncta, through which it is drawn, by the action of that curious suction apparatus formed by Horner's muscle, into the lachrymal sac, and thence into the nose. The detritus entering the puncta is partly pressed and partly floated along the canaliculi until it reaches the lachrymal sac.

The **lachrymal apparatus** may be divided into a secretory and an excretory portion. The former includes not only the lachrymal glands, but the mucous glands of the conjunctiva. As a matter of fact, the moisture that commonly cleanses the ocular and conjunctival surfaces is contributed by the mucous follicles of the conjunctiva, while more copious supplies of tears are furnished by the lachrymal gland. The latter is of the salivary variety, of a reddish-gray color, and consists of an upper and lower lobe, incompletely separated from each other by the anterior tendinous expansion of the levator palpebræ superioris. The upper lobe is larger, and more compact than the lower; it is oval in shape, and measures about 20 to 25 mm.



Lachrymal Apparatus.

in length, and 12 to 14 mm. in thickness. The gland is situated in a depression beneath the external angular process of the frontal bone; its upper surface, which is convex, lies close to the periosteum of the orbit, to which it is attached by loose connective tissue; the under surface rests upon the eyeball at the superior fornix toward the external canthus. This gland secrets a slightly alkaline fluid containing much sodic chloride, which is "sprayed" onto the globe through a fan-shaped array of from seven to twelve ducts opening at the outer aspect of the superior fornix.

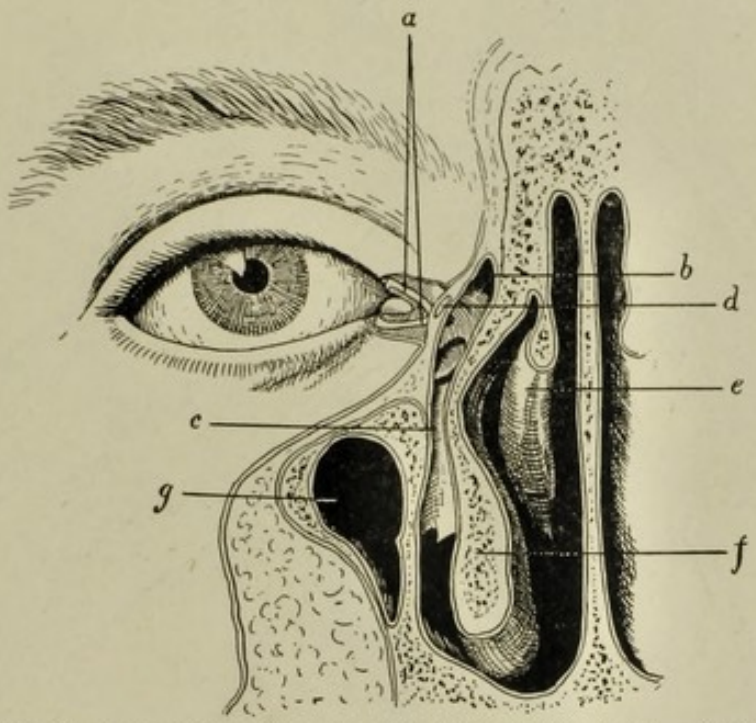
The blood supply of the lachrymal gland is from the lachrymal branch of the ophthalmic artery.

The sensory nerve supply to the lachrymal apparatus is from the lachrymal branch of the ophthalmic or first division of the fifth; the secretory function of the gland is regulated by the sympathetic.

The excretory portion of the lachrymal apparatus consists in the

canaliculi, the lachrymal sac, and the nasal duct which is continuous with the sac.

The *canaliculi* have their origin in minute whitish elevations—the *puncta lachrymalia*—which, as before mentioned, are situated on the lid-margins about 6 mm. from the angle of the inner canthus, or at the inner termination of the tarsal cartilages. The first millimeter of their course is in a vertical direction—upward in the upper lid, and downward in the lower lid; after this they turn at an acute angle and run 5 or 6 mm. in the direction of the nose. They either meet



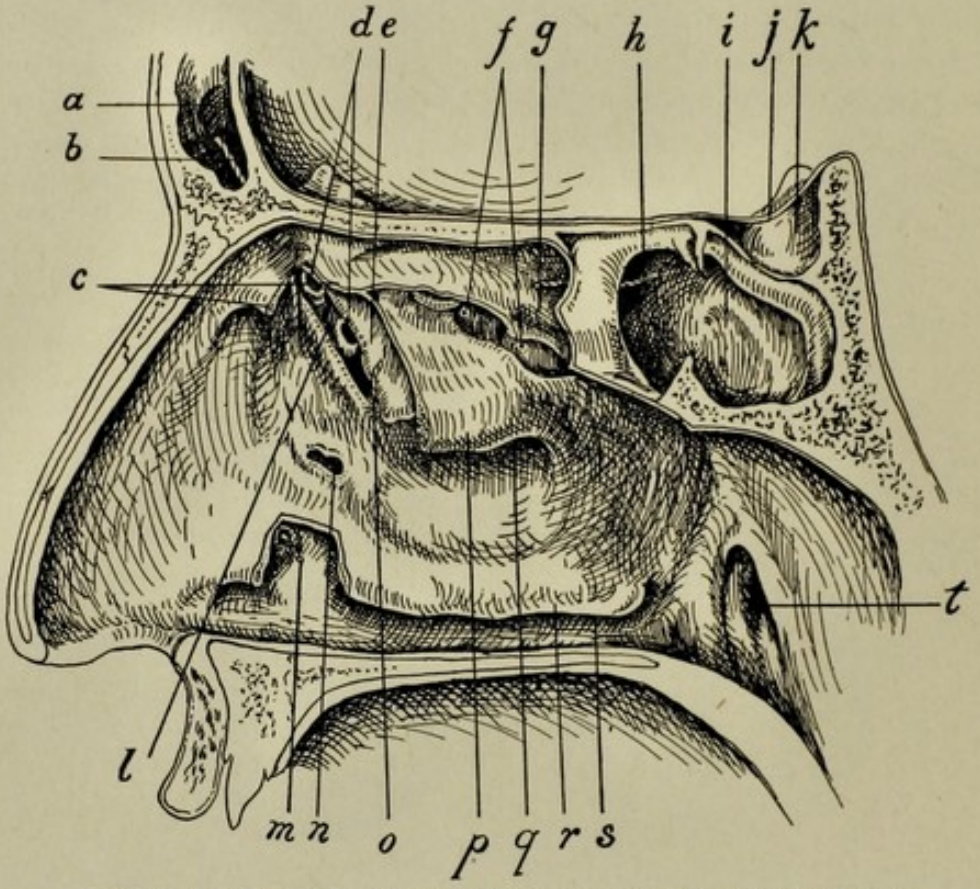
The Lachrymal Apparatus Showing the Nasal Relations. (After Quain.) a, The Upper and Lower Canaliculi; c, Naso-Lachrymal Duct; b, e, f, Turbinal Bones; g, Antrum of Highmore.

and form a common canal, or empty separately into the lachrymal sac; generally the former. They are lined by pavement epithelium.

The *lachrymal sac* is 12 mm. long and 6 mm. wide; it opens directly into the nasal duct. Its upper extremity, which has no outlet, lies behind and a little above the ligamentum palpebræ mediale, the entire sac completely filling a groove in the lachrymal bone in which it rests. The epithelium of its lining mucous membrane is of the cylindroid variety, and is continuous with that lining the nasal duct.

The *nasal duct* is directly continuous with the lachrymal sac. It is about 21 mm. long, and 4 to 6 mm. wide, but by no means uniform in its diameter. There is a slight constriction where it joins the sac, and a somewhat expanded orifice where it enters the nose; its narrowest portion being about the middle. Regurgitation from the nasal

cavity is prevented by a fold of mucous membrane—the *plica lachrymalis,* or valve of Hasner—situated at the opening of the duct into the inferior meatus just underneath the attachment of the anterior third of the inferior turbinate bone; also by irregular folds of mucous membrane forming imperfect valves along the course of the tube.



Orifices of Nasal Duct and Accessory Air Chambers of Nose.

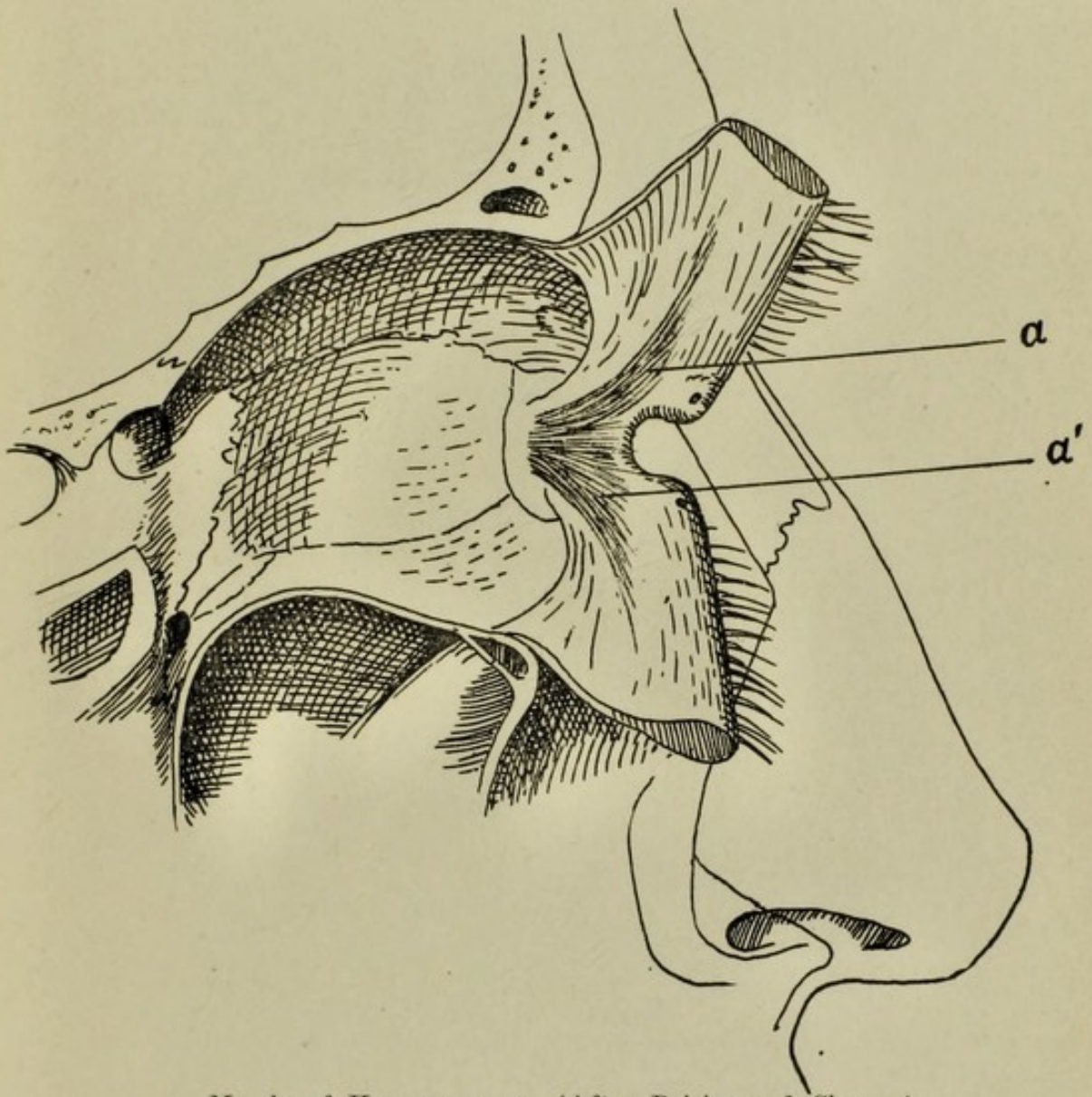
a, Frontal sinus; b, Twine in infundibulum; c, Middle turbinal (cut); d, Orifices of anterior ethmoidal cells; e, Bulla ethmoidalis; f, Orifices of posterior ethmoidal cells in superior meatus; g, Superior turbinal (cut); h, Twine in orifice of sphenoidal cell; i, Sphenoidal cell; j, Diaphragmia sellæ; k, Cavum sellæ; l, Hiatus semilunaris; m, Twine in nasal duct; n, Additional orifice of antrum of Highmore; p, Middle turbinal (cut); q, Middle meatus; r, Inferior turbinal; s, Inferior meatus; t, Orifice of Eustachian tube.

The epithelium is ciliated. The direction of the nasal duct is downward, outward, and backward; it is enclosed in a canal formed by the lachrymal, superior maxillary, and inferior turbinate bones.

The mucous membrane lining the sac and the nasal duct is attached to the surrounding periosteum by loose areolar tissue which supports a rich venous plexus.

As a congenital anomaly (q. v.) the puncta lachrymalia or the canaliculi may be double, or may be absent altogether.

The tears are drawn into the sac by suction, the motor power being supplied by the tensor tarsi, or Horner's muscle. This is a small, thin muscle about 6 lines in length, and 3 lines in width; it lies behind the ligamentum palpebræ mediale near the inner canthus.

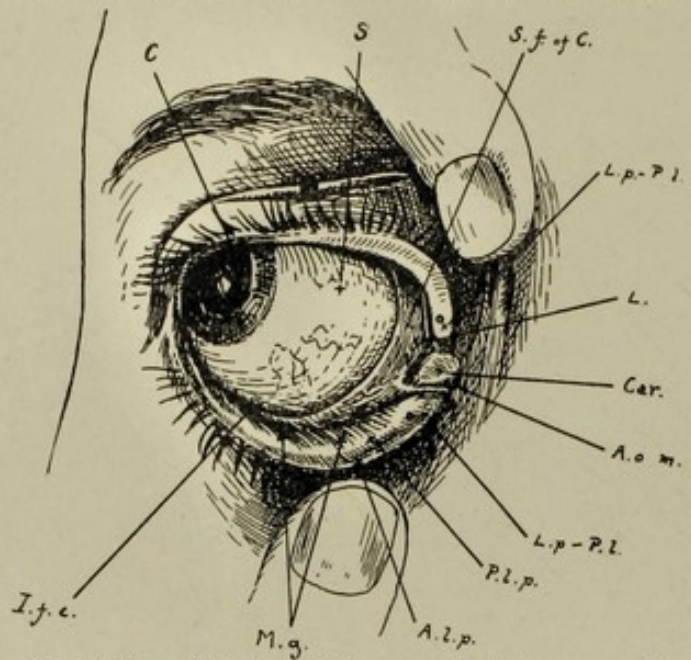


Muscle of Horner, a, a.[1] (After Poirier and Charpy.)

Spiral fibres of this muscle surround the canaliculi; they compress the tubules many times during the act of winking, thus sucking the secretion through the puncta, which are closely applied to the surface of the eyeball. In this way, corneal and conjunctival débris—epithelium, microbes, mucus, tears, dust, etc.,—is scraped off the whole globar surface and pushed toward the lachrymal outlet, the cleansing action of Horner's muscle being kept up as long as necessary. Tears and other fluids may to some extent collect in the lach-

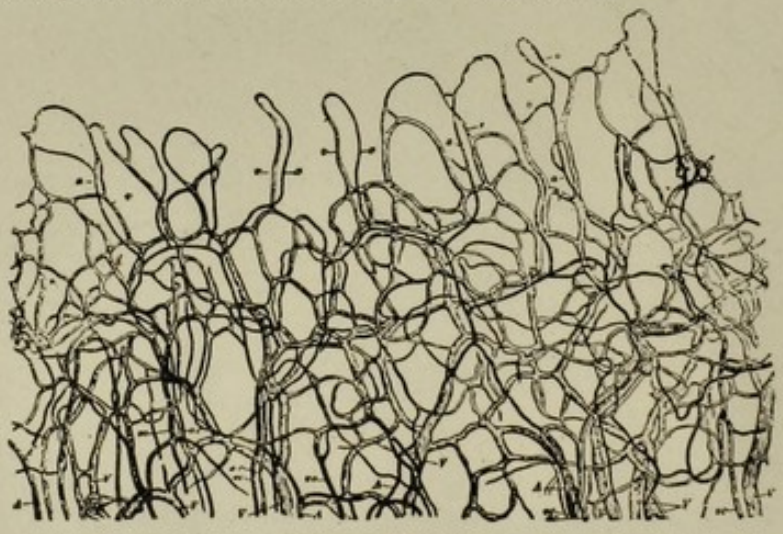
rymal sac before they percolate through the nasal duct into the inferior meatus.

The **conjunctiva**, a most important mucous membrane, joins, as



Right Eye (lids forcibly spread at inner canthus).

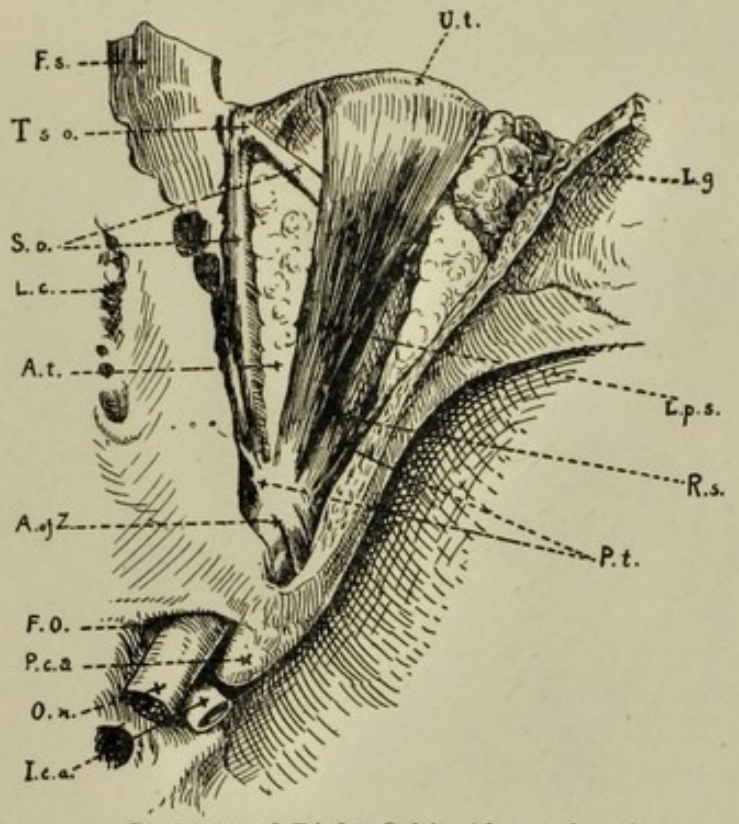
C, Cornea; s, Sclera with tunica conjunctiva bulbi; s. f. of c., Semi-lunar fold of conjunctiva; L. p.-P. l., Lachrymal papilla with punctum lacrimale; L, Lacus lacrimalis; Car., Caruncula lacrimalis; A. o. m., Angulus oculi medialis; P. l. p., Posterior limbus palpebralis; A. l. p., Anterior limbus palpebralis; M. g., Meibomian glands; I. f. c., Inferior fornix of conjunctiva.



Vascular Network of Superficial (visible) Conjunctival Branches of the Episcleral vessels; also of the deep anterior ciliary vessels invisible to the naked eye in normal states. (Leber.)

its name implies, as well as covers most of the parts in the front of the eye. It is a loose, lymphoid structure, continuous with the epidermis at the margin of the lid, and lining the inner surface of the lid, in which location it is known as the palpebral conjunctiva.

Upon leaving the lids it forms the superior and inferior palpebral folds, and is then reflected onto the eyeball, where it bears the name of ocular conjunctiva. This place of reflection is known as the fornix conjunctivæ, or sulcus, of which there are two, namely, a superior and an inferior. Upon the abundance and looseness of the membrane in this position, depends the free movement of the eyeball. When the eyelids are closed the free margins of this membrane come together and form the conjunctival sac.



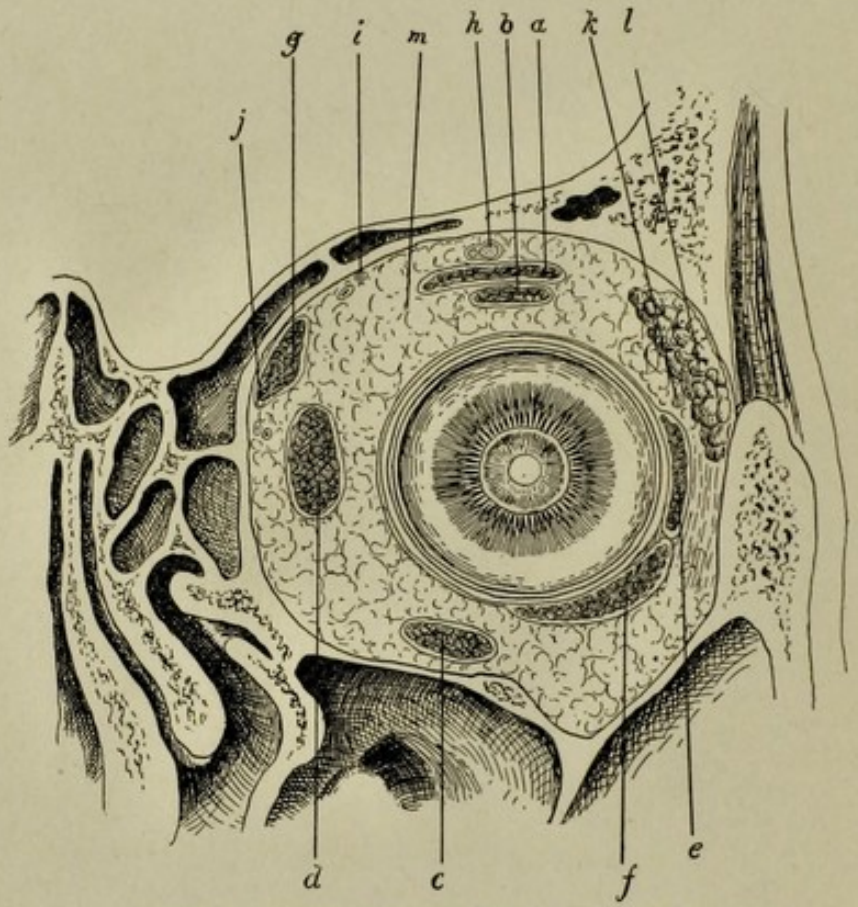
Contents of Right Orbit (from above).

U. t., Upper tarsus; L. g., Lachrymal gland; L. p. s., Levator palpebræ superioris; R. s., Rectus superior; P. t., Periorbital tissue; I. c. a., Internal carotid artery; O. n., Optic nerve; P. c. a., Processus clinoideus anterior; F. o., Foramen opticum; A. of Z., Annulus of Zinn; A. t., Adipose tissue; L. c., Lamina cribrosa; S. o., Superior oblique; T. s. o., Trochlea superior oblique; F. s., Frontal sinus.

The *palpebral conjunctiva* presents a smooth surface, and is intimately and immovably connected with the underlying tarsus. On the upper lid it receives its blood supply from two arterial loops, the *arcus tarseus superior* and the *arcus tarseus inferior*. The latter lies on the anterior surface of the superior tarsus, and sends branches through its entire thickness to the palpebral conjunctiva. The line where the vessels emerge from the tarsus is called the *sulcus subtarsalis*, and is recognized as a shallow groove on the surface of the conjunctiva about 2 to 3 mm. from the free lid-margin. The arcus tarseus superior lies somewhat above the convex margin of the supe-

rior tarsus upon the fascia tarso-orbitalis, through which structure branches pass to the conjunctiva. The under lid has but one arterial loop.

The *ocular conjunctiva* is paler and less vascular than that of the palpebræ. It covers the entire surface of the globe, including the cornea, and may be divided into two sections, viz.: the conjunctivæ scleræ and the conjunctivæ corneæ. The conjunctiva of the cornea



Coronal Section through Right Eye and Orbit.

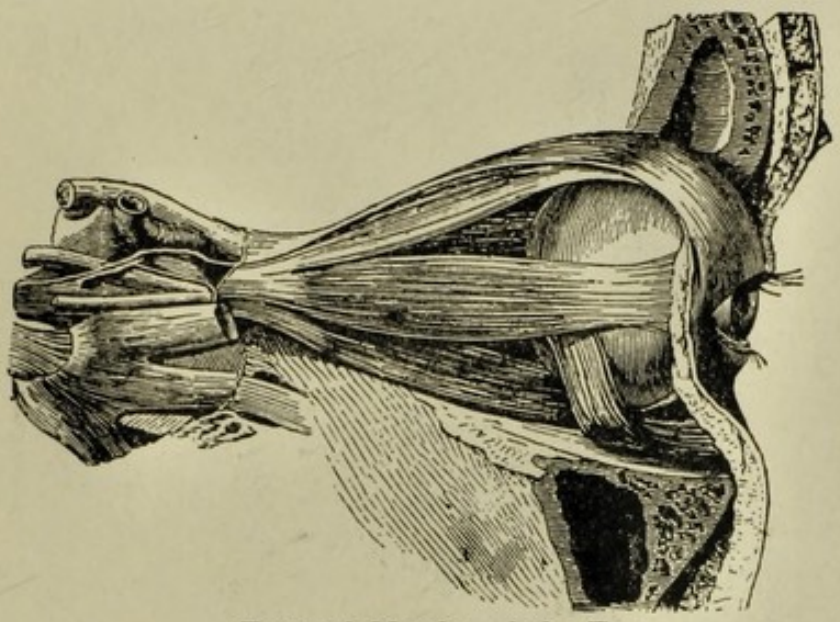
a. Levator palpebræ.
b. Superior rectus.
c. Inferior rectus.
d. Internal rectus.
e. External rectus.
f. Inferior oblique.
g. Superior oblique.
h. Supra-orbital nerve.
i. Supra-trochlear nerve.
j. Infra-trochlear nerve.
k. Lachrymal gland.
l. Temporal muscle.
m. Lachrymal nerve.

is extremely transparent, and so intimately a part of the cornea that it may properly be regarded as its outer layer. The conjunctiva covering the sclera is very thin, and so loosely attached to this structure by connective tissue fibres (the episcleral tissue) as to permit of free and independent movement of the eyeball.

The conjunctiva covering the sclera is always stretched during wide excursions of the eyeball. Near the sclero-corneal margin, or

limbus, the attachment is very secure; this point is taken advantage of by surgeons who seize the membrane here with catch forceps for the purpose of steadying the globe during operative procedures.

In adults, there may be seen at each side of the corneal margin in the line of the lid-fissure, a small, yellowish elevation of triangular form, with the base toward the cornea; this is called the *pinguecula,* and is present as a result of a fatty tissue-change in the conjunctiva



External Muscles of the Eye.

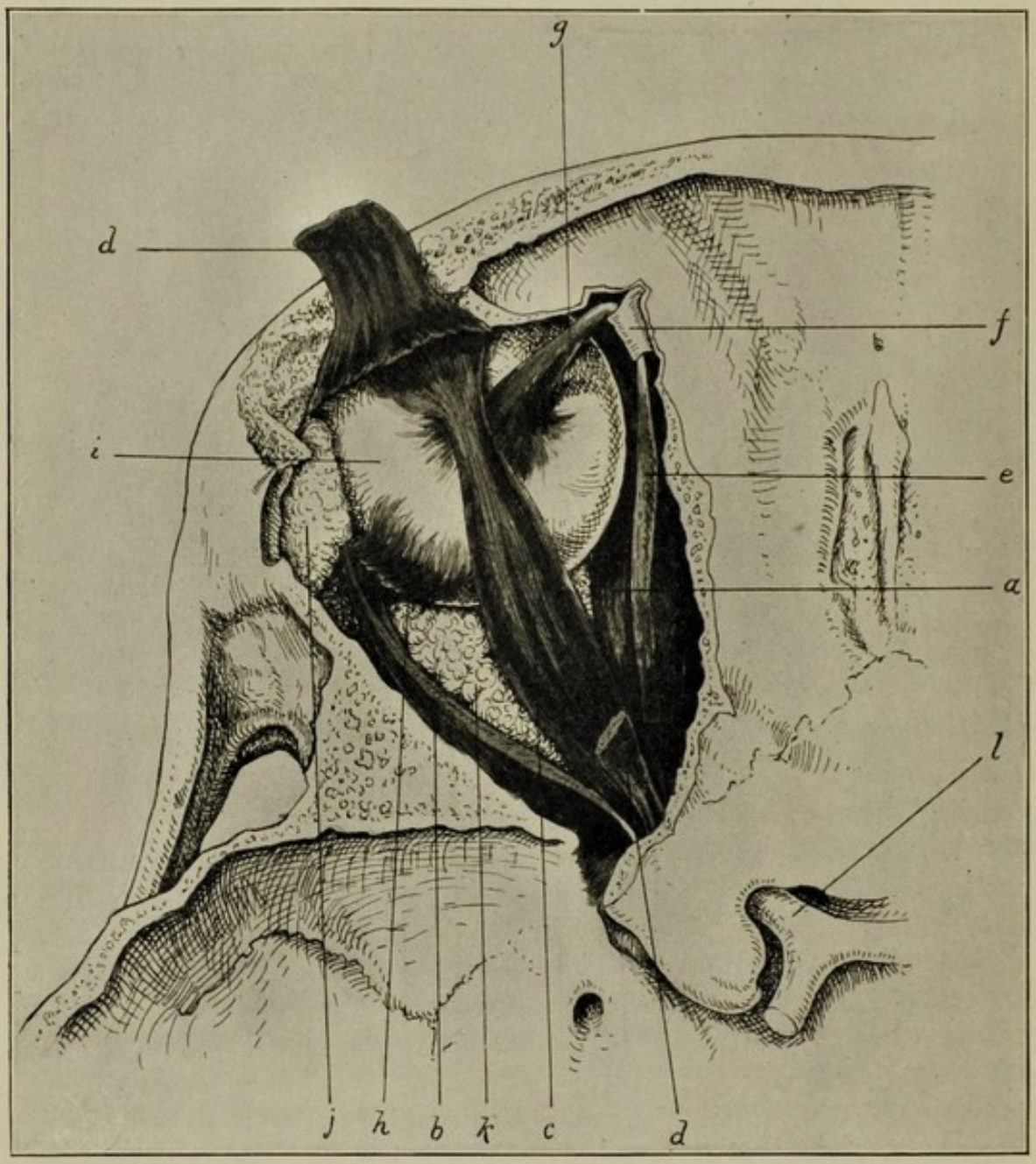
where it is exposed to the influence of the air, namely, in the zone of the lid-fissure.

The whole membrane is covered with pavement epithelium, which is continued over the cornea; it also lines the canaliculi as far as the lachrymal sac.

At the inner canthus between the caruncle and the eyeball, is a delicate fold, or reduplication, of the conjunctiva, called the *plica semilunaris conjunctivæ;* it is analagous to the nictitating membrane (q. v.) found in birds.

The blood supply of the ocular conjunctiva is derived chiefly from the posterior conjunctival branches of the vascular arches of the lids, by way of the fornices; also from the anterior ciliary vessels, which come out of the four straight eye-muscles. These latter course underneath the conjunctiva up to near the limbus, where they suddenly disappear and pass through the sclera into the interior of the eyeball; before doing this, however, they give off anterior conjunctival branches which anastomose with the posterior conjunctival vessels to form a network of vascular loops close up to the margin of the

cornea. From this network the cornea derives the major portion of its nourishment. Other branches of the anterior ciliary vessels run backward to anastomose with those of the fornices.



Muscles of Orbit as Viewed from Above and Behind.

a. Internal rectus muscle.
b. External rectus muscle.
c. Superior rectus muscle.
d. Elevator of the upper lid (severed).
e. Superior oblique muscle.
f. Pulley of superior oblique.
g. Superior oblique tendon.
h. Inferior oblique muscle (insertion).
i. Eyeball.
j. Lachrymal gland.
k. Orbital fat.
l. Optic nerve.

The vessels run loosely in the conjunctival tissue, so that it is always possible to differentiate them from the deeper vessels by

virtue of the fact that they can easily be moved to and fro with the membrane itself.

The veins of the conjunctiva, both palpebral and ocular, pursue very nearly the same course as the accompanying arteries, and are tributary to the ophthalmic vein.

Branches of the ophthalmic division of the fifth cerebral nerve furnish the sensory supply to the conjunctiva, these nerve-endings terminating in rich plexuses.

The **extra-ocular,** or **orbital muscles** (q. v.)—also called the extrinsic, or external eye-muscles—are seven in number, as follows:

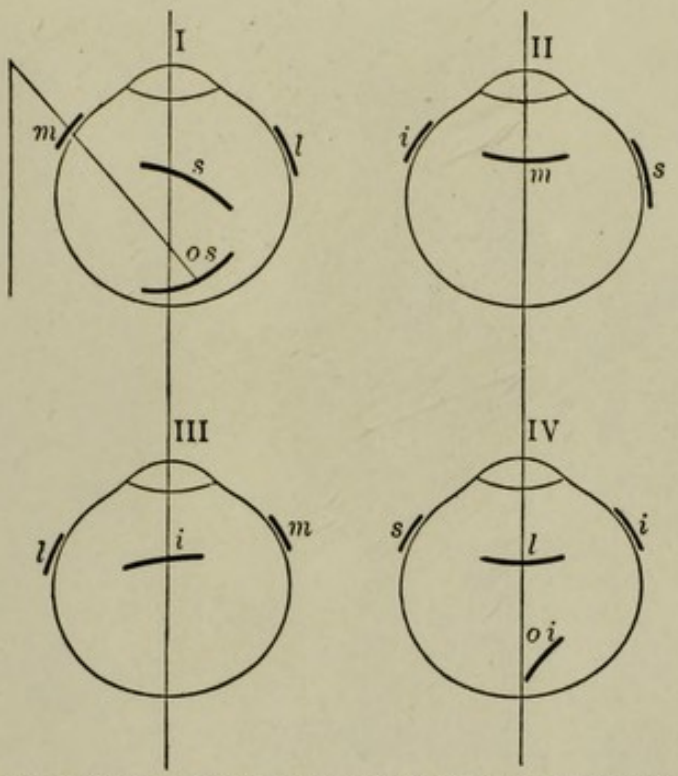
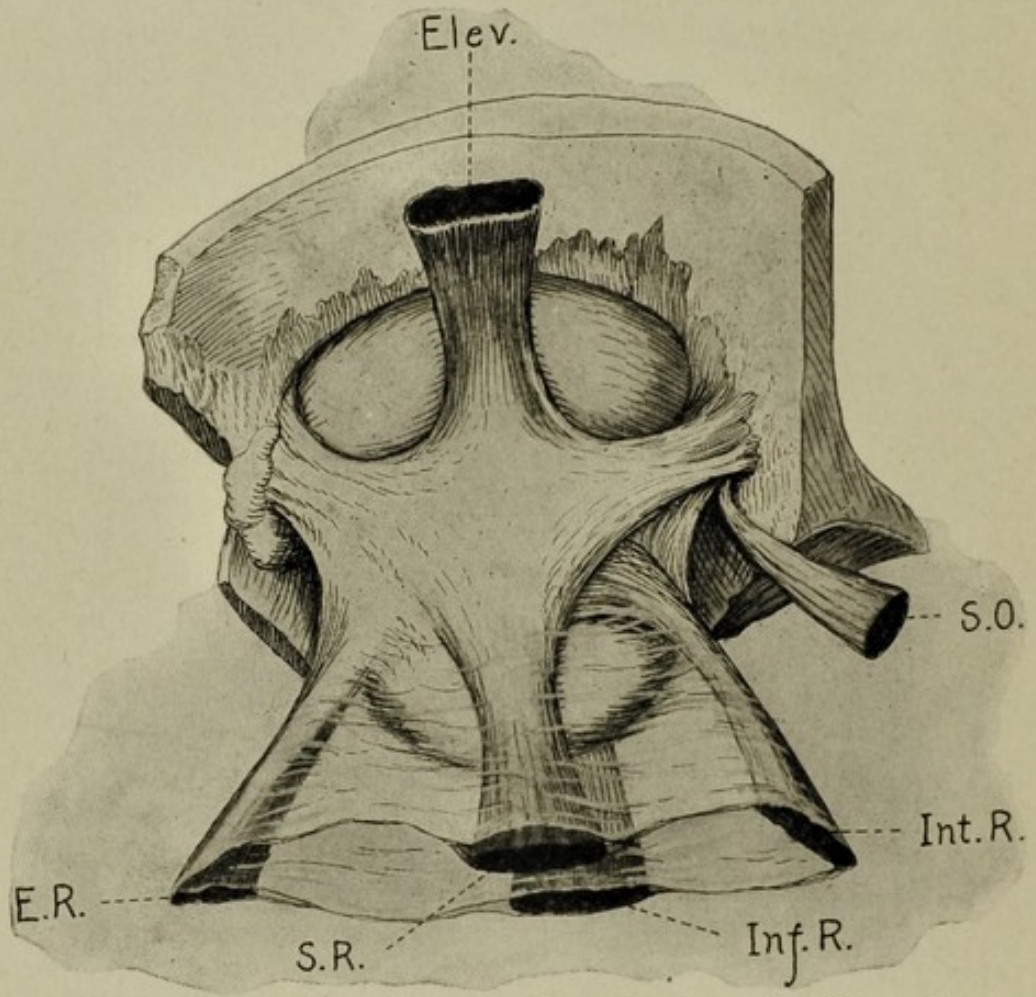


Diagram Showing Relative Attachment of the Extrinsic Muscles to the Eyeball.

levator palpebræ superioris, rectus superioris, rectus internus, rectus externus, rectus inferioris, superior oblique, inferior oblique.

With one exception all of these muscles arise from, or near, a funnel-shaped, tendinous ring (annulus tendineus communis), which surrounds the sphenoidal fissure and the optic foramen. The exception is the inferior oblique, which has its origin from the orbital plate of the superior maxilla. The *inferior rectus* is attached to the lower part of this ring; the *external rectus,* strengthened by an additional head, is attached to the outer side; while from the inner side, and above, arise the *internal* and *superior recti,* the *superior oblique,* and the *levator palpebræ superioris.* The levator, superior rectus and superior oblique are attached close together, as shown in the diagram.

The *levator palpebræ superioris* is a long, thin, flat, triangular muscle, which lies, for the most part, immediately underneath the upper wall of the orbit, above the superior rectus, and so close as to make them appear almost as one muscle. The superior rectus separates from the levator at the equator of the eyeball into which it becomes inserted, while the levator continues on forward, bends down in the form of a bow, expands and divides into two layers; the stronger, or



Relations of the Extrinsic Ocular Muscles to the Connective Tissue Structures of the Orbit as Viewed from Above and Behind (after Motais). Note the lateral expansion of the tendons and the delicate membranous connections of the muscle sheaths. Elev. Elevator of upper lid. E. R. External rectus. S. R. Superior rectus. Inf. R. Inferior rectus. Int. R. Internal rectus. S. O. Superior oblique.

posterior layer is attached to the anterior surface of the superior tarsus at its upper margin; the anterior layer passes in front of the tarsus to the posterior surface of the orbicularis, through which a few bundles are sent to the skin of the lids; it is also attached laterally to the walls of the orbit. This expansion of the levator is intimately attached to, and forms a part of, the tarso-orbital fascia. The action of the levator is to elevate the upper lid.

Lying on the under surface of the expansion of the levator, and attached to the upper margin of the tarsus, is a group of involuntary fibres under the control of the sympathetic, to which is applied the name musculus tarsalis superioris, or muscle of Mueller. The function of this muscle is to keep the lid skin and the palpebral conjunctiva smooth when the upper lid is raised. An analagous bundle, called the musculus tarsalis inferioris, is to be found in the lower lid on the under surface of the inferior rectus muscle, and likewise attached to the tarsus.

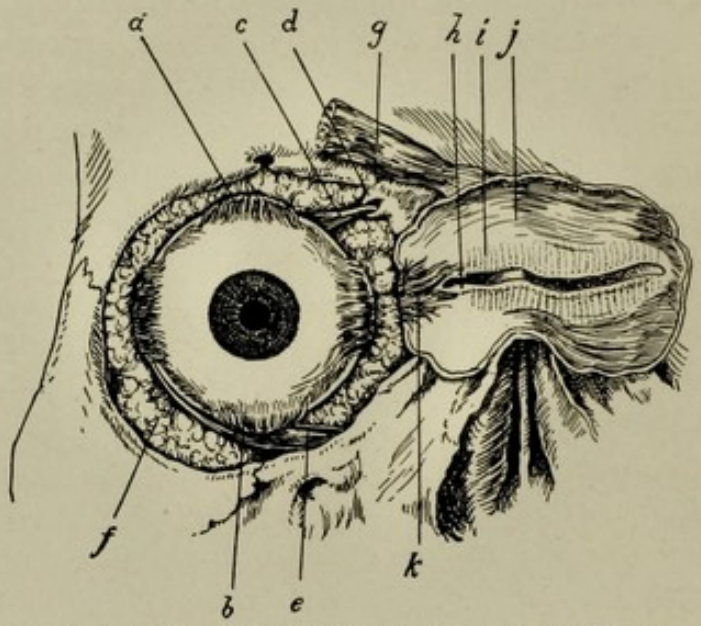
The four straight muscles are long and flat, narrow at their origin, and growing broader toward their insertion into the sclera. They diverge as they pass forward, forming an irregular, cone-shaped space the base of which is formed by the eyeball; the apex is at the optic foramen, and in it lie the optic nerve and the ophthalmic vessels. These muscles are attached to the eyeball in front of the equator. Their attachment, as is the case with all of the extrinsic muscles, is by thin, broad, tendinous expansions, which enter into and form a part of the scleral tissue. They differ from one another in shape and size. The superior rectus is the longest and thinnest; the internal rectus somewhat shorter; the external rectus still shorter; the inferior rectus the shortest of the four.

The *superior rectus* arises from the tendinous ring at the optic foramen. On its way to its attachment to the sclera it passes forward, and also somewhat outward. Its direction does not, therefore, correspond exactly with the saggital axis of the eyeball, but forms with it an angle of about 25 degrees opening backward and toward the nasal side. It is attached to the sclera 7.7 mm. from the corneal margin, the width of the tendon at its line of insertion being 10.8 mm. From its origin to its attachment to the eyeball, it lies immediately under the levator palpebræ superioris. This muscle draws the anterior pole of the eye upward and toward the median line; it also inclines the upper pole toward the median line. As will be seen in the illustration the tendon of the superior rectus, and of some of the other muscles as well, is not attached parallel to the corneal margin. Most of the attachment of the superior rectus is to the outer half of the globe with its inner edge in advance of the outer.

The *internal rectus* is the heaviest (0.747 grammes), and strongest of the extra-ocular muscles, and has the longest tendon. The width of the tendon at its line of insertion is 10.3 mm. As its attachment is nearest the corneal limbus (5.5 mm.), it has a greater "pull" upon the eyeball, and greater power of rotation. This is as it should be, since the inner rotation of the globe is the most important and the

most frequent one, and calls for the greatest expenditure of muscular energy, the larger portion of which is supplied by this the chief of the adductor muscles. The other adductors are the nasal fibres of the superior and inferior rectus, and, perhaps, the superior oblique.

The *external rectus* is the other extreme, it being the weakest of the straight muscles, although one of the most important of the orbital muscles. It has an average weight of 0.514 grammes. The tendon is 5.8 mm. long, and at its line of insertion has a width of 9.2 mm. It arises by two distinct heads from the margin of the optic foramen, and passes forward and outward to be inserted into the



Tensor Tarsi and Corrugator Supercilii Muscles.

a, Superior rectus muscle; b, Inferior rectus muscle; c, Tendon of superior oblique muscle; d, Pulley; e, Inferior oblique muscle; f, Orbital fat; g, Corrugator supercilii muscle; h, Puncta lachrymalia; i, Meibomian glands; j, Conjunctiva; k, Tensor tarsi muscle.

sclera 6.9 mm. from the margin of the cornea. It is the principal abductor muscle, its action being to turn the anterior pole laterally. The other abductors are the temporal fibres of the superior and inferior rectus, and, perhaps, the inferior oblique.

The *inferior rectus* arises from the common tendon at the optic foramen, and passes forward and downward in such a manner as to form an angle of about 25 degrees with the direct visual line. It is attached to the sclera 6.6 mm. from the margin of the cornea by a tendon 9.8 mm. broad at its line of insertion. Forward in the orbit it is separated from the lower orbital wall by the inferior oblique muscle. Its action is to turn the anterior pole downward and toward the median line, and to incline the upper pole laterally.

Processes from the orbital fascia, called *check-ligaments,* are inserted into the sclera near the tendons of the straight muscles—especially near the insertion of the rectus internus and externus. They serve the useful purpose of preventing the overaction of the orbital muscles; they also prevent the eyeball from protruding from the orbit following tenotomy of the recti.

The *inferior oblique* is the shortest of all the extra-ocular muscles. It arises from the orbital plate of the superior maxilla, close to the beginning of the naso-lachrymal duct, and passes laterally, upward, and backward, crossing underneath the tendon of the inferior rectus. It is inserted into the sclera back of the equator mostly below the horizontal meridian. It forms an angle of about 50 degrees with the straight visual line. The tendon, which is the shortest of all the eye muscle tendons, is about 10 mm. wide at its line of attachment. By the action of this muscle, the anterior pole is turned upward and outward, and the upper pole is inclined outward.

The *superior oblique,* which is the longest and thinnest of the eye-muscles, arises from the common tendon at the orbital apex, and passes forward close to the wall of the orbit along its upper and inner aspect. The belly of the muscle is round. At the internal angular process it loses most of its muscular fibres and becomes tendinous; while still retaining its rotundity, it passes through a pulley, and, taking an angle of about 50 degrees to its former direction, turns backward, outward, and downward to its insertion into the sclera back of the equator, on the upper half of the eyeball. At its point of attachment the tendon is about 10 mm. broad. Before becoming attached to the sclera it passes underneath the superior rectus. Its action is to turn the anterior pole outward, and laterally, and to incline the upper pole toward the median line. This muscle is often called the trochlearis, from the trochlea, that remarkable, curved pulley of hyaline cartilage, through which its reflected tendon passes.

The fourth cerebral nerve (*trochlearis*) supplies the superior oblique; the sixth cerebral nerve (*abducens*) the external rectus; the other ocular muscles, including the levator palpebræ superioris, the sphincter pupillæ, and the ciliary muscle, are innervated by the oculomotorius, or third cerebral nerve.*

The *center about which the eyeball rotates* is situated in the line of its visual axis, about 14 mm. behind the cornea. Six muscles turn (not

*A useful mnemonic that will assist in remembering these innervations is the radical SO_4, meaning the superior oblique is innervated by the fourth nerve. Then all one has really to recollect is that the 6th nerve supplies the external rectus, and the 3rd nerve the remainder of the orbital muscles.

draw) it in every possible direction, as well as give it a sort of wheel motion on its axis. If it were possible for these muscles to operate separately we might regard the external rectus as rotating the globe directly outwards, the internal rectus as turning it directly inwards, the superior rectus as rotating it directly upwards, the inferior rectus as turning it directly downwards, while more complicated movements in various directions would be effected by the combined action of these muscles with the superior and inferior oblique. As a matter of fact, no movement of either eyeball—to say nothing of their combined movements—is effected by less than two or three muscles; probably every rotation is attended by the contraction or relaxation of all of them.

When the eyelids are closed in sleep, or during narcosis, the globe rotates upward and slightly inward.

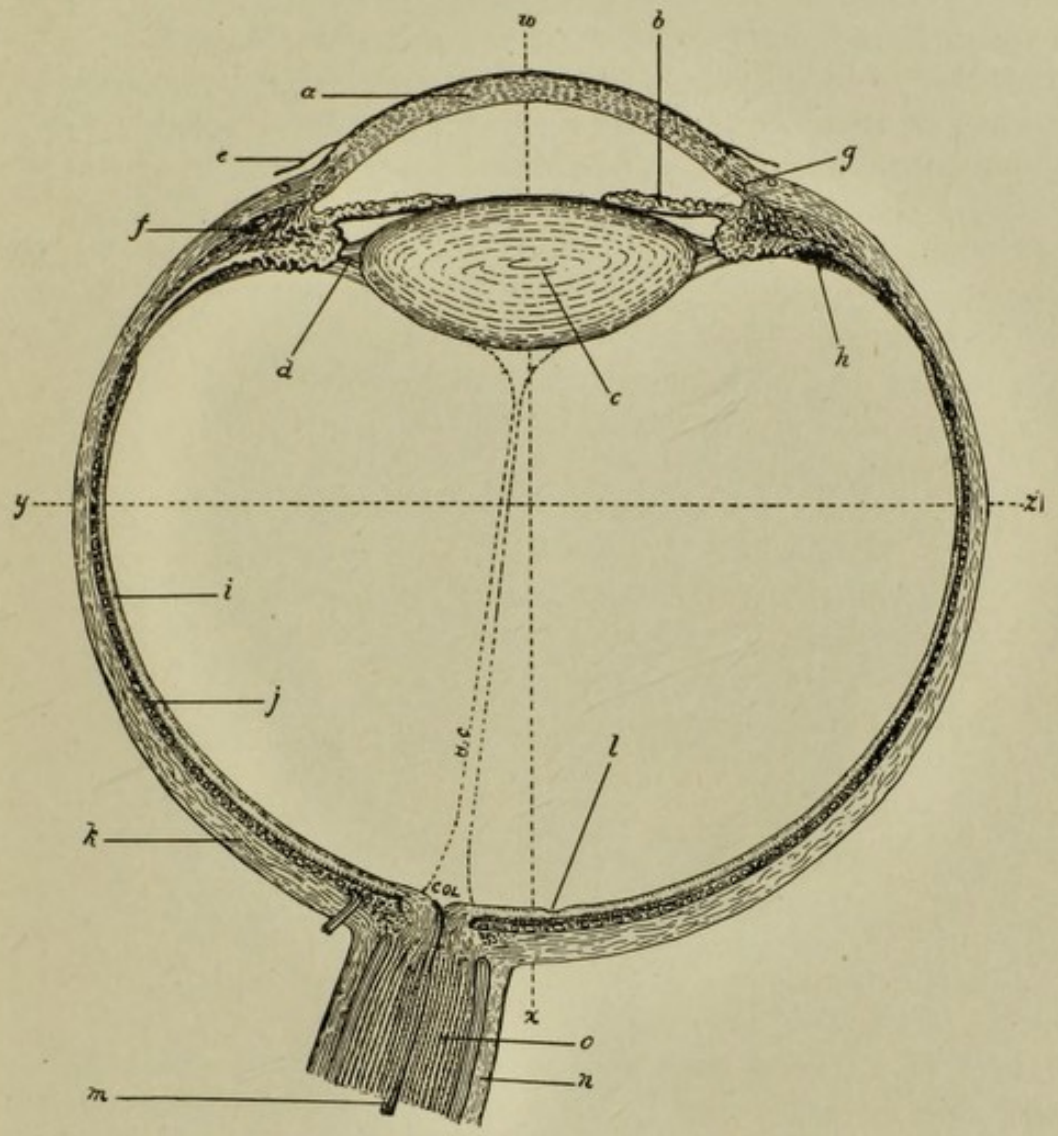
The **eyeball** at birth is small and nearly round, although it varies considerably in size as well as in form. The average antero-posterior diameter is 17.3 mm. The period of most rapid growth, involving chiefly the anterior segment, is during the first years of life; this is followed by a period of slower growth, although the eyeball steadily increases in size up to the age of puberty. From the 14th to the 20th year there is still another period of rapid growth, which involves the posterior segment. The cornea reaches its maximum measurement at the third year, although even during the first year of life the average diameter is not much less than that in the adult eye.

The apparent size of the eyeball depends more upon the width of the space between the lids than upon the length of its diameters. The prominence of the globe varies with the amount of orbital fat, but may be affected by disease.

The adult eyeball is a more or less spheroidal body, measuring about one inch (24 mm.) in its antero-posterior, or long diameter. In women all of its dimensions are about 0.5 mm. smaller than in men. The posterior one-half of the eyeball is, in general, of more uniform curvature than the anterior one-half. Three coats, or tunics, are designated, viz.: an external, a middle, and an internal coat.

The external tunic, or tunica fibrosa, is composed mainly of dense, unyielding connective-tissue. It gives shape to the globe, protects the delicate inner structures, and resists intra-ocular pressure. About one-sixth of this coat is transparent, and is called the cornea; the remaining five-sixths, opaque and dull-white, are known as the sclera, or "white of the eye." With the exception of a round hole, the foramen opticum scleræ, near the posterior pole of the eyeball, incompletely closed by a sieve-like, perforated plate (the lamina cribrosa),

this capsule is closed on all sides—disregarding, of course, the minute perforations for the transmission of vessels and nerves to the middle

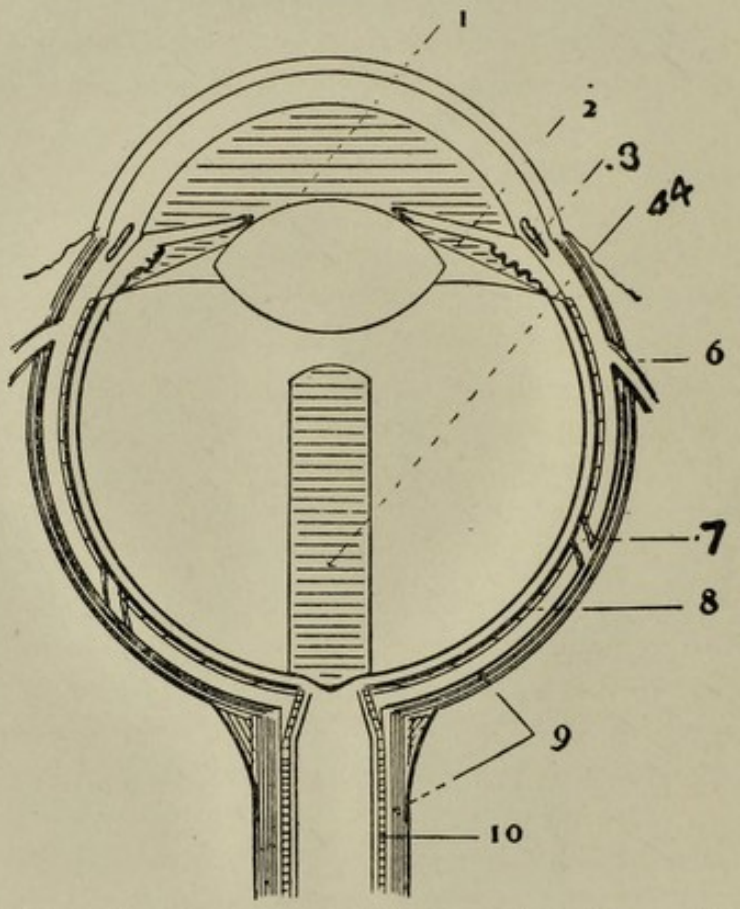


Section of the Eyeball to Show the Crystalline Lens System and Its Bulbar Relations. (After Quain).

a. Cornea.
b. Iris.
c. Lens.
d. Zonula of Zinn.
f. Ciliary body.
g. Canal of Schlemm.
h. Retina.
j. Choroid.
k. Sclera.
H, C. Hyaloid canal.
l. Macula.
o. Optic nerve.
w. Anterior capsule.

coat. Some authors, notably Thomson, of Oxford, refer to the cornea as an entirely separate structure imbedded in an anterior aperture of the sclera (foramen scleræ anterius).

The middle coat of the eyeball, or the tunica vasculosa, carries the vascular, nervous, and nutritive supply to the bulbar contents; it contains the muscle of accommodation, and is well furnished with pigment that lines the dark chamber of the globe and prevents reflections within it. In front, it forms a delicate curtain—the iris—pierced by an aperture—the pupil; posteriorly this membrane is known as the choroid. The tunica vasculosa, although lying close up against the sclera, is not actually connected with it, except at two



The Chambers, Lymph Spaces and Humors of the Eye. (Fuchs, Ball.)
1, anterior chamber, and 2, posterior chambers filled with aqueous humor; 3, canal of Schlemm; 4, (hyaloid), canal of Cloquet; 6, Tenon's capsule about an ocular tendon; 7, lymph space around a vena vorticosa; 8, perichoroidal space; 9, supravaginal space; 10, intervaginal space.

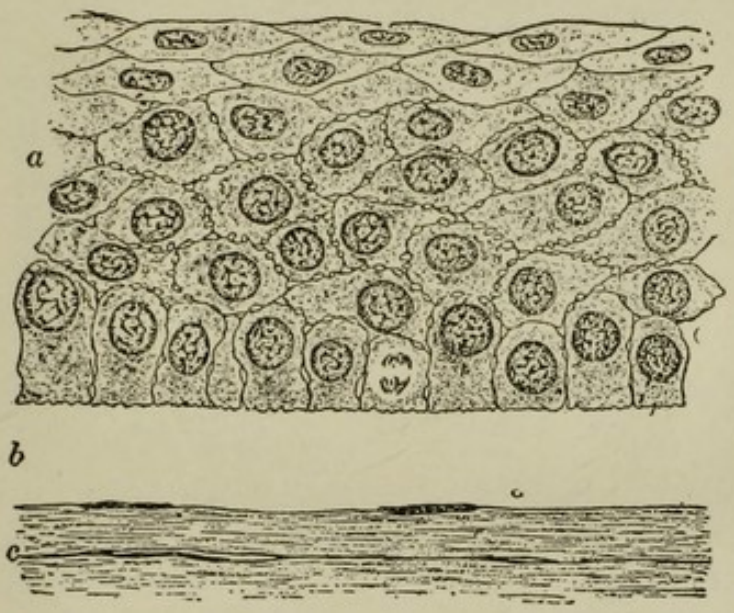
places, i. e., at the opening of the optic nerve (posterior insertion ring), and at the corneo-scleral margin (anterior insertion ring). The capillary space extending between the two rings is called the perichoroidal space. A few blood vessels and nerves cross it, and it is bridged by extremely delicate tissue lamellæ.

The inner coat is composed entirely of nerve tissue, and is called the retina.

The larger spaces, or chambers, within the eyeball are filled with

fluid. That lying immediately behind the cornea is known as the *aqueous chamber,* and contains the aqueous humor. In fetal life a delicate membrane covers the pupil, completely subdividing the aqueous space into an anterior and posterior chamber; after birth the pupillary membrane disappears, and the two spaces communicate through the pupil. The large space back of the lens is filled with a gelatinous fluid called the vitreous humor.

The *anterior chamber* is bounded in front by the inner, concave surface of the cornea; behind by the anterior surface of the iris and that portion of the crystalline lens exposed in the pupillary area. Although it varies in depth in different individuals, and under vari-



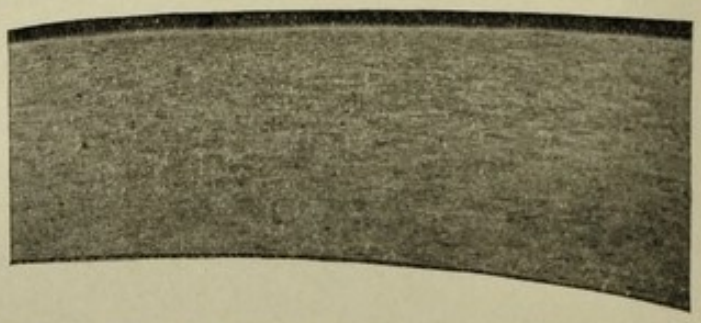
Section of the Anterior Layers of the Cornea.

ous conditions, normal and abnormal, its average depth is about 2.2 mm., measured from the posterior surface of the center of the cornea. It is shallower in youth than in old age; shallower in hyperopic than in myopic eyes; and is subject to a certain amount of variation in depth through changes in the volume of the lens. At the extreme periphery of the aqueous chamber is the so-called filtration angle, or angle of the iris, an area of great importance, which will be considered in connection with the sclera.

The *posterior aqueous chamber,* as described by Salzmann, is a more extensive and complicated space than that of the older anatomists, who applied this name to the space limited by the posterior surface of the iris, anterior extremities of the ciliary processes, anterior fibres of the zonule of Zinn, and the anterior surface of the lens corresponding to the undilated pupil. According to Salzmann, the pos-

terior boundary of the chamber is formed by the anterior border-layer of the vitreous up to the ligamentum hyaloideo-capsulare, and from there on by the circumference and anterior surface of the lens; the anterior border is formed by the pigment epithelium of the iris and the ciliary epithelium; toward the median line the space communicates with the anterior chamber; posteriorly (or peripherally) it terminates in a narrow cleft-formed space between the orbiculus ciliaris and the corresponding anterior border-layer of the vitreous. The posterior chamber, therefore, according to these boundaries, contains the ciliary processes and the zonule of Zinn.

There are four subdivisons, according to the new nomenclature, namely, the orbicular space of Salzmann, or most posterior portion,



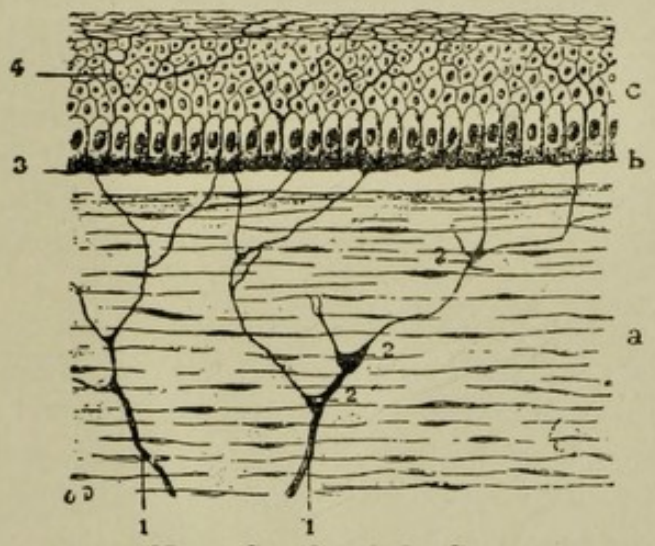
Normal Cornea, Magnified Thirty-six Times. Note the Increased Thickness towards the Limbus (Verhœff).

which is almost wholly filled with zonular fibres; the space lying between the ciliary bodies, or system of ciliary valleys; the circumlental space, lying between the anterior extremities of the ciliary bodies and the equator of the lens; and the posterior chamber proper (pre-zonular space of Czermak). This latter space is bounded in front by the posterior surface of the iris; behind by the anterior surface of the lens underneath the iris, and the anterior layer of the zonule of Zinn; laterally by the anterior extremities of the ciliary processes.

The more interesting part of the external fibrous coat of the eyeball is the glass-like **cornea,** which, in the adult, makes up about one-sixth of the whole tunic. At birth it constitutes about one-fifth of the circumference of the globe. Viewed from the side, it is easy to demonstrate the fact that it forms a segment of a smaller circle superimposed upon the surface of a larger one. The radius of curvature for the central one-third of the anterior surface is 7.8 mm.

The normal cornea is not absolutely circular, being 12 mm. in its horizontal, and 11 mm. in its vertical, diameter. It weighs 180 mgr. It is thin in the center (0.8 mm.) and comparatively thick (1.10 mm.)

at its junction (limbus corneæ) with the sclera (margin of the foramen scleræ anterius). In the latter situation, the white sclerotic coat overlaps the transparent cornea; the inner, concave surface of the latter is greater than the outer convex surface, producing a bevelled effect. In other words, the cornea extends, to a slight degree, beneath the sclera, being partially hidden by the opaque, white, tissue with which it is intimately blended. It is attached to its scleral border much as a watch-glass is set into its case. In the newborn, this does not hold true, for here the corneal margin seems to occupy a groove in the scleral substance.



Nerve Supply of the Cornea.

The stroma of the cornea and Descemet's membrane become continuous with the iris at its angle, by means of the meshwork of the iris angle, which will receive separate consideration.

The cornea attains its full growth early in life, and, unless the eye be attacked by some intrauterine or infantile disease that stretches the eye-coats, such as buphthalmus (congenital glaucoma), its diameters are not much affected by subsequent diseases. This is why the stretching of the tunic in axial myopia, and in the various forms of adult glaucoma, acts chiefly on the posterior segment of the eyeball.

The narrow, yellowish-gray, crescentic ring, sometimes seen at the upper part of the cornea, is known as the arcus senilis (gerontoxon). It may extend completely around the corneal margin; or there may even be two rings, one inside of the other, on the otherwise transparent surface. It is generally a sign of senility, but may occur at all ages, and without other evidence of vascular degeneration. It is a hyaline and not a fatty metamorphosis of the corneal fibres.

The composition of the cornea and sclera is very similar; it is chiefly the arrangement of the fibres that makes the one transparent and the other opaque. The substantia propria of both is made up of closely-woven bundles of connective tissue fibres arranged in layers.

The cornea is made up of five layers, or laminæ, viz.: the anterior epithelial layer; Bowman's membrane; the substantia propria; Descemet's membrane; and an endothelial layer.

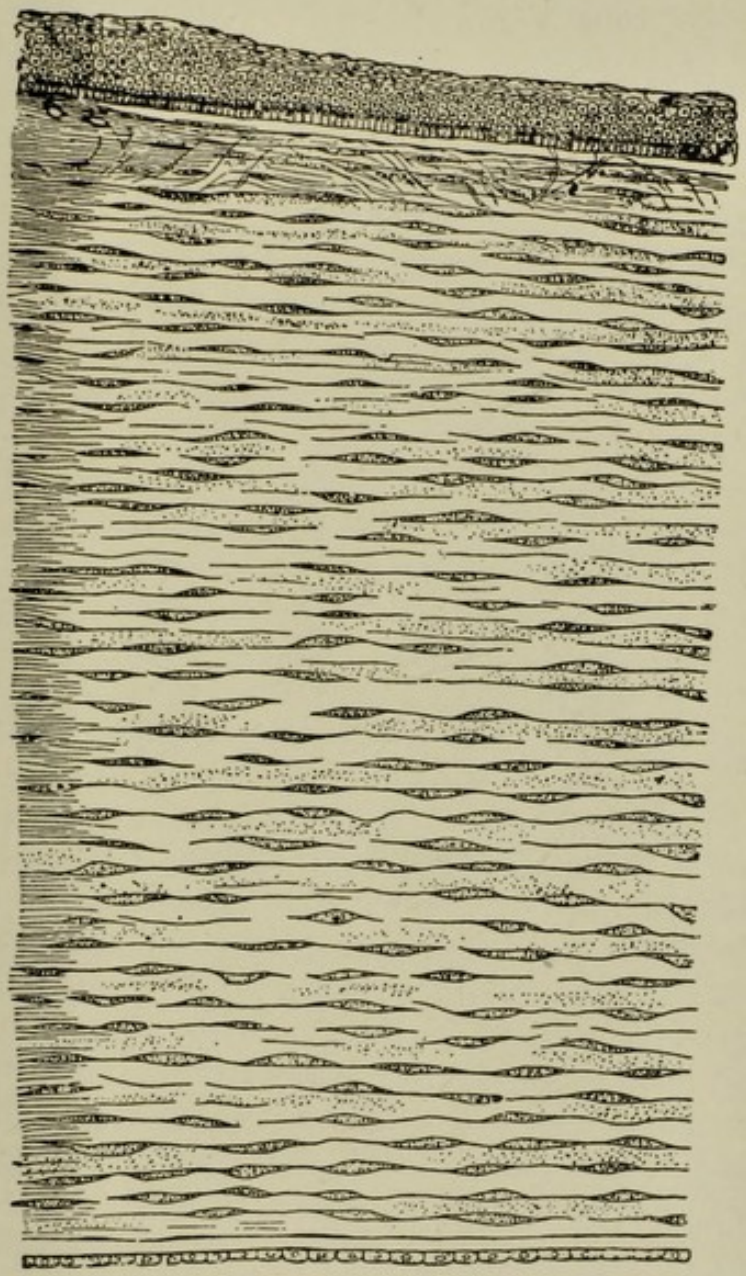
The anterior lamina consists of from five to ten layers of epithelium, continuous, and almost identical with the epithelium of the conjunctiva covering the globe. This is the only layer of the cornea which is regenerated after having been destroyed. The cells lying next to Bowman's membrane are cylindrical in shape, becoming more and more flattened as they approach the external surface, where they are seen as stratified pavement epithelial cells. The arrangement of this epithelium is the most regular of any in the human body, and necessarily so, in view of the function of the cornea as a part of the optic system.

Bowman's membrane (*lamina elastica anterior*), the anterior limiting layer, is of homogeneous structure, without cell-nuclei or fibrillation; its thickness is almost uniform throughout. It does not extend clear to the margin of the true cornea, but ceases, in most eyes, about 1 mm. from it. It is intimately connected with the corneal stroma, from which it cannot be detached. Numerous minute openings, or "pores," for the transmission of the corneal nerves—the rami perforantes—are occasionally to be found.

The true corneal substance (*substantia propria*) consists of a lacework of intersecting connective-tissue fibres, containing corneal cells within lymph spaces (lacunæ). This layer constitutes the great mass of the cornea, comprising about 90 per cent. of its entire thickness. At the sclero-corneal margin, it becomes greatly thickened near the posterior surface, owing to the increased number of lamellæ. Fixed cells of the cornea lie in the spaces of the stroma; aside from these, there are the so-called wandering cells (leucocytes), some of which are also found in the anterior epithelial layer near Bowman's membrane. From this layer of the cornea the tissue forming the meshwork of the iris angle is chiefly derived.

Descemet's membrane, the posterior limiting membrane, is a thin, highly refractile, transparent, homogeneous structure, very firm and elastic. By virtue of its structure it is a typical so-called "glass membrane." At its periphery it becomes greatly thinned out and enters into the formation of the meshwork of the iris angle.

The endothelial, or inner, layer of the cornea is made up of a single layer of transparent, flattened, hexagonal cells, continuous over the meshwork of the iris angle, and over the anterior surface of the iris.



Section of the Cornea.

The bloodless cornea forms the "object glass" of the ocular photographic apparatus. It is so well supplied with nerves, lymph spaces, etc., that it is remarkable how perfectly transparent it is. The corneal elements are so arranged that there is no irregular refraction of the light rays passing through them. Many abnormal conditions, such as increased intra-ocular pressure, as in glaucoma; congestion of the blood-vessels at the limbus corneæ, as in iritis; decrease of

tension, as in atrophy of the globe; and chronic uveitis, may disarrange these closely packed tissues and bring about either a temporary or permanent loss of transparency. In health no vessels are to be found in the cornea itself.

The capillary loops which form a vascular network about the corneal margin, take the place of Bowman's membrane at the sclerocorneal junction. The deeper of these capillaries (derived from the anterior ciliary vessels), are not seen in the normal eye, but when engorged with blood, as the result of irritants, they constitute the condition known as ciliary or pericorneal congestion, and may be recognized with the naked eye.

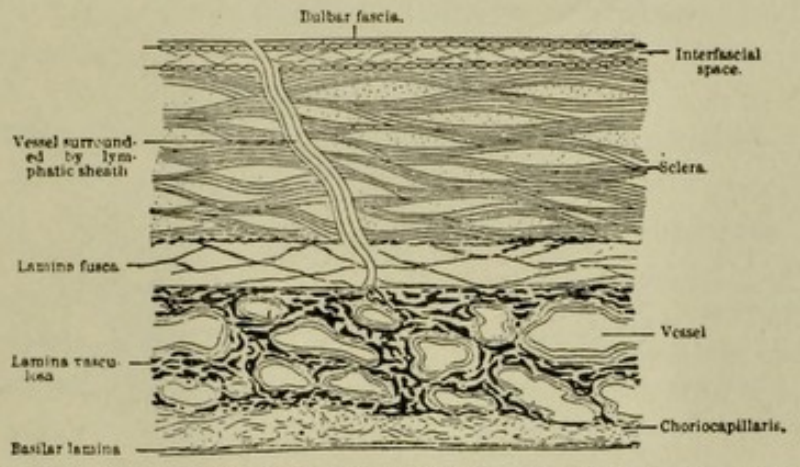
An intricate system of inter-communicating spaces affords a circulation of nutritive fluids throughout the entire substance of the cornea. These fluids, derived chiefly from the marginal vessels, nourish the anterior epithelium and the superficial layers of the substantia propria, while the deeper layers and endothelium absorb the aqueous humor, a portion of which may filter through the spaces between the hexagonal cells.

The nerves of the cornea are derived from the ciliary plexus; some of the fibres join those supplying the conjunctiva, while others proceed directly to the cornea. About 70 principal branches are supplied to the corneal tissue; they lose their medullary covering 3 to 5 mm. from its margin. Of these branches about 50 are distributed to the anterior epithelium, and the remainder supply the posterior layers; those of the latter group being somewhat coarser in structure than the former.

The **sclera** (*tunica fibrosa,* or *sclerotic coat*) forms about five-sixths (in the newborn, about four-fifths) of the fibrous covering of the eyeball, and is continuous with the cornea. Indicating the point of blending of the sclera and cornea is a superficial, shallow, circular furrow, the sulcus scleræ externus, which is usually filled out with scleral conjunctiva. The fibrous bundles which compose the sclera are generally disposed at right angles to one another, forming a strong, closely-woven structure, still further strengthened by elastic and other fibres which run at all angles between the other bundles. Fixed nucleated cells lie between the bundles, particularly in the angles formed by their crossing. The spaces of the sclera resemble those of the cornea, although the scleral organs and components are not so regularly placed.

The thickness of the tunic varies greatly with the individual, being generally thinner in youth and in the female. In the newborn it does not vary so much as in the adult, although it is inclined to be

proportionally thicker near the sclero-corneal margin. At the posterior pole it measures 1 mm. or a little more, and gradually decreases toward the equator to about 0.3 mm. The minimum thickness is, therefore, attained immediately underneath the recti muscles, close to the insertion of their tendons; immediately beyond this point, however, the thickness becomes doubled (0.6 mm.) since the muscle tendons at the line of insertion are often as thick as the sclera itself. As a rule, the tendons course obliquely inward into the sclera and disappear farther forward among its fibres. As the sclero-corneal margin is approached the thickness increases until it measures 0.9 mm. At this point, on the inner surface, is located the scleral spur, or annular ligament, composed of circular fibres. It is a wedge-



Section of Sclera and Choroid Showing the Interlacing Warp and Woof of the Scleral Coat (Dwight-Testut).

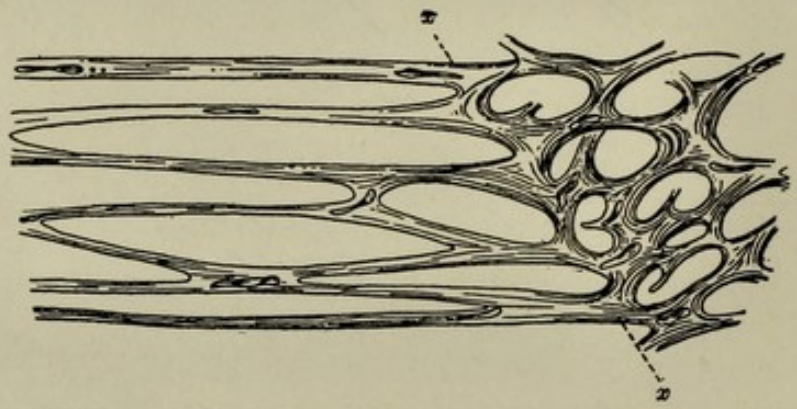
shaped process of scleral tissue which assists in the formation of the sulcus scleræ internus, and serves as the point of attachment of the meridional fibres of the ciliary muscle, and meshwork of the iris angle; it also forms the posterior limit of Schlemm's canal.

At the posterior pole of the eye, 1 mm. below the horizontal meridian, and about 3 mm. to the inner side of the vertical meridian, is the opening for the optic nerve (*foramen opticum scleræ, porus opticus*, optic entrance, optic canal). Internally the diameter of this opening is about 2 mm.; externally it measures a little over 3 mm. The inner fibres of the sclera are continued across the nerve, between the nerve bundles, forming the lamina cribrosa; the outer fibres are continuous with the dural sheath of the optic nerve.

In addition to the opening for the optic nerve, the sclera is pierced by minute canals, or *emissaria*, through which pass the vessels and nerves supplying the uvea. These canals vary both in size and direction, being in some instances straight, in others quite oblique. Those through which pass the long posterior ciliary arteries, the ciliary

nerves, and the vortex veins, course very obliquely; the canals for the latter are about 3 mm. in length. The venæ vorticosæ, usually four in number, are arranged in pairs, upper and lower; they leave the sclera 6 to 8 mm. behind the equator, and their points of emergence are about 90 degrees apart. Loose connective tissue binds the vessels and nerves to the walls of the canals. The oblique direction of these canals prevents bending and tearing of the structures passing through them, during motions of the eyeball, or in the shifting of the choroid during the act of accommodation.

The scleral layer next the choroid is called the *lamina fusca.* It is a dirty-brown layer, and is probably an extension into the scleral tissue of the choroidal pigment. It shows through the sclera as a bluish discoloration, when that coat is abnormally thin, in some



Showing the Fibres of the Sclera Joining Obliquely Those of the Cornea and Forming the Limbus Corneæ.

young children, in brunettes, and in most dark races. The sclera itself but rarely contains any pigment, except for the slate-gray spots often seen about the perforations for the anterior ciliary vessels (congenital melanosis of the sclera).

Sattler and others believe that the human lamina fusca is analogous to the *tapetum,* a peculiar layer of the choroid found in lower animals. It is composed chiefly of connective tissue in the pachyderms and ruminants, and is known as the tapetum fibrosum. Irregular patchy deposits of pigment in these layers cause rays falling upon the retina of such animals to be irregularly reflected, and produce a sheen such as one sees on the surface of "mother-of-pearl." This retinal reflex is also seen in the eyes of children.

The inner surface of the sclera is much smoother than the outer. Toward the front of the eye it has an almost silky lustre; posteriorly it is duller, and of a brownish color. On the inner surface, close to its anterior limit, is situated the scleral furrow, or sulcus scleræ in-

ternus, a shallow groove about 0.7 mm. broad. Its posterior boundary is the scleral spur, previously referred to; its anterior boundary is formed by thickened stroma of the cornea which projects slightly above the level of the surface near the sclero-corneal margin. Occupying a part of the floor of the furrow, close to its posterior margin, is the canal of Schlemm; the remainder is occupied by the meshwork of the iris angle.

The *canal of Schlemm* is a slit-like space, or cleft. It is not one uninterrupted canal, as the name indicates, but is divided, at various places in its course, into one, two, or more, luminæ. Its outer wall is formed by dense scleral tissue; its inner wall by the meshwork of the iris angle. It is lined by endothelium continuous with that lining the aqueous chamber. Vessels are given off at intervals, thus establishing a free communication with the venous system; they unite in the scleral tissue with the anterior ciliary veins. Through the medium of this canal of Schlemm the aqueous chambers are in communication with the general lymph system.

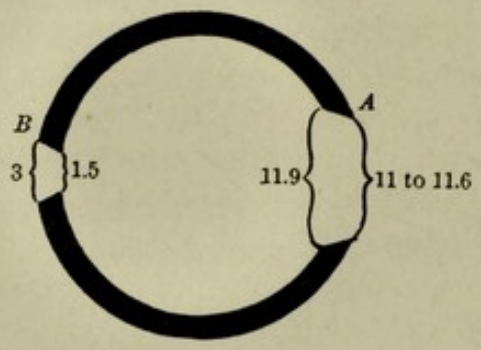
The *iris angle*, or circumference of the anterior chamber, is occupied by an open meshwork, or trabecular structure composed of fibro-elastic tissue derived from the stroma of the iris and Descemet's membrane. Its first point of attachment is the scleral spur, after leaving which it fills out the extreme periphery of the aqueous chamber, and passes on around to become continuous with the stroma of the iris. According to the nomenclature of H. Virchow, that portion of the meshwork forming the inner wall of Schlemm's canal is called the scleral meshwork (trabeculum sclero-corneale of the old nomenclature) and forms the greater bulk of the structure; that portion extending from the scleral spur to the root of the iris is called the uveal meshwork (ligamentum pectinatum of the old nomenclature). In the latter structure are the spaces of Fontana, which communicate with the anterior chamber, through minute channels of which the structure is chiefly made up. The surface directed toward the anterior chamber, the spaces of the meshwork, and Schlemm's canal, are all lined by a continuation of the endothelial layer of the cornea; after leaving the angle of the iris, it is continued over the iris proper as the anterior endothelial layer.

As the chief function of the scleral coat is not only to serve as a protecting envelope about the delicate structures within, but to preserve the shape and size of the eyeball, its fibrous framework is very tough, and capable of resisting pressure both from without and from within. The weak points in this protecting coat are the cornea in front (most ruptures from direct violence taking place at the sclero-

corneal junction), the optic entrance behind, and the points at which the nerves and arteries enter, and the veins (especially the four venæ vorticosæ) leave the eyeball. The entrance of the optic nerve (optic canal) is strengthened by the lamina cribrosa.

Aside from an occasional capillary in the sclera, it can be said that this tissue is devoid of vessels which supply it directly.

Branches of the ciliary nerves supply the sclera; their distribution being similar to that found in the cornea. Sensory endings only have been found in the human eye. Many minute nerves perforate the tunic in its anterior part to supply the cornea.



Weak Areas in the Sclera Measured in Millimeters. (Testut.)

Covering the sclera is a thin layer of tissue of much looser structure than the sclera itself. This is called the *episcleral tissue*. The bundles composing it are delicate and tortuous, except on the side near the sclera, where they become thicker, firmer, and more closely interwoven; they graduate over into the scleral tissue. This layer is very vascular. It is readily differentiated when the eyes are inflamed. Its vessels are branches of the anterior and posterior ciliary arteries, which are, as usual, accompanied by veins. Near the limbus corneæ there is a thick capillary and venous net, which, when overfilled with blood, produces that which is recognized as ciliary injection.

The **aqueous humor** is mostly secreted by the vessels of the ciliary processes. It is a transparent, colorless, watery lymph of alkaline reaction, and is very quickly replaced when lost. Its solvent powers are great, and through its medium many active agents are brought into contact with the interior of the eye. Atropia, either taken in large doses internally, or dropped into the conjunctival sac, is soon found in the aqueous humor; the aqueous, when thus impregnated, will dilate the pupils of other subjects when instilled into their eyes. The aqueous dissolves the crystalline fibres, if, through injury of the lens capsule, it is allowed to come in contact with them. Its refrac-

tive index and specific gravity are slightly greater than distilled water. The average amount of human aqueous in the adult is about 280 cubic mm., and its weight is less than one-third of a gramme.

The **vitreous body,** the most transparent of the refractive media, lies between the lens and the retina, and occupies about four-fifths of the ocular cavity. It is a colorless, almost homogeneous, transparent, jelly-like mass, of firm consistency, with a framework of extremely fine, soft, fibrillæ. It receives the lens in its patellar fossa in front, and forms a general support to the retina, from which it is separated by a delicate layer of transparent tissue called the hyaloid membrane, or membrana limitans interna retinæ. Normally, there are no blood-vessels, nerve fibres, or living fixed-cells in the vitreous body. It is readily separable from the retina, except at its attachment to the ciliary epithelium at the ora serrata, which is very firm; and at the optic nerve head, and ligamentum hyaloideo-capsulare, where it is quite intimately attached. The ligamentum hyaloideo-capsulare of Wieger, is a ring-form attachment of the anterior border-layer of the vitreous to the lens, 8 or 9 mm. in diameter, concentric with its margin. Within the ring, the vitreous is separated from the lens by the post-lenticular space of Berger.

Unlike the aqueous, the vitreous body is rarely, if ever, regenerated; when destroyed its place is taken by other fluids and tissues.

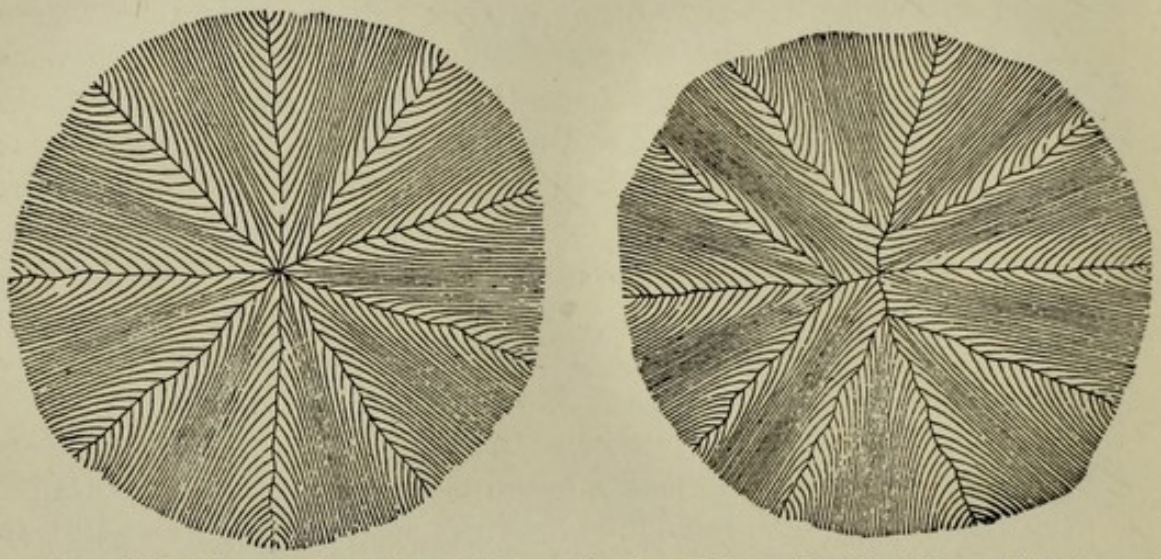
The presence of a canal (fetal vestige) in the vitreous body, has been demonstrated; it runs from the optic papilla to the posterior surface of the lens, close to the axis of the vitreous toward the nasal side, and is from 1 to 2 mm. wide. This is the *canal of Cloquet.* In the human fetus (and in some animals) the retinal system of vessels supplies a branch—the hyaloid-artery—which passes through this canal to the lens and iris. Under the name of persistent hyaloid artery, this vessel may fail to be absorbed before birth and so interfere, to some degree, with distinct vision.

The vitreous depends upon the uveal vessels for its nutritional supply. Hence it is often implicated in diseases of the uveal organs —especially of the ciliary body and choroid.

The **crystalline lens** is an interesting intra-ocular organ being a circular, biconvex, transparent, glass-like body, lying between the iris and the vitreous humor. It fits accurately into the shallow, saucer-shaped, patellar fossa of the vitreous, from which it is separated by the post-lenticular space of Berger. It is held in place by a *suspensory ligament,* the zonula (or zonule) of Zinn, and by the *ligamentum hyaloideo-capsulare.* The equator, or edge, of the lens, is about 1 mm. from the ciliary processes.

An anterior and posterior pole of the lens are designated, each being in the center of the corresponding surface. An imaginary line drawn between the two is called the axis of the lens.

The lens is enclosed in a delicate, structureless, elastic envelope, lined in front by endothelial cells, which are wanting on the posterior surface. Owing to this and other differences, and, for the purpose of reference, this covering of the crystalline lens has been called the anterior and posterior capsule, although there is no distinct line of separation between them. The capsule is quite strong



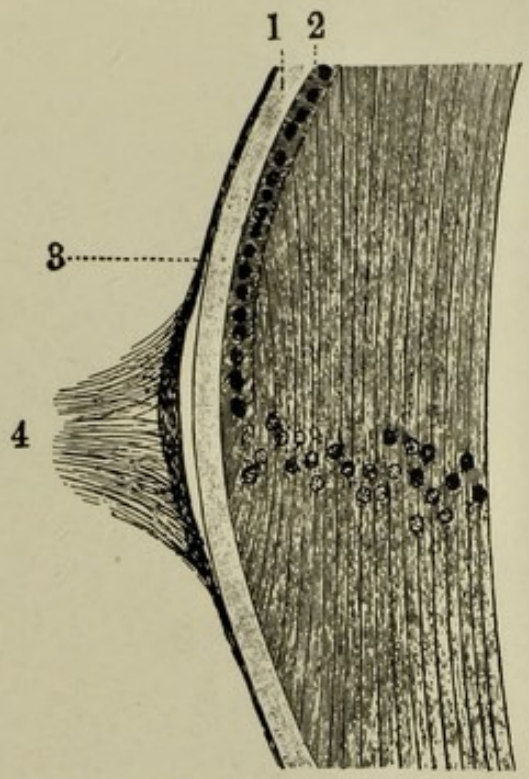
Central Portion of Anterior and Posterior Lens Stars Showing Lines of Union of Sectors. (Babuchin.)

and elastic, though brittle. When cut through it tears irregularly, and the incised edges curl up in a roll with the inner surface outward. The minimum thickness of the capsule is at the posterior pole. Each surface shows a zone of maximum thickness occupying a position concentric with the equator toward the periphery of the lens.

The lens substance is formed by the invagination of the ectoderm, and is, consequently, an epithelial structure—the capsule being derived from the mesoderm. For this reason the lens grows (by conversion of the marginal cells of the anterior capsule into young lenticular fibres) larger, heavier, thicker, and harder, as age advances. Lens substance in process of formation can be found at all ages of life.

The hardening process begins in childhood, and affects chiefly the central portions, so that in the adult a distinct condensation of the tissues occurs, and a nucleus can be demonstrated. Later the differ-

ence between the cortex and nucleus can generally be demonstrated with the mirror. In old age, the whole lens increases so much in hardness that changes in its form are with difficulty brought about



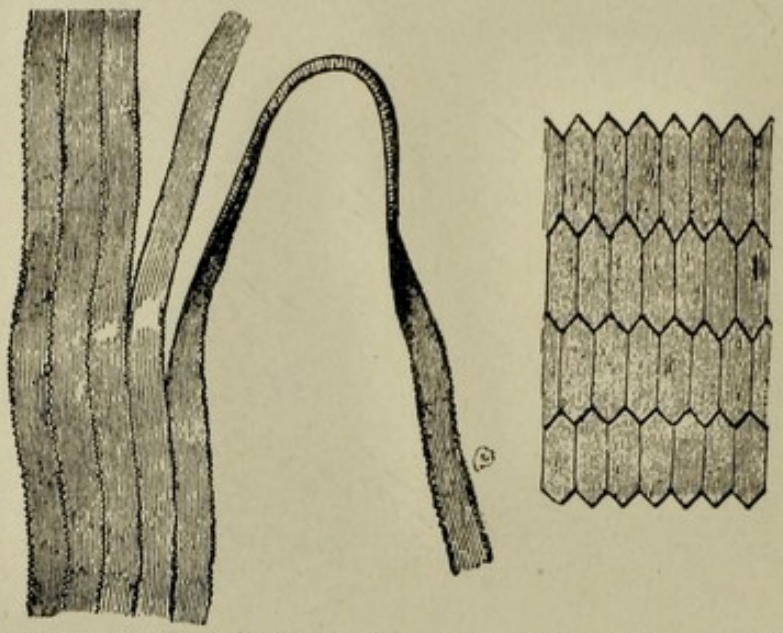
Parts at Equator of Lens Showing the Growth of Its Epithelial Cells Into Lens Fibres. (Schultze.)

by the ciliary muscle, and the loss of accommodative power is very marked. Moreover, the denser nucleus reflects more light, and the outline of the lens is seen through the pupil, which does not appear as black as in youth. This appearance generally deepens, until, by reflected light, it may show a distinct opalescence, not uncommonly giving rise to a suspicion of cataract, even when no true opacity is present.

The adult lens is about 9 mm. in its transverse diameter, and is from 4 to 6 mm. thick. The posterior surface is somewhat flattened; the anterior surface has more the outline of a sphere. These, and other measurements vary with the state of the accommodation, with age, and with stature—very tall individuals having large lenses. The specific gravity of the lens is greater than that of the vitreous, so that on rupture of its attachments it settles to the bottom of the globe.

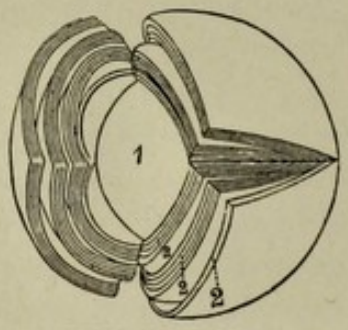
After removal of the capsule, the lens readily separates into a number of concentric laminæ much like the layers of an onion, ex-

cept that they do not extend entirely about the organ. Examined microscopically, the lenticular layers are found to consist of long ribbon-like fibres, some of them with nucleated cells and serrated



Single Lens Fibres, Longitudinal and in Transverse Section. (Arnold-Ball.)

edges, but when the ribbon fibres are seen in cross-section they represent a prismatic or honeycomb appearance. The saw-like edges of

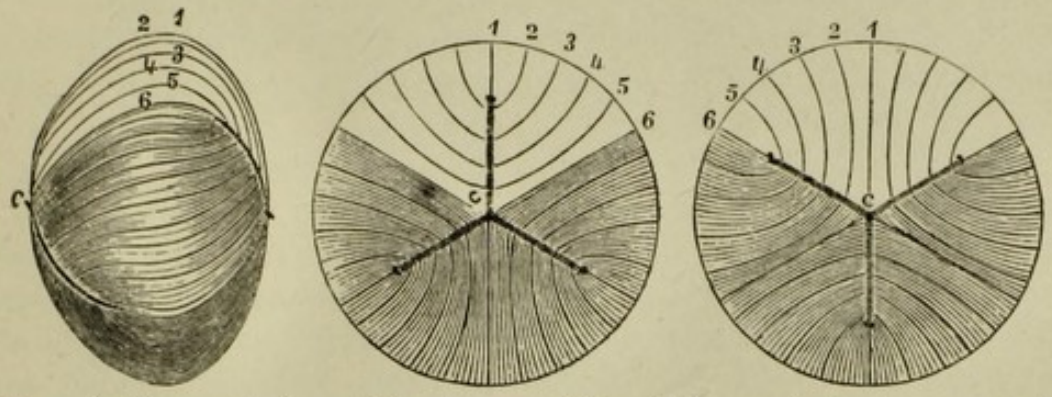


Separation of Layers of Lens Following Treatment with Dilute Alcohol. After Arnold. (Schwalbe.)
1. Nucleus or central portion. 2. Layers of Cortical Substance.

the fibres do not always closely fit into one another, but are bound together by a cement substance, a semi-fluid albuminous material.

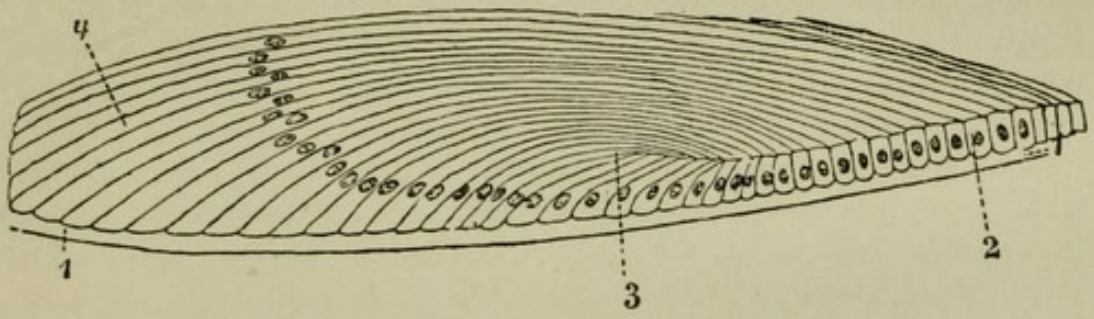
The cement substance not only binds together adjacent fibrils of the lens, but joins the sectors into which the whole mass is divided. The non-symmetrical stellate figures thus formed show on both the anterior and posterior surfaces of the lens. The lens star always has three, but may have as many as six or more rays. When one looks at a distant street lamp, the rays of light that appear about the

central part of the flame are generally the result of unequal refraction of the light by the various sectors into which the human crystalline lens is divided. This is true even of normal eyes.



Schematic Representation of the Course of Lens Fibres and the Arrangement of Lens Stars in the Fœtus and Newborn. (Schwalbe.)

The *zonule of Zinn*, or suspensory ligament of the lens, is a collection of delicate fibres,* a few of which originate as far back as the ora serrata; the majority spring from the valleys between the ciliary



Meridional Section Through Lens Margin—Rabbit's Eye. (Schwalbe.)
1. Lens capsule; 2. Epithelium of the lens; 3. Transformation of epithelium into lens fibres; 4. Lens fibres.

processes, and pass forward as separate layers, to the margin of the lens; here they are attached to a zone about 2 mm. broad, concentric with the equator of the lens—one layer in front, and the other behind. A few fibres pass directly to the extreme circumference of the lens. By the divergence of these layers from their origin to their attachment, a wedge-shaped cavity is formed, which is called the canal of

*Thomson, with good corroborative evidence, regards the zonular fibres as the shredding of a delicate membrane blended posteriorly with the layers of the pars ciliaris retinæ. This view is not held by other authors, most of whom do not specify their derivation, but merely their point of origin.

Petit. This space can be injected with air. The zonule of Zinn is concerned in the mechanism of accommodation.

The lens has no blood-vessels, but is nourished by the imbibition of fluids supplied by the ciliary body; these probably enter it at the equator, and circulate between the fibrillæ.

The elasticity of the lens may be demonstrated by gently squeezing it and then suddenly removing the pressure—it at once springs back to its original shape.

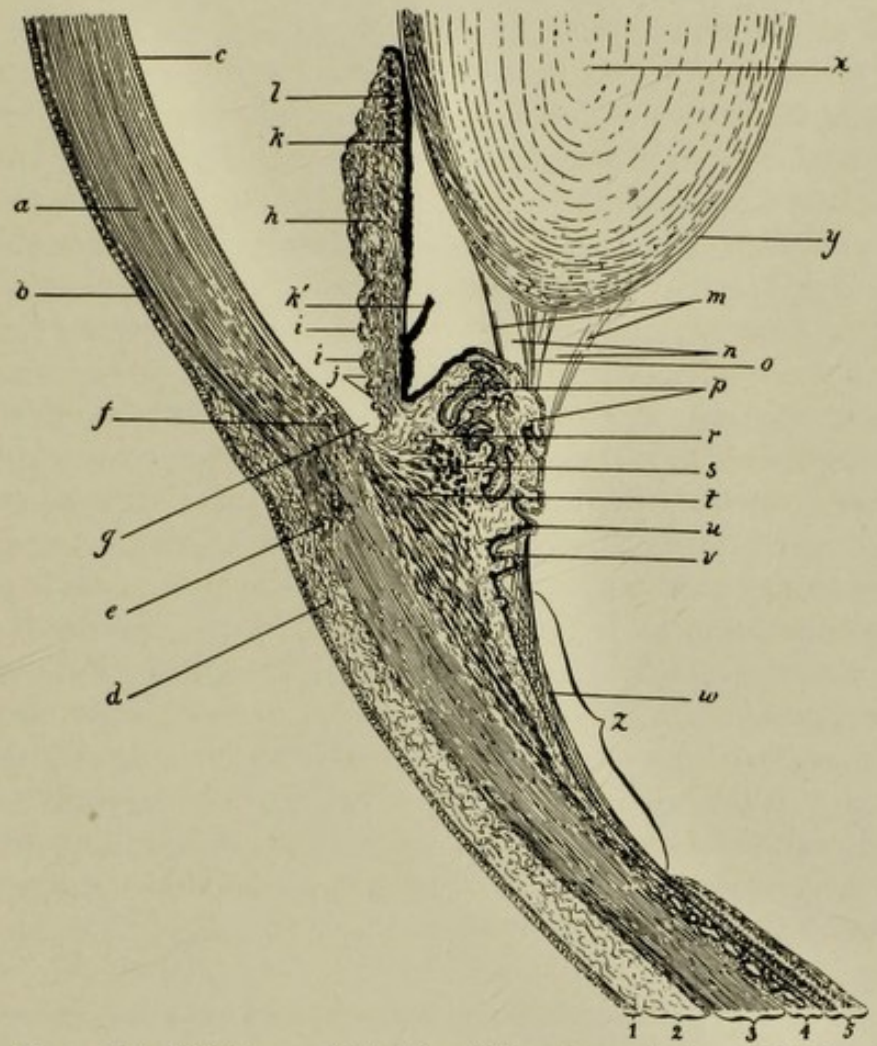
The so-called *Purkinje-Sanson images,* or lens-reflexes, are best elicited in a dark room. By placing a lighted candle in front, and a little to the side of, the dilated pupil, three images of the candle are produced. One is large, upright, and brilliant, and is the corneal reflex. The second is also bright, but is very minute, and must be searched for; in this case the image of the candle is inverted, and is the reflex from the posterior surface of the lens. The third image is from the anterior surface of the lens; it is upright and larger than the other two, but is very faint, and rather difficult to see.

The **uveal tract,** or *uvea,* comprises the choroid, the ciliary body, the ciliary processes, and the iris. This collection of pigmented and highly vascular tissues forms, anatomically, physiologically, and pathologically, a rather definite section of the intraocular apparatus. It derives its name from the fact that when the outer covering, composed of the cornea and sclera, is removed from the globe, a middle coat is exposed that closely resembles a purple (uvea) grape. The anterior segment of the uvea is composed of the iris, pierced by the pupil. The iridic tissue extends to the sclero-corneal junction, where it is continued inward as the ciliary body, a meridional, circular organ, that still farther backward sends out ciliary processes and joins the choroid, which, in its turn, lines the ocular interior back to the optic nerve entrance.

The whole tract is soft and readily breaks down. The choroidal elements are composed chiefly of connective tissue, bearing blood-vessels and lymph spaces, intended to afford nourishment to most of the organs within the eyeball. The ciliary body is made up of the muscle that regulates the focusing apparatus (accommodation) of the eye, as well as of numerous vascular and nervous bundles, that are concerned in intraocular secretion and excretion. These constituent organs will be considered separately.

The **iris,** which is continuous with the choroid, is a circular, colored curtain, or diaphragm, lying in front of the lens. It has a circular opening of varying width—the pupil—which lies slightly to the nasal side of the center, and acts chiefly as a regulator of the amount of

light admitted into the interior of the eye; in conjunction with the other parts of the dioptric apparatus, it assists in giving sharp definition to fundus pictures. It separates the anterior from the posterior aqueous chamber. The pupillary margin of the iris is bevelled at the expense of the outer surface, and is finely crenated. Until the seventh month of fetal life the pupil is closed by a thin, semi-trans-



The Immediate Relations of the Crystalline Lens System. (After Quain).
a, Cornea; f, Canal of Schlemm; g, Iridic angle; h, Iris; k, Posterior pigment layers (detached); m, c, Zonular fibres; n, Interfibrillar spaces; p, r, s, t, Ciliary body; 1, 2, Conjunctiva; 3, Sclera; 4, Choroid; s, Retina.

parent membrane, which occasionally persists, in part or in whole, after birth, under the name of persistent pupillary membrane. When the iris is contracted its pupillary margin rests lightly on the anterior surface of the lens. At its periphery, or root, at the sclero-corneal junction, it turns abruptly backward and becomes continuous with the ciliary body; this is called the ciliary border. The diameter of this border is 12 mm. and does not vary. When the pupil is dilated

the iris hangs (or floats) free in the aqueous humor, and does not touch the lens. The average width of the pupil is 4 mm.; a slight difference in the size of the pupils is not necessarily pathologic. This thickness of the iris varies; when contracted it measures 0.3 mm., when dilated 0.75 mm. The point of minimum thickness is at the ciliary border, where it measures 0.2 mm.

Seen from in front, the iris presents a great number of patterns, as well as all sorts of colors, from light-blue to deep-brown; the variation in color being due chiefly to the differing quantity and arrangement of the dull brown pigment deposited on its anterior surface and viewed through the corneal and aqueous media.

A zig-zag line near the pupillary margin serves to separate the anterior surface into two zones—a narrow pupillary zone (annulus iridis minor, Merkel); and a broad ciliary zone (annulus iridis major, Merkel). The shallow cavities or spaces seen on the surface of the iris near the pupillary margin are formed by the spreading apart of elevated trabeculæ, or ridges, extending between the zig-zag line and the periphery. They are called the "pupillary crypts."

Running concentrically with the ciliary border of the iris are the so-called contraction furrows. They deepen when the pupil dilates, and are almost obliterated when it contracts.

In albinos pigment is lacking, not only in the stroma of the iris, but in all other portions of the uveal tract as well; in negroes, the amount is relatively large. The pigment deposit, whether large or small in amount, does not appear until after birth; hence all babies have light blue eyes for the first few weeks. Irregularities may occur in this deposit, so that an iris may be partly blue and partly brown (heterochromia). When this happens the parents are generally of different complexions.

The *iris stroma* is made up chiefly of blood-vessels and nerve-plexuses, supported by a very loose, spongy network of connective tissue. The vessels run in a radial direction from the ciliary to the pupillary border. They show a thick adventitia, and their course is more or less winding, to allow for contraction and dilatation of the pupil. At the ciliary and pupillary borders the vessels form irregular circles, called respectively circulus arteriosus major, and circulus arteriosus minor.

Contraction of the pupil is brought about by the sphincter pupillæ muscle, a narrow band of fibres about 0.9 mm. broad, which encircles the iris near the free border of the pupil. This muscle is supplied by branches of the third (oculomotorius) nerve.

Dilatation of the pupil is accomplished by relaxation of the sphinc-

ter pupillæ, contraction of the muscular coat of the iridic arteries, and by contraction of an irregular layer of unstriped muscle fibres called the dilator pupillæ, derived from the stratum pigmenti. These fibres radiate from the margin of the pupil to the ciliary body. The last two sets of muscle fibres are controlled by the sympathetic.

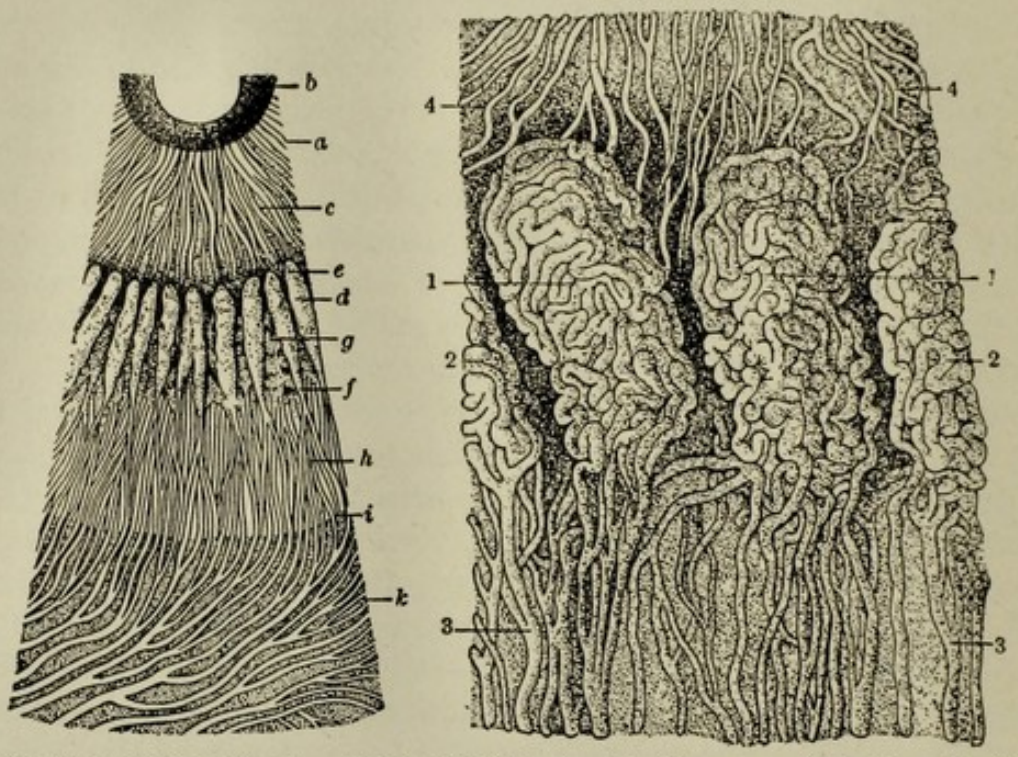
A deeply pigmented layer, a continuation of the pigmented layer of the retina, thickly covers the posterior surface of the iris, and extends as far forward as the anterior margin of the pupil, about which it is slightly turned. Like the anterior surface of the iris it is readily thrown into folds, to allow of easy expansion and contraction of the pupil. The iris pigment is easily detached, and may adhere to the anterior capsule of the lens during an attack of iritis; such adhesions are called posterior synechia. On this surface near the pupillary margin is a zone about 1 mm. in width, presenting radial folds, (contraction folds of Schwalbe). This area corresponds to the situation of the sphincter pupillæ muscle.

The **ciliary body** *(corpus ciliare)* is that portion of the uveal tract which extends from the root of the iris to the ora serrata, or zig-zag anterior border of the retina. This area is from 5 to 6 mm. broad, and may be divided into two zones, viz.: a broad, flat zone, approximately 4 mm. wide, situated in front of the ora serrata and known as the orbiculus ciliaris; and a narrower zone, the corona ciliaris (corona radiata), occupying the remaining 2 mm. of the space. From the latter zone arise the ciliary processes. These are a number of curious club-like elevations, arranged meridionally, and composed almost entirely of anastomosing blood-vessels. There are, in all, about 70 of these processes; they rest upon the non-striated fibres of the ciliary muscle. Separating each process from its neighbor is an interspace, or depression, called a "ciliary valley." The pigment of the ciliary body is much darker than that of the choroid, although the free borders of the processes contain less pigment than the underlying surface—hence, they appear lighter against the dark background. The rounded anterior ends of the ciliary bodies are separated from the lens by a space about 1 mm. in width—the circumlental space.

It is to be noted that the blood from the ciliary arteries flows directly into the veins without intervening capillaries, as in the glomeruli of the kidney. The analogy probably also holds good as to their function, since they both readily allow the watery portions of the blood to escape through their pervious walls. The ciliary processes secrete the aqueous humor in the same manner that the renal vessels excrete the urinary fluid.

The extreme vascularity of the ciliary region makes it susceptible to inflammatory attacks, especially following injury; it constitutes the "dangerous zone" of Nettleship.

The ciliary muscle was first demonstrated microscopically in 1835 by an American, named Wallace; although Eustachius actually pictured it about 1570. On cross section it appears as a triangular band



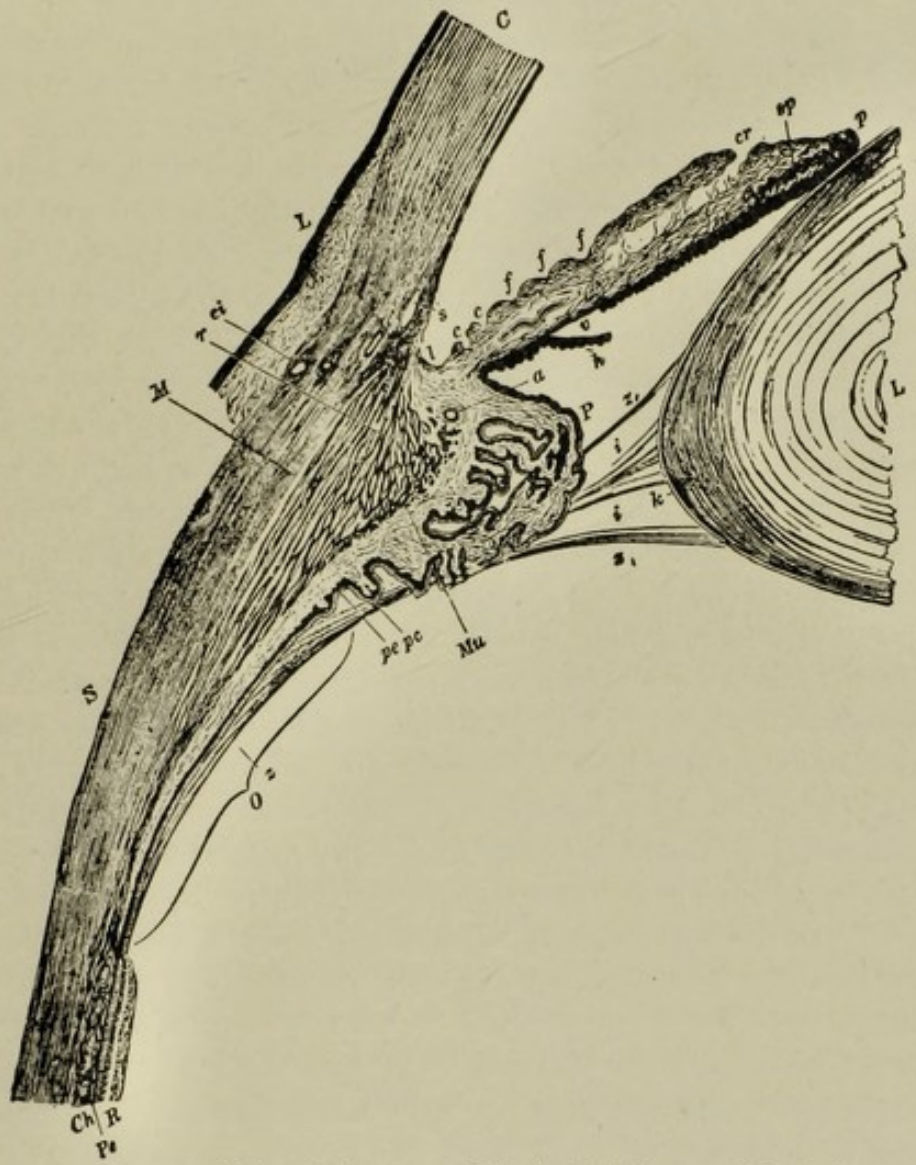
Section of Uveal Tract, with Details Showing the Plexuses of the Vascular Ciliary body. (Sappey.) d, e, i, 1, 2, 2, ciliary processes; 4, 4, veins from iris discharging into the ciliary processes; 3, 3, veins connecting the processes with the venæ vorticosæ.

of unstriped muscle fibres, inserted directly into the anterior insertion ring (scleral spur); and lies between the ciliary processes and the sclera. The base of the triangle is near the anterior insertion ring, and the muscle extends from this region as a gradually thinning layer to its insertion into the choroid (tensor choroidæ), where it blends with the choroidal stroma. There are three sets of fibres making up this muscle, which run in various directions. On the outer side toward the sclera are seen long muscle bundles lying parallel to the surface, which are called meridional fibres. Inward from these are muscle bundles disposed in a radial manner—the radial fibres. The third set, a group of fibres located far forward in the ciliary body, run in a circular direction and form the so-called Mueller's muscle, or compressor lentis.

There is no doubt but that the proportion of these muscle fibres

varies with the requirements of accommodation; the circular fibres that govern active changes in the lens are absent in myopic subjects, who do not often require an extensive accommodation; in hyperopic individuals, however, they are greatly increased, and may amount to one-third of the whole muscle.

On the temporal side the ciliary muscle occupies an area about 6 mm. wide; in the nasal side it is but 5 mm. wide.



Organs of Uveal Tract and Their Relations. (Fuchs.)

The ciliary nerves are both sensory and motor in character. Those containing sensory fibres alone are derived from the nasociliary branch of the ophthalmic division of the fifth cerebral nerve; those containing a mixture of fibres—sensory, sympathetic, and motor—derive their motor fibres from the ciliary ganglion. About ten of the larger trunks, varying greatly in number and size, enter the eye-

ball near the posterior pole, run forward in the perichoroidal space, send off branches to the sclera and choroid en route, and terminate chiefly in the ciliary plexus (plexus gangliosus ciliaris) which lies external to the orbiculus ciliaris and the ciliary muscle; from this latter source the ciliary processes, iris, and deeper layers of the cornea receive their nerve supply. Perforating branches, lying farther back, supply the superficial layers of the cornea.

The *perichoroidal* space lies between the lamina fusca of the sclera and the outer layer of the choroid—the lamina suprachroidea. It is a slit-like lymph space, which, in extent, is almost equal to the sclera itself. It is traversed throughout by numerous delicate lamellæ fused together here and there, thus subdividing the space into smaller, intercommunicating portions. Binding the two surfaces intimately together, in places, are nerves and blood-vessels passing from the sclera to the choroid, and vice versa. The posterior ciliary arteries and the ciliary nerves pass forward through this space.

The **choroid** (chorioid), a portion of the middle tunic, covers about two-thirds of the interior of the globe. Near the optic nerve entrance it measures 0.1 mm., becoming gradually thinner as it approaches the ora serrata, where the thickness is about 0.06 mm. It is a soft, brownish membrane, extending from the optic nerve entrance to the ora serrata—about 7 mm. from the corneal limbus, externally. At this point it becomes continuous with the ciliary body. It is rather loosely attached to the sclera, a condition that allows of its easy adjustment to variations in position and size, caused by the action of the ciliary muscle and the changes in volume of its many blood-vessels. It is, however, quite firmly adherent at the papilla, where it sends many connective tissue fibres and vessels to the optic nerve. When the fundus oculi is examined with the ophthalmoscope the color of the background is determined chiefly by the amount of pigment in the stroma, and the volume of blood in the choroidal vessels.

The choroid may be divided into four layers, viz.: the lamina supra-choroidea, the lamina vasculosa, the lamina choriocapillaris, and the lamina basilis.

The *supra-choroidea,* or external layer, is formed chiefly of elastic fibres and pigment corpuscles, loosely arranged. It contains lymphatic spaces lined with endothelium, but has no vessels.

The *lamina vasculosa* forms the mass of the choroid. It consists of arteries and nerves, and of a stroma of elastic fibres and pigment cells, which supports the large venous whorls known as the venæ vorticosæ. This layer contains many lymphatic spaces, which

are particularly well developed around the blood vessels. The larger vessels are found in the outer layers toward the sclera.

The sclera demands but little nourishment, hence the large vessels which take small part in nutritive processes are placed in this position. This arrangement is, in at least one sense, a distinct disadvantage; when inflammation or other changes attack the choroid they generally affect the minute capillaries, and are consequently liable to damage the retina.

The venæ vorticosæ remove most of the blood from the choroid and the interior of the eyeball. The main trunks of these whorl-like veins pass obliquely backward through the sclera, and empty into the ophthalmic vein. Fuchs says that their compression, by the action of the superior oblique and other muscles in sustained near work, may, by interfering with the ready exit of blood from the eyeball, distend the globe. He further believes that such a continual obstruction to escape of blood from the eye may bring about a stretching of the sclera in young subjects, whose tissues are not as unyielding as they become later in life. This elongation of the antero-posterior diameter constitutes the common form of myopia.

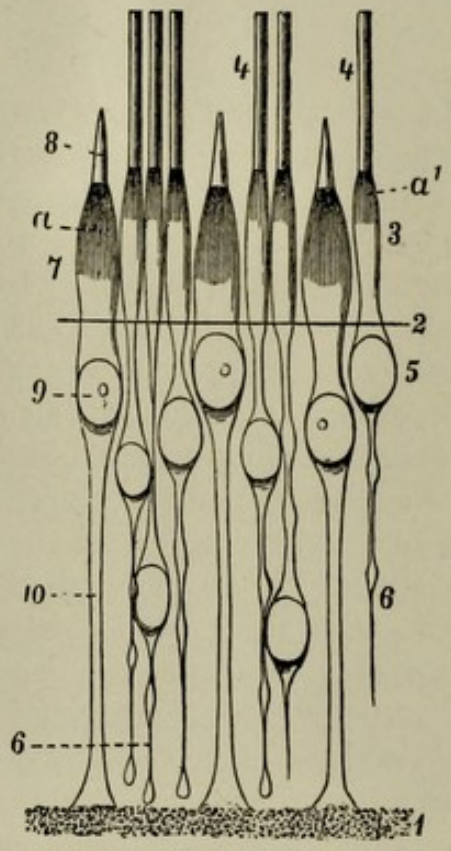
The *lamina chorio-capillaris* is a layer of fine capillaries, supported by an almost homogeneous, non-nucleated stroma. This layer occupies that part of the choroid (inner aspect) which constantly requires an outpouring of nutritive fluids for the retinal elements that lie close to it. By referring to the description of the retina, it will be seen that the most active layer of that membrane—the layer of rods and cones—is super-imposed upon the chorio-retinal epithelium, and that all of these structures are entirely dependent for nutritive fluids upon the vessels of the chorio-capillaris. As a matter of fact, this capillary network forms the richest vascular plexus in the whole body, being better supplied with blood than the pulmonary alveoli, or than the pia mater, which membrane the whole structure of the choroid resembles. The capillaries in this layer are very broad; so broad, in fact, that several blood corpuscles can pass through them side by side. They do not form a meshwork, but a net—that is, they occupy one plane. This net is especially thick in the region of the fovea centralis retinæ.

The inner layer, or *lamina basilis*, separates the lamina chorio-capillaris from the retina. It consists of an inner and outer layer; the former homogeneous, the latter exhibiting very delicate elastic fibrillæ. It is firmly grown to the stroma of the capillary layer, and is highly refractile.

The principal arteries of the choroidal coat are the recurrent

branches of the long posterior ciliary and anterior ciliary arteries, which supply the anterior part of the membrane, and about 20 branches (short posterior ciliary) of the ophthalmic artery that penetrate the sclera near the optic entrance, and constitute the major part of the chorio-capillaris.

The **retina,** or "sensitive plate" of the human visual apparatus, lies between the choroid and the vitreous. Its attachment to the choroid in general is very delicate; at the entrance of the optic nerve and at the ora serrata, however, the union is quite firm. It may be



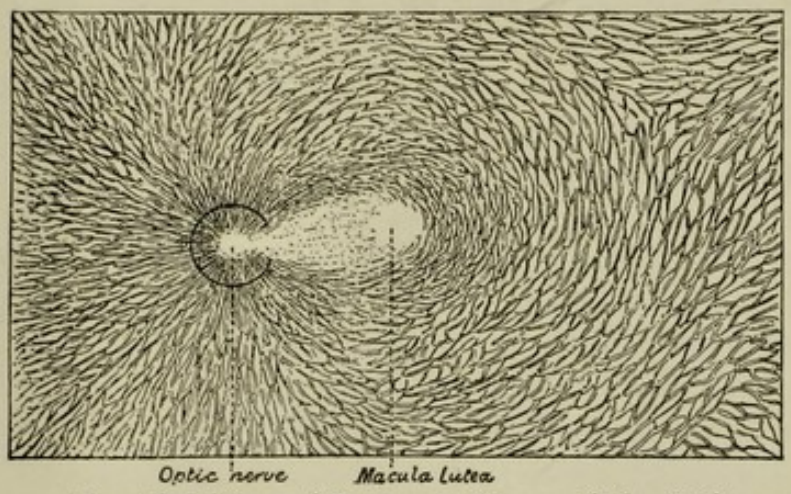
Layer of Rods and Cones and Outer Nuclear Layer—Schematic. (Schwalbe.)
1. Outer pleiform layer; 2. Membrana limitans externa; 3. Inner member of rod; 4. Outer member of rod; 5. Rod granule with nucleus; 6. Rod fibre; 7. Inner member of cone; 8. Outer member of cone; 9. Cone granule with nucleus; 10. Cone fibre; a. Longitudinal striations of inner member of cone; a'. Longitudinal striations of inner member of rod.

divided into two sections, viz.: a large posterior section called the *pars optica retinæ,* containing the expansion of the optic nerve fibres, and extending forward to the ora serrata where it ends abruptly; and a small anterior portion, the *pars ciliaris retinæ,* which is continued forward from the ora serrata over the ciliary processes. This latter section is made up almost entirely of the pigment layer of the retina *(stratum pigmenti).*

The *ora serrata,* which reaches farther forward on the nasal than on the temporal side, marks the anterior limit of the light and form perceiving elements. The pars optica retinæ is shorter on the nasal than on the temporal side, owing to the position of the optic nerve. At the nerve head it measures 0.56 mm. in thickness; at the equator about 0.18 mm.; while at the ora serrata it thins out to about 0.1 mm.

The retina is a delicate, complex, inelastic membrane, semi-transparent during life, but becoming clouded and opaque immediately after death. It is made up of a large number of layers, nine in all. It is thickest about the entrance of the optic nerve, especially above and below it (0.4 mm.); it thins out to about 0.14 mm. at the periphery, at first rapidly, and then more gradually.

The blood supply of this membrane is derived almost entirely from the central retinal artery, which, with the accompanying vein,



Magnified View of Innermost Layer of the Retina.

runs in the inner layers; the outer layers, next the choroid, are nourished by the chorio-capillary plexus. In the macular region no vessels are to be seen with the ophthalmoscope. The retinal circulation is a terminal one; there are no anastomoses with collateral branches (except with the ciliary vessels at the papilla), so that when thrombosis or embolism occurs, the area supplied by the occluded artery remains blind.

The following consideration of the retinal layers applies to the extra-foveal region; the foveal region itself will be taken up separately.

The various layers of the retina are bound together by a system of supporting fibres, or elongated cells, of purely mechanical nature, called the fibres of Mueller; these begin as closely apposed conical expansions, at the inner surface of the retina, and pass, perpendicular to the surface, through all the layers between the limiting

membranes; they terminate in fine fibrillæ in the layer of rods and cones. An oval nucleus is to be seen in each fibre near the center of the inner nuclear layer. These fibres take part in the formation of the framework of the various layers through which they pass, particularly the plexiform layers, in which they give off many fine extensions parallel to the surface.

The most important layer of all is the *layer of rods and cones.* In this portion of the retina, light, form, and color are perceived. Probably color perception is the chief function of the cones; light and form are mostly recognized by the rods. In birds the proportion of cones to rods is much greater than in the human retina.

The rods, which are more numerous than the cones, are solid, cylindrical structures, composed of an inner and outer portion, or member. The outer portion, which is somewhat longer than the inner one, is a slender, highly refractile body, made up of a number of thin, superimposed discs held together by a cement substance. It has the appearance of being transversely striated; it also shows very faint longitudinal markings. The inner portion, which rests upon the membrana limitans externa, is shorter than the outer one, and somewhat thicker. The outer third of this member shows distinct longitudinal striations; the inner portion is indistinctly granular, and shows, also, very fine longitudinal striations near the membrana limitans externa; these latter striations represent the terminal threads of the *fibres of Mueller.* Each rod is connected by a fibre with the outer nuclear layer adjoining. Visual purple is found in the outer member of the rods, except in a zone 3 to 4 mm. wide at the ora serrata.

The cones are flask-shaped structures, the bases of which rest upon the *membrana limitans externa.* Like the rods they are made up of two members, an outer and an inner one. The outer member is tapering, and not cylindrical like the corresponding portion of the rod; the inner one is broader in the center, and resembles the inner member of the rods in-so-far as that it has an outer striated and an inner granular appearance. Each cone connects by a fibre with the outer nuclear layer adjoining. The cones contain no visual purple, and vary a great deal in form, size, and number, in different locations.

The *membrana limitans externa* is a very delicate supporting membrane, containing perforations corresponding exactly to each rod and cone, and separating them from the layer beneath.

The *outer nuclear layer* consists mainly of nuclei, which are so numerous and thickly placed as to appear to constitute the whole

layer. Each rod is prolonged into this layer as a delicate, tortuous, varicosed rod-fibre, which distends into a rod granule, containing one of the nuclei; from here it passes on to the outer plexiform layer in which it terminates in a small bud. In a similar manner, each cone is prolonged into the outer nuclear layer as a cone-fibre, which expands into a spindle-shaped cone-granule containing a nucleus; it is shorter and thicker than the rod-fibre. These fibres also terminate in the outer plexiform layer—in this case as a cone swelling or cone foot, which gives off short lateral branches.

The *outer plexiform layer* consists of a reticulum of fibrous elements interwoven and crossing, both parallel and at right angles to the surface of the retina. These fibres are derived from the layer of rods and cones, from the supporting fibres of Mueller, and from the inner nuclear layer. An outer and an inner portion may be distinguished. The former is the thicker portion, making up about two-thirds of the layer; the latter shows a fine reticular structure, being made up of delicate extensions from the inner nuclear layer.

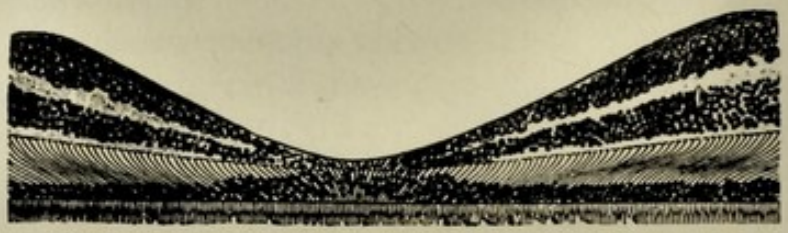
The *inner nuclear layer,* while much thinner than the outer nuclear layer, is the most complicated of all the retinal structures. It consists almost entirely of cell nuclei; these give off processes, which vary in number as well as direction. In this layer are found, among others, the so-called horizontal, and bipolar cells, as well as the nuclei of Mueller's supporting fibres. Capillary branches of the arteria centralis retinæ are to be seen in this layer.

The *inner plexiform layer* is similar to the inner portion of the outer plexiform layer, in that it has a fine reticular appearance. Several secondary or sublayers are recognized, although they are not very distinct in the human retina. This layer is crossed by retinal vessels.

The *ganglion cell layer* shows, on the nasal side, a single row of ganglion cells, while on the temporal side, in the extra foveal region, the cells are superimposed. Lying between the cells, are the supporting fibres of Mueller. Neuroglia cells are also present. This layer varies in thickness in certain portions. The cells, which have a round, clear nucleus, vary greatly in appearance and in size; they are multipolar, and are provided with dendrites, which broaden out in the inner plexiform layer. They are, in general, provided with axis cylinders which go over into the nerve fibres of the adjoining layer.

The *nerve-fibre layer* is thickest about the optic nerve entrance, except on the temporal side. It decreases in thickness toward the periphery, first rapidly, and then more gradually. This layer shows

a delicate fibrous structure. On the nasal side its elements are arranged radial to the optic nerve entrance; on the temporal side this arrangement is disturbed, in that the fibres bow away from the foveal region. Grouping in small bundles is characteristic of the nerve-fibres everywhere in the retina. They are non-medulated, and are, in general, spread out in one plane, except at the disc, where the fibres are superimposed. In addition to the nerve fibres and Mueller's supporting fibres, this layer contains neuroglia, consisting of cells and fibres, which form a meshwork between the nerve fibres. Here also are found the branches of the arteria and vena centralis retinæ, which are imbedded among the fibres, and, in part, in the ganglion cell layer. The vessel wall is but slightly developed—this is particularly true of the muscularis.



Section through the Human Macular Region. (Graefe-Saemisch.)

The *membrana limitans interna* is a structureless, homogeneous layer, previously referred to as the hyaloid membrane; it separates the vitreous from the retina. By some authorities it is regarded as a layer of the retina, while others consider it an independent structure.

The macular region includes the *macula lutea,* which is the most sensitive part of the retina, is a circular region about 2 mm. in diameter, lying directly in the axis of vision. It is about 1 mm. below, and 3.5 mm. from the center of the nerve head, toward the temple.

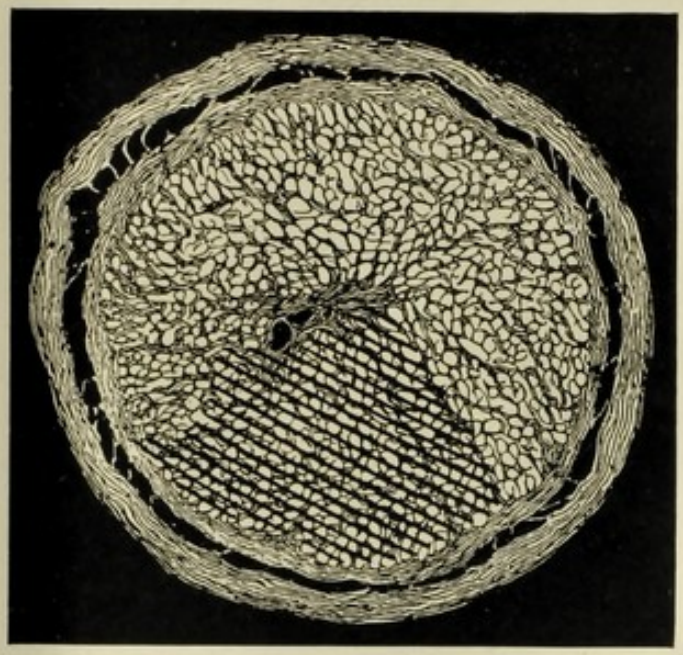
Occupying the center of this region is a minute pit or depression, called the fovea centralis retinæ, which varies slightly in size, but usually measures 0.5 mm. across. With the ophthalmoscope it shows as a brownish-red spot, somewhat lighter than the surrounding retina. Here visual impressions are most acute; it is this point that is directed toward the object which one wishes to see distinctly.

The layer of rods and cones attains its greatest thickness in the macular region. The rod element, however, disappears at the margin of the fovea centralis, the floor of which is occupied mainly by elongated cones, and by the thickened outer nuclear layer. The membrana limitans externa continues to separate these two layers as in the extra-foveal region. As the foveal region is approached,

the rods and cones assume an oblique direction. The supporting fibres of Mueller also become oblique as the fovea is approached, and disappear at its margin.

The outer plexiform layer becomes modified into an outer fibre layer of Henle; it becomes very thin as it passes over the floor of the fovea.

The inner nuclear layer and the layer of ganglion cells increase markedly in thickness at the margin of the fovea, but almost disappear in the center of this region.



Transverse Section of Optic Nerve in Front of the Entrance of the Central artery showing dural, subarachnoid and pial sheaths, enclosing corresponding lymph spaces. The shaded portion shows the nerve fibres supplied to the macular region. (Merkel, Ball.)

The inner plexiform layer and the nerve fibre layer apparently cease at the margin of the fovea, although, according to Dogiel, a wide-meshed plexus of fibres extends over the floor.

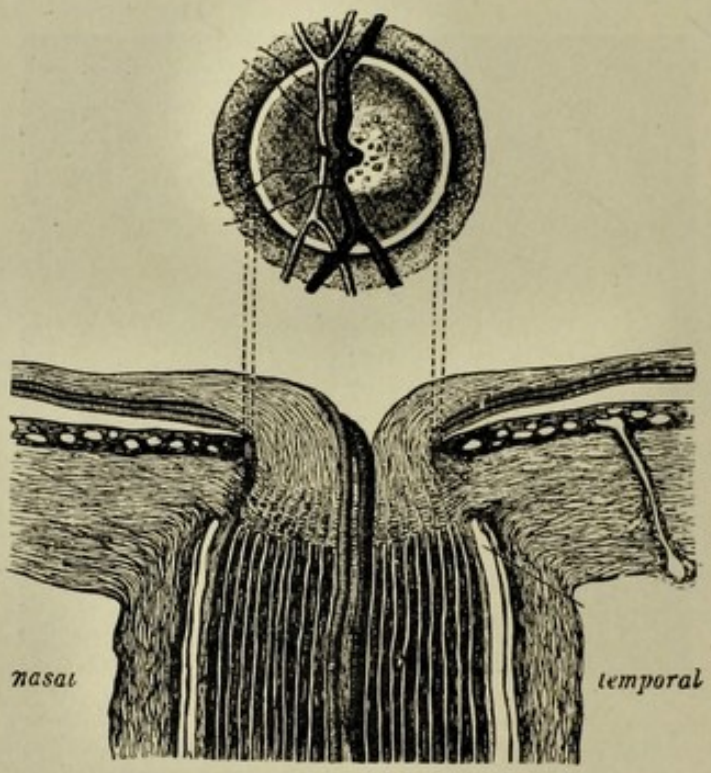
The membrana limitans interna continues unchanged over the floor of the fovea.

The **optic nerve** proper is divided into an orbital and an intracranial portion. The nerve pierces the eyeball at the posterior end of the optic axis, about 3 mm. to the inner or nasal side, and about 1 mm. below the horizontal meridian. Here it forms the nerve-head, optic papilla, or optic entrance. It is made up of nerve bundles separated by connective tissue and lymph spaces.

The *orbital portion* of the nerve extends from the optic foramen to the papilla. It is a round, S-shaped, whitish cord, 30 mm. in

length, and about 5 mm. in diameter. The double curve permits of free movement of the eyeball during its rotations.

This nerve has three sheaths, all derived from the brain coverings. The outer, or *dural sheath,* continuous with the dura mater, loosely covers the nerve and at the globe blends with the sclera. The *pial sheath,* an extension of the pia mater, directly encloses the nerve bundles as a whole, and gives off the septa that divide them from one another, thus forming part of the nervous framework. Between



The Optic Nerve Entrance, Showing the Appearances by the Ophthalmoscope, and a Sectional View. (Fuchs.)

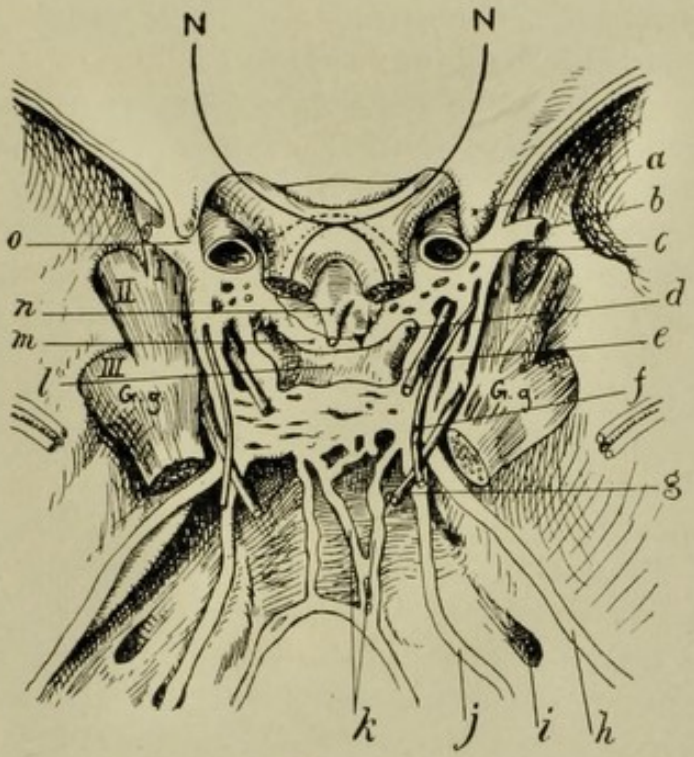
these two coverings is the *arachnoid sheath,* a delicate septum closely joined to the dural sheath, with which it fuses near the globe; some of the fibres are recognizable in the tissues of the sclera. The *intervaginal space* lies between the dural and pial coverings; it is incompletely divided into two subpaces by the arachnoid sheath, viz.: a sub-dural and a sub-arachnoid space, both of which communicate directly with the corresponding intracranial spaces. The walls of these spaces are lined with endothelium, and are probably true lymph channels. From the pial sheath and its septal prolongations into the optic nerve proper, numerous capillaries are supplied to the nervous tissue, supplemented by twigs from the central retinal vessels.

The existence of spaces within the optic coverings, that com-

municate so directly with the brain, explains the lesions of the nerve tissues in so many intracranial diseases.

If one examine a transverse section of the optic nerve, it will be found to be made up of about 800 distinct medullated nerve fibres, separated from one another by connective tissue septa, derived, as just explained, from the pial sheath.

At the optic entrance, the outer layers of the sclera are continued as the outer nerve sheath; while the inner layers cross the nerve, interlacing with the bundles to form a sieve-like opening called the lamina cribrosa. At this point the fibres lose their medullary covering, and pass into the eye as naked, transparent axis-cylinders.



Optic Chiasm.

a, Anterior clinoid process; b, Medial cerebral vein; c, Carotid artery; d, Posterior clinoid process; e, Oculomotor nerve; f, Trochlear nerve; g, Abducens nerve; h, Superior petrosal sinus; i, Internal auditory meatus; j, Inferior petrosal sinus; k, Veins of basilar plexus; l, Dorsum sellæ; m, Sinus intercavernosus; n, Infundibulum; o, Ophthalmic vein.

Occasionally, however, the medulla is retained, producing in the fundus oculi a dazzling white sheaf of opaque nerve fibres spreading out from the disc.

A vascular circuit of nutrient vessels (circle of Zinn) surrounds this region, and penetrates all of the coats of the eyeball. The canal through which the optic nerve enters the globe is the weakest part of the eye coats, and is generally the first part to give way under increased intraocular pressure, as, for instance, in glaucoma.

An optic nerve from each eyeball joins its fellow at the chiasma,

which is situated in the optic sulcus of the sphenoid bone. One-half of the fibres of each nerve pass over, join the opposite nerve, and proceed toward the occipital lobe as an optic tract. These wind around the crura cerebri, making connections with practically every central neuron and with one another, until they reach and form the parts surrounding the calcarine fissure of the occipital lobe, which is known as the cortical center of cerebral vision. Thus each retina is connected by nerve fibres with the great centers of both sides of the brain.

The temporal or outer half of the right retina, and the nasal half of the left retina are supplied by right sided fibres; the nasal half of the right retina and the temporal half of the left retina are innervated from the left side of the brain.

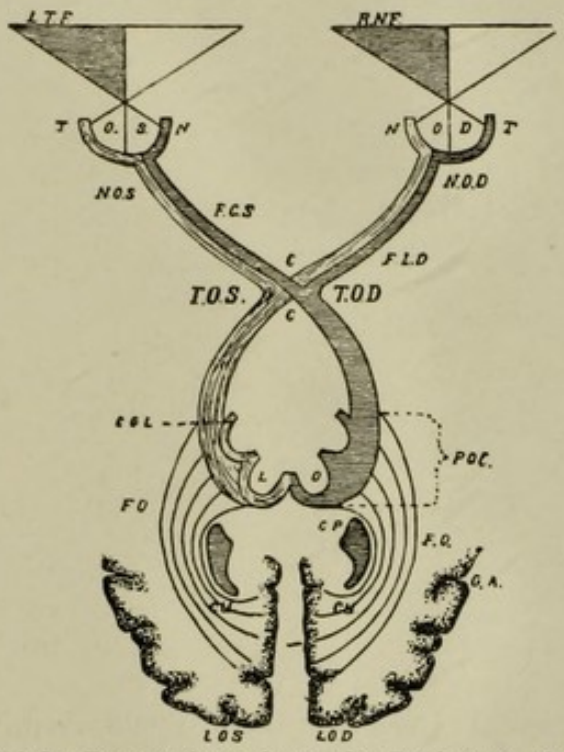
The *optic papilla* (optic disc, porus opticus, nerve-head) rises above the general level of the fundus 1.5 mm., as a result of the nerve fibres becoming superimposed. This is the locality where the axis cylinders and other tissues of the optic nerve enter the eyeball, bend over the scleral margin, and are afterwards displayed upon the fundus oculi as part of the retina. Seen by the ophthalmoscope, the nerve-head is a pinkish, almost circular area from 1.5 mm. to 1.75 mm. in diameter. It is situated about 3.5 mm. to the nasal side and about 1 mm. above the level of the fovea centralis. The central (or central-nasal) four-fifths (or a larger portion in many instances) of the disc is occupied by a funnel-shaped depression called the physiological "cup," or excavation; this is to be distinguished from depressions in the nerve-head due to diseased conditions.

It is here that the *arteria centralis retinæ* enters, and the corresponding *vena centralis retinæ* leaves, the eyeball. These vessels enter the nerve 20 mm. from the sclera, and run between the nerve bundles to the center of the disc, where they divide and subdivide dichotomously until they disappear as minute capillaries. After leaving the disc the chief branches are called the superior and inferior temporal, and the superior and inferior nasal, arteries and veins. In addition to these, fine branches run toward the macular region, and also toward the nasal side.

The whitish or light pink appearance of the papilla, as seen with the ophthalmoscope, is due to the fact that the lamina cribrosa and the medullated fibres beyond it, are seen through the translucent axis-cylinders that make up the substance of the papilla itself. Outlining the disc is the edge of the sclera; when seen with the ophthalmoscope it appears as the white scleral ring. In many cases, one may also distinguish at the margin of the papilla some of the underlying

choroidal pigment, which shows as a crescentic line, partially or completely surrounding the disc. Within all of these is the light-pink color of the nerve itself.

Optic nerve fibres compose most of the papillary substance and do not perceive light; hence we find with the perimeter that the disc corresponds to a blind area or scotoma, called in this instance the blind spot of Mariotte.



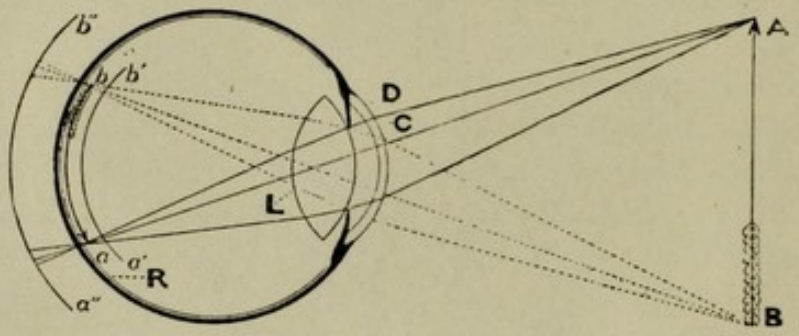
The Path of Light Impressions from the Retina to the Occipital Lobe. (Visual Center.)

In their course from the calcarine fissure in the brain the optic radiations send fibres to almost every large center—both cerebral and spinal—thus demonstrating anatomically what the ophthalmologist has long known from clinical observation, viz.: that almost every lesion of the brain or cord is sooner or later followed by morbid alterations in, or functional disturbances of, some portion of the visual mechanism.

To follow again and briefly the path of the optic fibres:—In the occipital lobe they occupy a narrow area and rather shallow position about the edges of the calcarine fissure. Passing forward and downward toward the base of the brain from the calcarine fissure and cuneus, the optic fibres from each hemisphere dip beneath the angular gyrus, receiving numerous radiations from all the basal neurons, especially from the oculomotor nuclei, external geniculate bodies, the anterior corpora quadrigemina, the optic thalmus, the medulla,

and the spinal cord. They then wind around the crus cerebri to form the tractus opticus, and, meeting a similar collection from the opposite side, join to form the chiasma or optic commisure. A semi-decussation of the fibres now takes place; about one-half of the optic fibres in each tract cross over and, uniting with half from the opposite tract, become one of the two optic nerves.

Although many animals possess a chiasma, it is those that habitually see with both eyes together, and obtain stereoscopic or binocular single vision (for example, birds, man and the higher monkeys) that exhibit distinct crossed and uncrossed fibres in the chiasma, optic nerve and retina. Such animals realize the height, breadth, and depth of objects, and one readily attributes these three dimensions to them. To accomplish these desirable ends, the light rays must fall upon the corresponding points of each retina, and especially upon

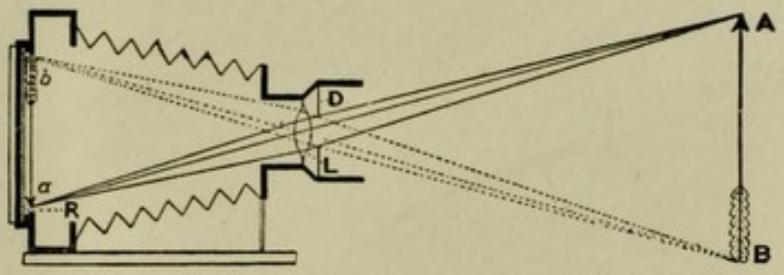


The Eye as a Photographic Camera. (Baker.)

similarly placed areas of the macular region. At birth the two human eyes do not see together; the infant expends from six months to a year in acquiring binocular vision; in the course of time he learns, mostly by experience, to judge of the distance and locality of objects, as well as their physical characteristics. Should the individual be born blind, and late in life obtain fair vision (as in the removal of congenital cataracts) he must "learn to see" just as he would have been obliged to do had he come into the world with a normal visual apparatus. In many cases of early squint, when the squinting eye has been straightened, the patient must laboriously strain the corrected eye to see and work with its fellow before binocular vision can be attained.

The similarity between a photographic camera and the human eye is quite apparent. The light rays, having been properly focused by the dioptric apparatus (cornea, iris, lens, ciliary muscle, etc.), fall upon, and filter through, the various internal layers of the sensitive plate called the retina, until they reach the rods and cones; the tips of the former are covered with a layer of eight-sided pigmented

epithelial cells. Here the incident images are actually photographed; the rods and cones probably recognizing white light and the form of objects; the cones perceiving colors. The simile may be carried still further, because the chemical changes that produce the photographic picture take place equally in the retinal pictures and in the sensitized films of the camera. It is well established that it is due to actual photo-chemical changes in the visual purple (rhodopsin) within the choroido-retinal epithelium, and upon the tips of the retinal rods, that visual images are photographed upon the background of the human eye. The visual sensations are then conducted, by means of the optic nerve and optic tracts, to the psychic center for vision in the posterior aspect (calcarine fissure) of the occipital lobe, where, in conjunction with other neurons with which it is joined, they are variously interpreted by the individual as the senses

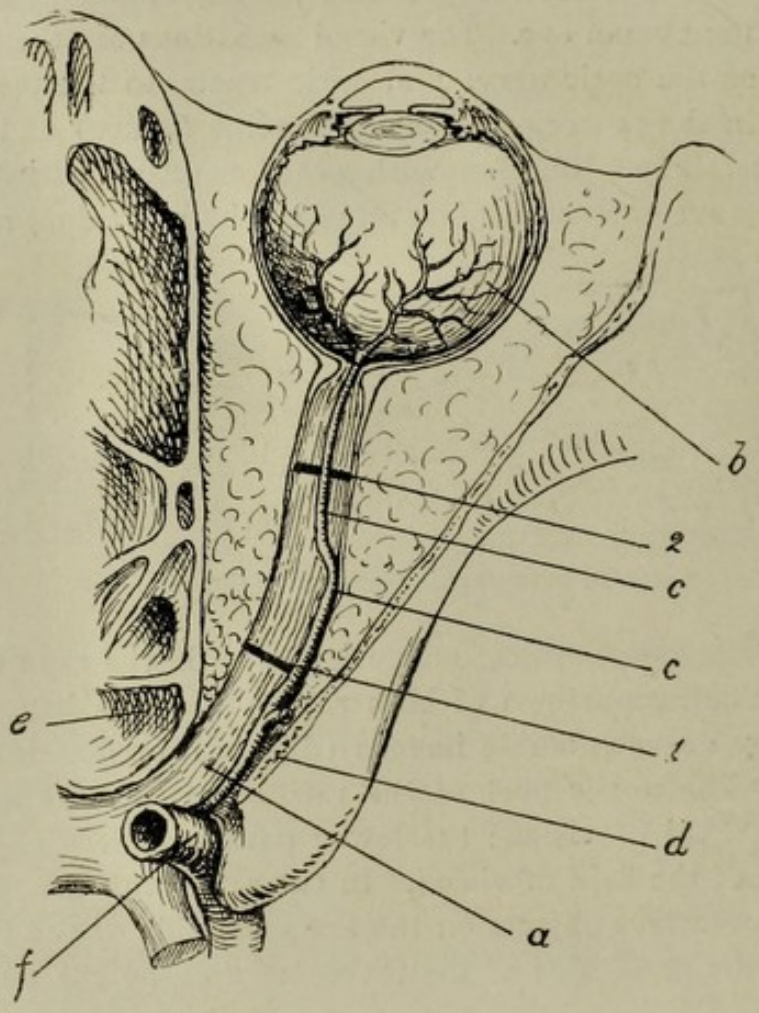


Photographic Camera. (Baker.)

of light, form, color, optical memories, etc. If the rays of light fall on corresponding portions of both retinæ, a single image is the result; if they do not, double images (diplopia, or double vision) are produced. The upper part of the retina sees objects in the lower part of the field of vision; the lower part perceives objects in the upper part of the field of vision. In the same way the nasal half of the retina perceives objects on the temporal side of the fovea, while objects on the nasal side of the fovea are seen by the temporal half of the retina.

The eyeball and its external appendages are placed within the **orbital cavity,** which is pyramidal in shape. The walls of this cavity are formed by no less than seven bones, namely, the superior maxilla, frontal, sphenoid, malar, palate, lachrymal, and ethmoid. The inner wall, which is very thin, separates the orbital cavity from the ethmoid cells and the sphenoid sinus; it is formed by the nasal process of the superior maxilla, the internal angular process of the frontal, the os planum of the ethmoid, the lachrymal bone, and the body of the sphe-

noid. The orbital roof, in front, is the orbital plate of the frontal bone at the apex, behind, it is the lesser wing of the sphenoid. It sometimes happens that a portion of the roof of the orbit, which is always thin, is lacking, in which case the periosteum and dura are in close apposition. Stabbing injuries of the orbit may easily be fatal owing to this ready access to the brain cavity. On the other hand, very large foreign bodies may be retained in the cavity of the orbit

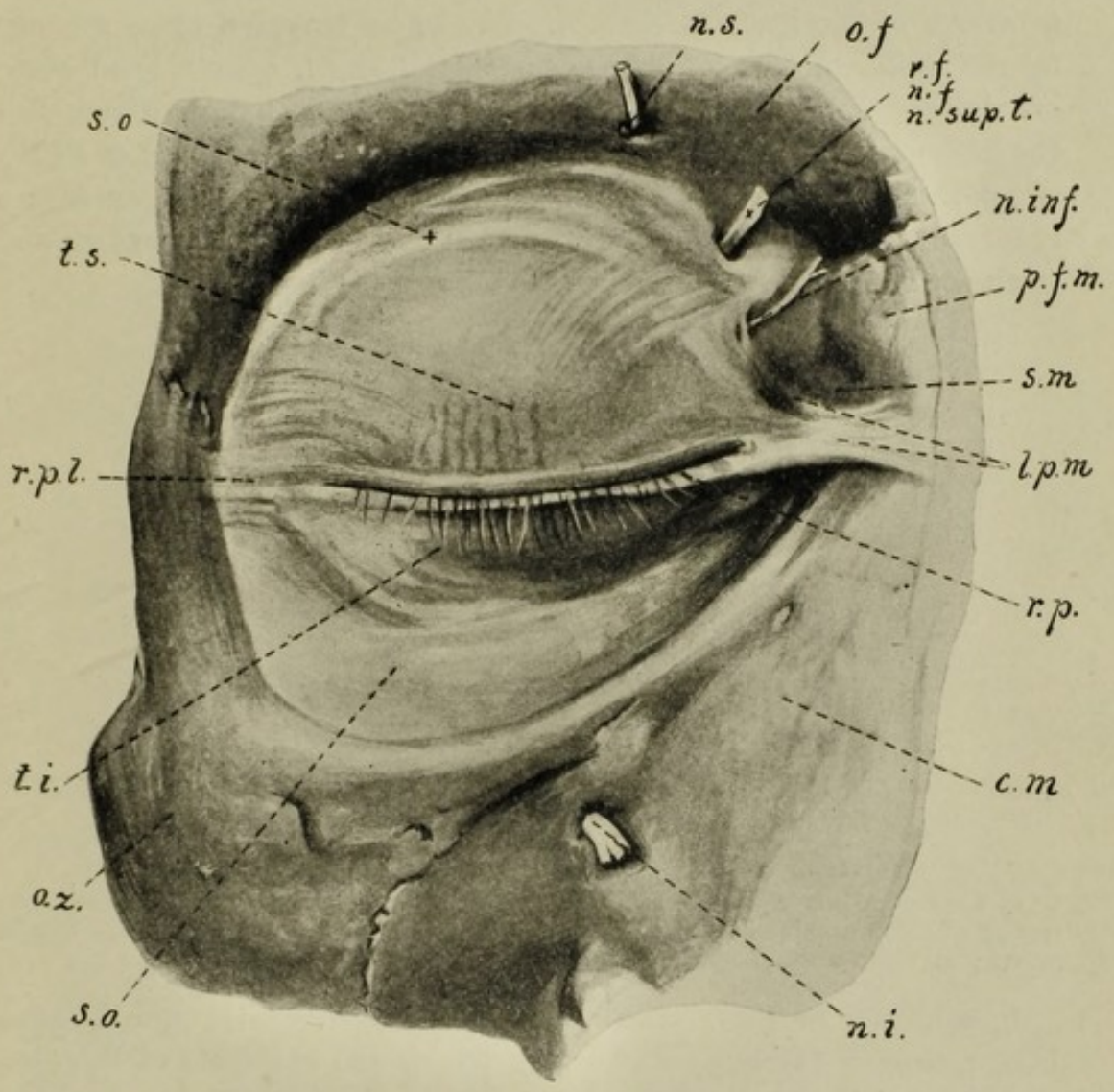


Horizontal Section of the Orbit, Showing the Central Artery and the Seat of Lesions in Both Bulbar and Retrobulbar Optic Neuritis.

a, Optic Nerve; b, Eyeball; c, Extraneural portion of the central artery of the retina; c, The intraneural portion; d, External wall of the orbit; e, Ethmoid cells; f, Internal carotid; 1, Possible situation of optic lesions in bulbar neuritis; 2, Possible situation of optic lesions in retrobulbar neuritis.

without raising a suspicion of their presence, owing to the comparatively wide space existing between the globe and the orbital walls. The outer wall of the orbit is formed behind by the greater wing of

the sphenoid; in front by the orbital process of the malar bone, and the external angular process of the frontal bone. The floor of the orbit, which slopes downward, forward, and outward, is composed of the orbital plates of the superior maxilla and the palate bone, and the orbital process of the malar bone. It forms the roof of the antrum



Septum Orbitale, Viewed from in Front. The m. orbicularis oculi has been dissected off. (After Spalteholz.)

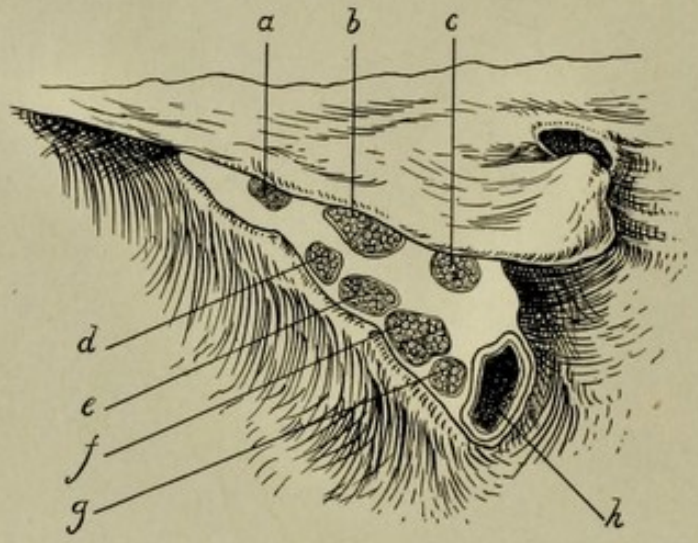
s.o., septum orbitale; t.s., tarsus superior; r.p.l., raphé palpebralis lateralis; t.i., tarsus inferior; o.z., os zygomaticum; n.s., n. supraorbitalis; o.f., os frontale; r.f., n. f., n. frontalis; n. sup. t., n. supratrochlearis; n. inf., n. infratrochlearis.; p.f.m., proc. frontalis; s.m., saccus lachrymalis; l.p.m., ligament, palpebral, median.; r.p., rima palpebrarum; c.m, corpus maxillæ; n.i., n. infraorbitalis.

of Highmore. The margins of the orbit are composed of a hard, and very strong, bony ring, well calculated to resist blows and other forms of injury from blunt weapons. The depth of the cavity, when

not covered with soft parts, is about 1¾ inches; at its anterior opening, or base, the vertical diameter is about 1¼ inches, and the transverse diameter about 1½ inches.

Of the *nine openings into the orbit,* the most important ones are the *optic foramen* and the *sphenoidal fissure* at the apex of the cavity.

Through the former pass the optic nerve and the ophthalmic artery, a branch of the internal carotid. The latter foramen gives passage to the motor nerves of the eyeball (the third, fourth, and sixth cranial nerves); to the three branches of the ophthalmic division of the fifth cranial nerve; to filaments from the cavernous plexus of the sympathetic; the orbital branch of the middle meningeal artery; a recurrent branch from the lachrymal artery to the dura mater; and to the ophthalmic vein.



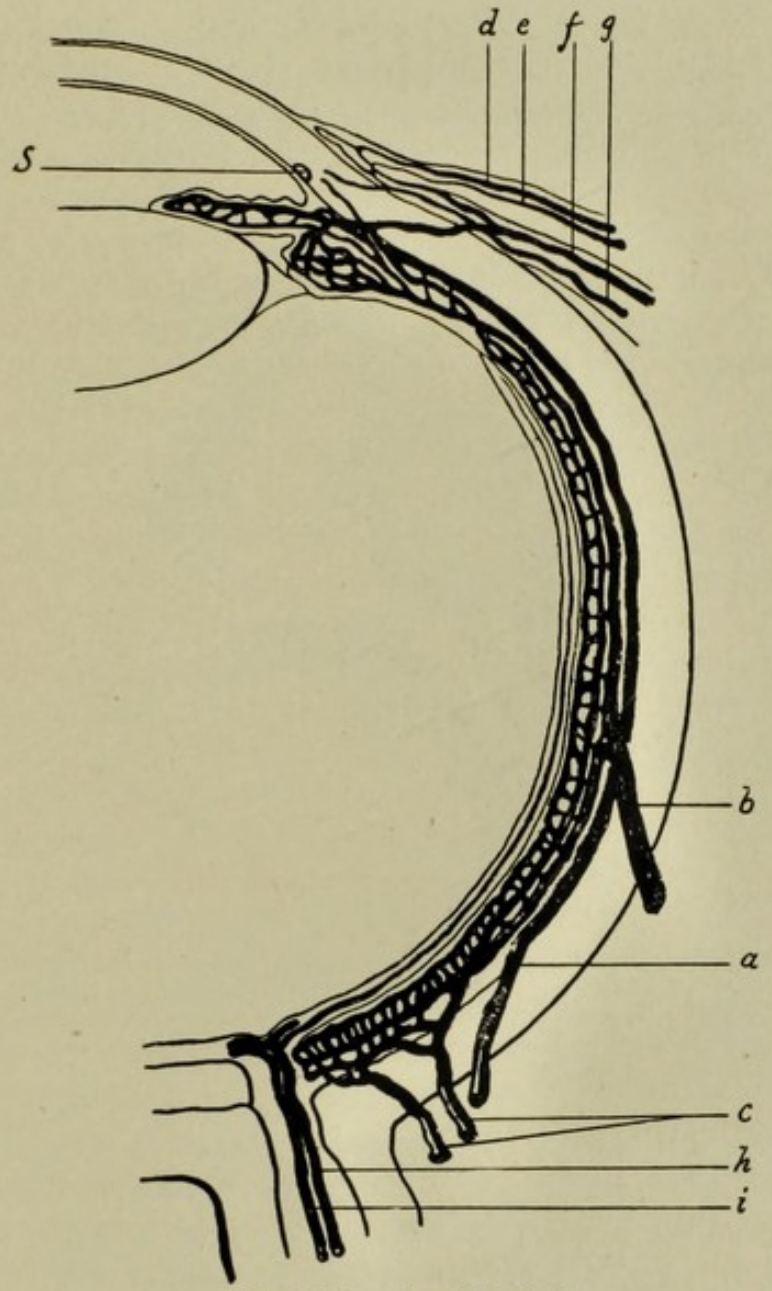
Nerves and Vessel Passing through the Sphenoidal Fissure.

a, Lachrymal nerve; b, Frontal nerve; c, Fourth cranial nerve; d, Superior division of third cranial nerve; e, Nasal nerve; f, Inferior division of third cranial nerve; g, Sixth cranial nerve; h, Ophthalmic vein.

In addition to these openings, are the *supraorbital* and *infraorbital foramina* (through which pass like-named filaments of the ophthalmic division of the fifth nerve), and the bony canal for the nasal duct. The last named canal runs downward, outward, and backward, as a rule; although its direction varies somewhat even in normal skulls. It opens into the inferior meatus of the nose underneath the inferior turbinate bone.

The orbital contents, forming a soft, cone-shaped mass that accurately fits the cavity, consist of the eyeball with its envelopes, the extra-ocular muscles, blood vessels, lachrymal apparatus, optic, ciliary, and other nerves and numerous ganglia, with considerable

adipose and connective tissue, which fill out the interspaces. These various structures are held together by prolongations of the orbital fascia, which is a continuation of the dura mater.

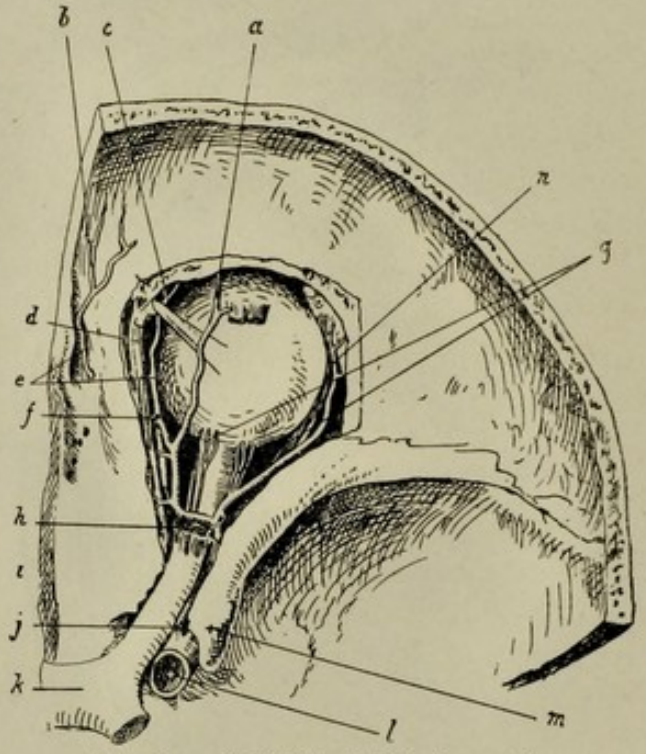


Blood Vessels of Eyeball.

a. Long posterior ciliary artery.
b. Vena vorticosa.
c. Short posterior ciliary arteries.
d. Conjunctival artery.
e. Conjunctival vein.
f. Anterior ciliary artery.
g. Anterior ciliary vein.
h. Central artery of retina.
i. Central vein of retina.
s. Canal of Schlemm.

The *orbital fascia* lines both the optic foramen and the sphenoidal fissure, and gives off coverings to all the important nerves and vessels that pass through them. It is prolonged forward as a covering

of the extra-ocular muscles, and also forms the thin, tough periosteum of the orbit. As this latter structure, it continues forward to near the margin of the orbit, where it divides into two layers—one is continuous with the periosteum of the orbital margin, the other joins the fascia of the lids connected with the tarsal cartilages, and forms the fascia tarso-orbitalis, or orbital septum. When the lids are closed, a temporary anterior wall of the orbit is formed.



Arteries of Right Orbit from Above.

a, Supraorbital artery; b, Anterior meningeal artery; c, Frontalis artery; d, Superior oblique muscle; e, Anterior ethmoidal artery; f, Posterior ethmoidal artery; g, Posterior ciliary arteries; h, Muscular ramus; i, Optic nerve; j, Ophthalmic artery; k, Optic chiasm; l, Internal carotid artery; m, Anterior clinoid process; n, Lachrymal artery.

The fascia also forms the *capsule of Tenon*, a thin, translucent, fibrous membrane, which covers the posterior two-thirds of the globe from the tendinous insertion of the straight muscles which pass through it, to the optic nerve, with the external sheath of which it is identical. A second layer separates the eyeball from the bed of fat upon which it rests. The two layers form a closed sac (*Tenon's space*), lined, in part, by flat, endothelial cells. This sac is thought by some to constitute a true lymph space, and to communicate with the arachnoid and dural spaces of the optic sheath. Tenon's capsule also forms, with the tendons and part of the bellies of the orbital muscles, a sort of cup-like receptacle, which not only cuts off important organs of the orbital cavity from the outside world, limiting

the danger from external agents, but, at the same time, enables the globe to be rotated by the extra-ocular muscles, without friction.

Lymphatic vessels and glands are not found in the orbital cavity.

The *ophthalmic artery*, a branch of the internal carotid, enters the orbit by way of the orbital foramen, below, and on the outer side of the optic nerve. It crosses over the nerve and passes forward along the inner wall of the orbit below the superior oblique muscle, terminating in a frontal and a nasal branch; the latter gives off a branch to the upper part of the lachrymal sac.

The lachrymal, or first branch of the ophthalmic artery, is given off near the optic foramen, and passes forward along the upper border of the external rectus to the lachrymal gland; after leaving the gland its terminal branches supply the lids and conjunctiva, anastomosing with the palpebral arteries.

The superior and inferior muscular, and the long and short posterior ciliary branches, are given off a little farther forward.

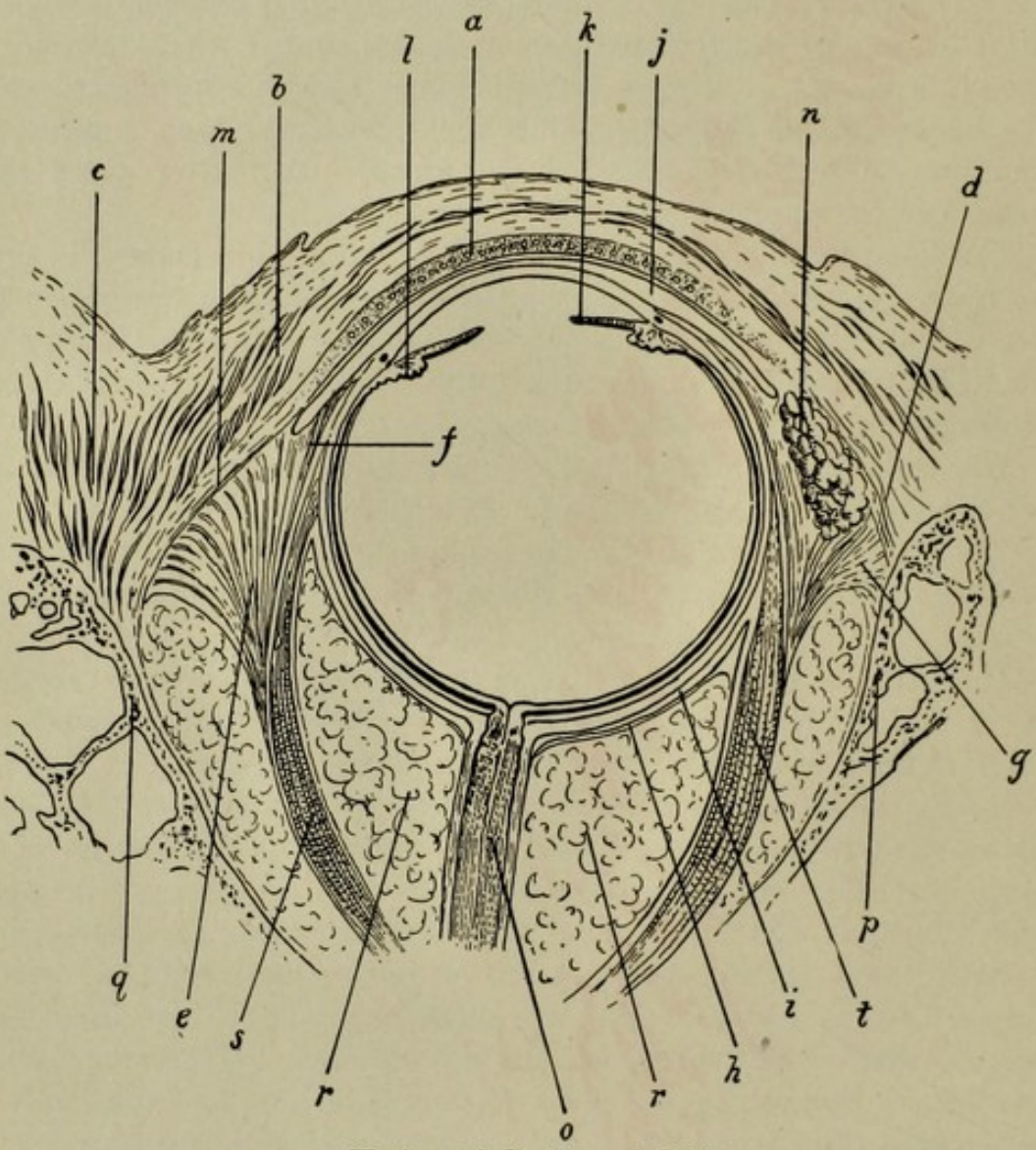
The superior muscular branch supplies the levator palpebræ superioris, the superior rectus, and the superior oblique, but is not constant.

The inferior muscular branch passes forward between the optic nerve and the inferior rectus; it supplies the external, internal, and inferior recti, and the inferior oblique. From the muscular branches —chiefly the inferior—are derived the anterior ciliary arteries, which pierce the sclera near the corneal limbus to supply the interior of the eyeball. Before entering the eyeball, however, they give off branches which terminate in the vascular plexus surrounding the cornea.

Both the *long* and *short posterior ciliary arteries* run directly forward to the eyeball, and pierce the sclera near the entrance of the optic nerve. The short posterior ciliary arteries (arteriæ ciliares posteriores breves) are from six to twelve in number; they pass directly into the perichoroidal space and supply the posterior half of the uveal tract, and the optic nerve, about which a few of the branches form a circle of anastomosis—circulus arteriosus nervi optici. The long posterior ciliary arteries (arteriæ ciliares posteriores longæ), two in number—one on the nasal side and one on the temporal side—are of large calibre. They run forward in the perichoroidal space to the front of the eyeball, without giving off any intermediate branches, supply the ciliary muscle and terminate in the arterial circles of the iris, anastomosing with the anterior ciliary arteries.

The central artery of the retina (*arteria centralis retinæ*) is one of the smallest branches of the ophthalmic. It arises near the origin

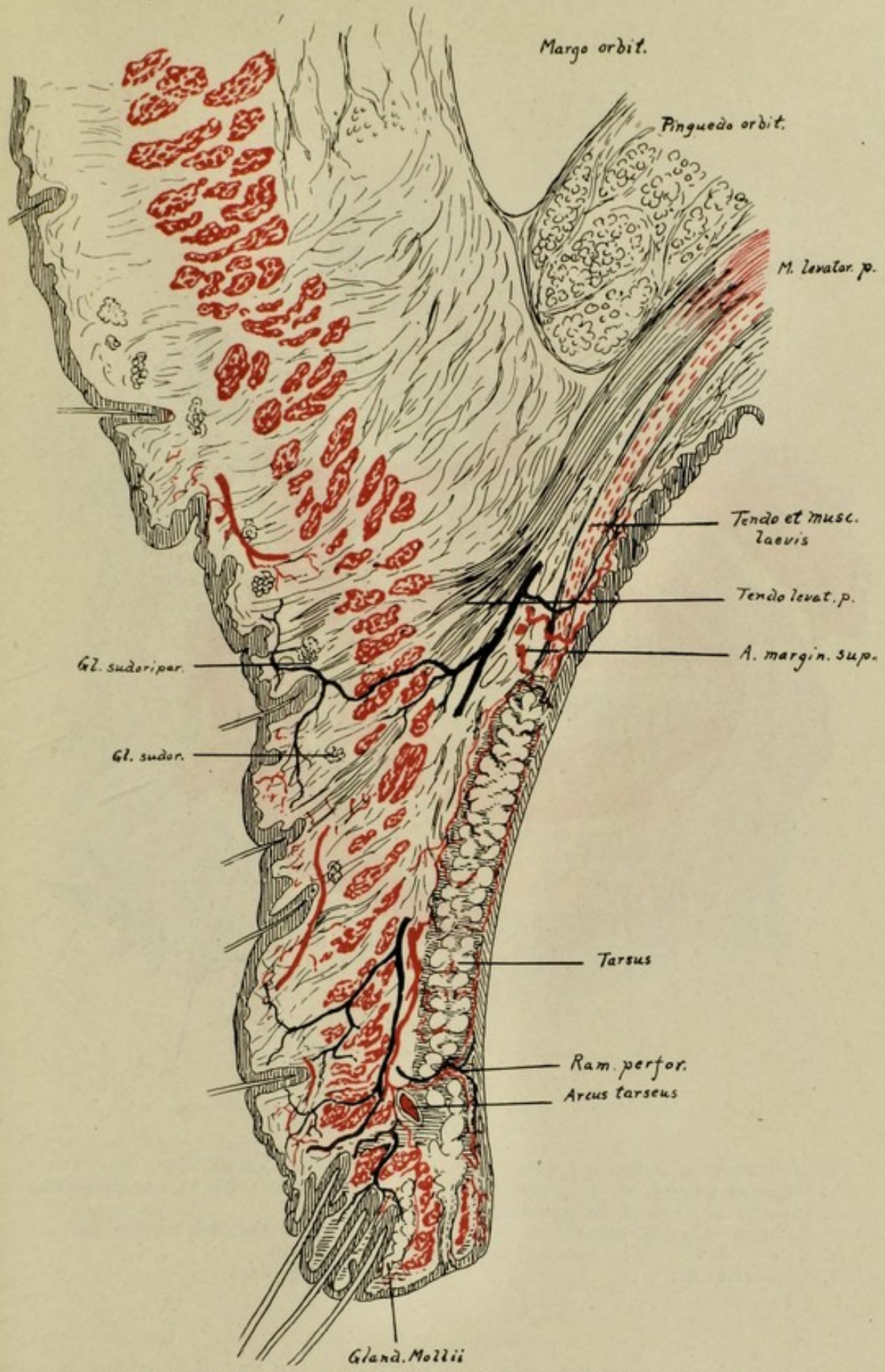
of the branches just described, and pierces the optic nerve obliquely about 20 mm. from the sclera. Upon entering the eyeball through the optic disc it is distributed over the retina as previously described.



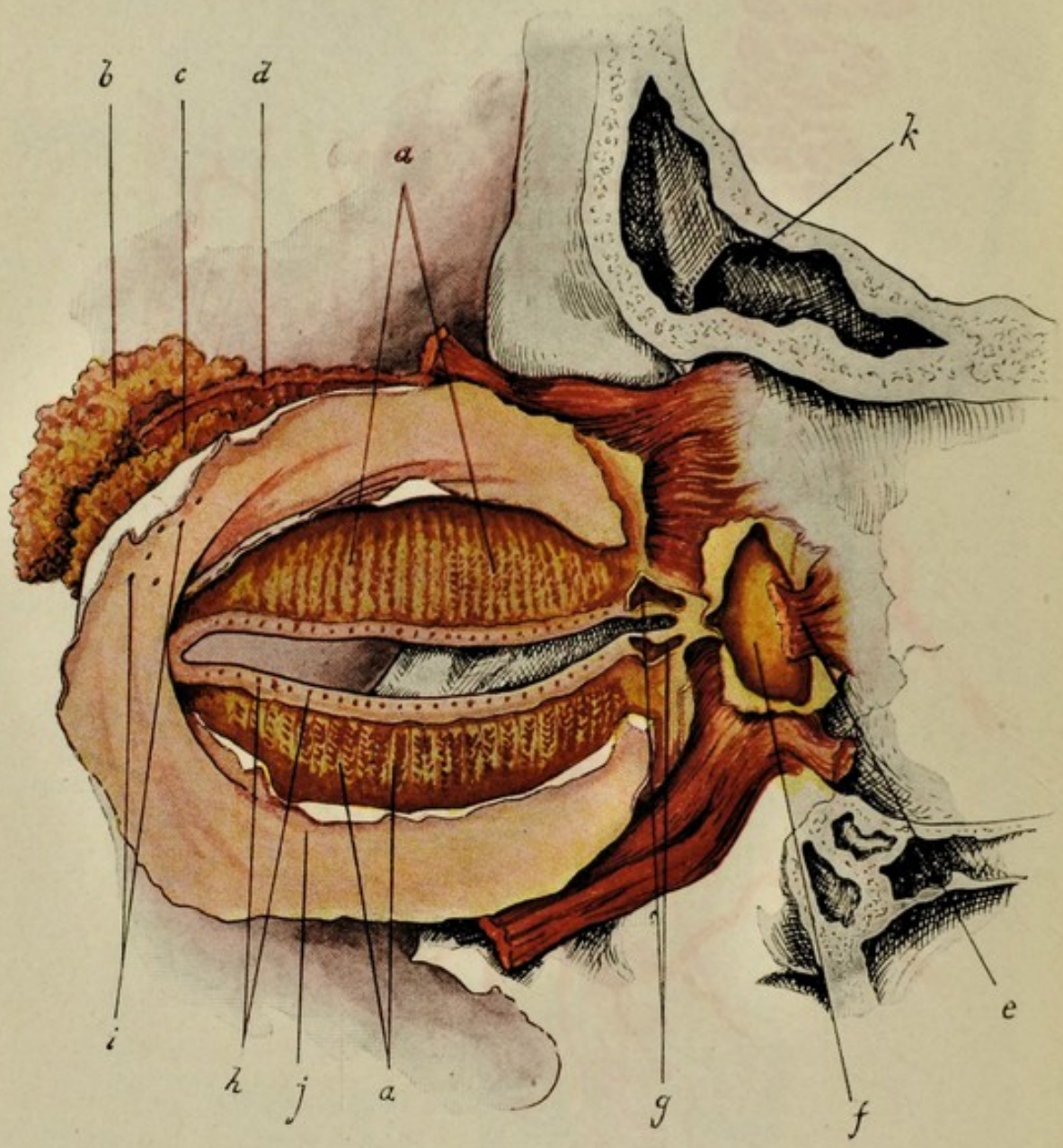
Horizontal Section of Orbit.

a. Tarsus.
b. Orbicularis.
c. Muscle of Horner.
d. Outer palpebral ligament.
e. Inner check ligament.
f. Attachment of Tenon's capsule to conjunctiva.
g. Outer check ligament.
h. Capsule of Tenon.
i. Space of Tenon.
j. Conjunctival sac.
k. Iris.
l. Ciliary process.
m. Septum orbital.
n. Lachrymal gland.
o. Optic nerve.
p. Lateral wall of orbit.
q. Mesial wall of orbit.
rr. Orbital fat.
s. Internal rectus.
t. External rectus.

The supraorbital branch, after leaving the main artery, passes upward above all the orbital muscles, and courses forward between the levator palpebræ superioris and the periosteum of the orbit to its

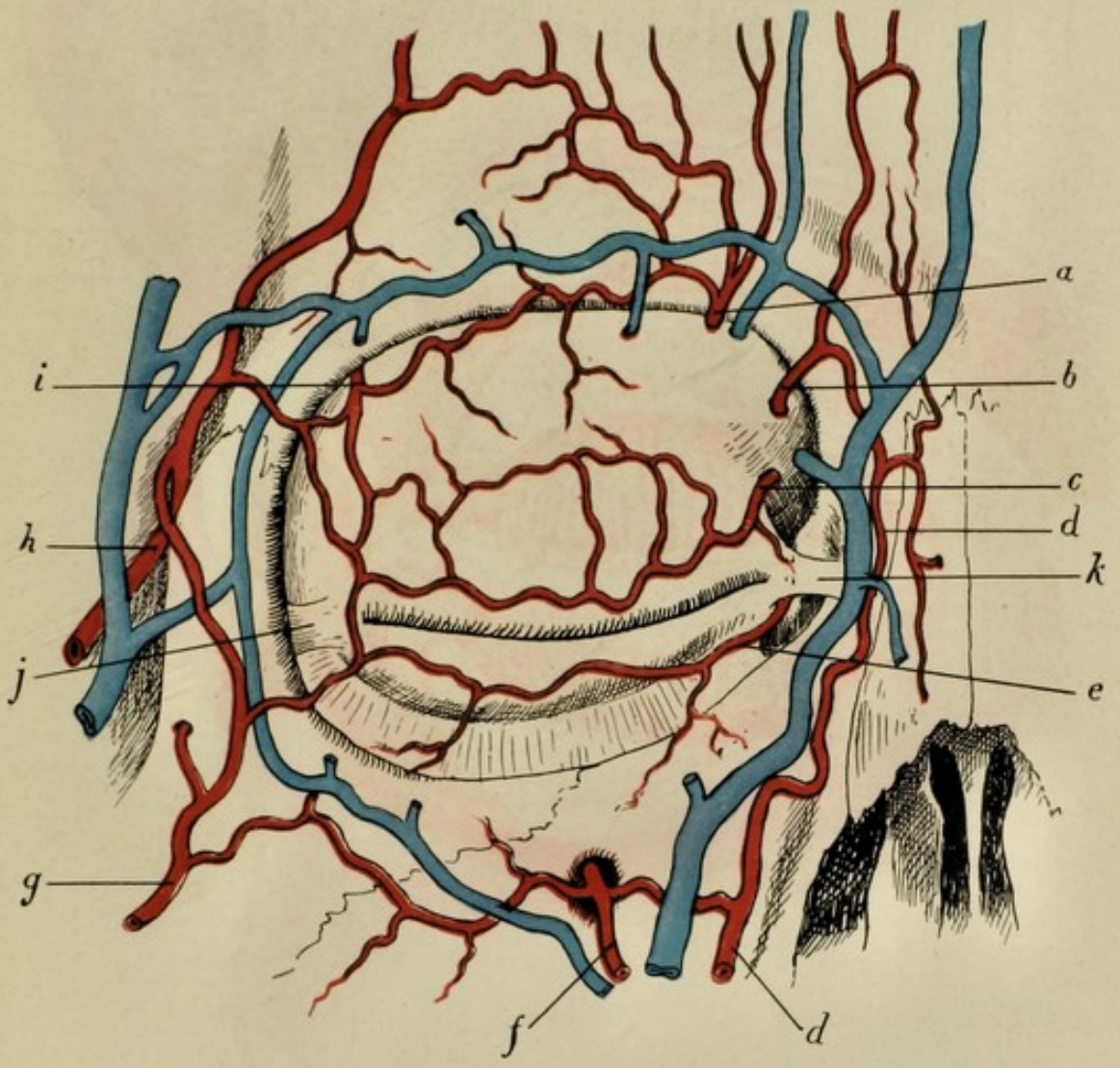


Vertical Section through the Upper Eyelid, showing also the Course of the Vessels and Nerves. (After Merkel and Kallius.)



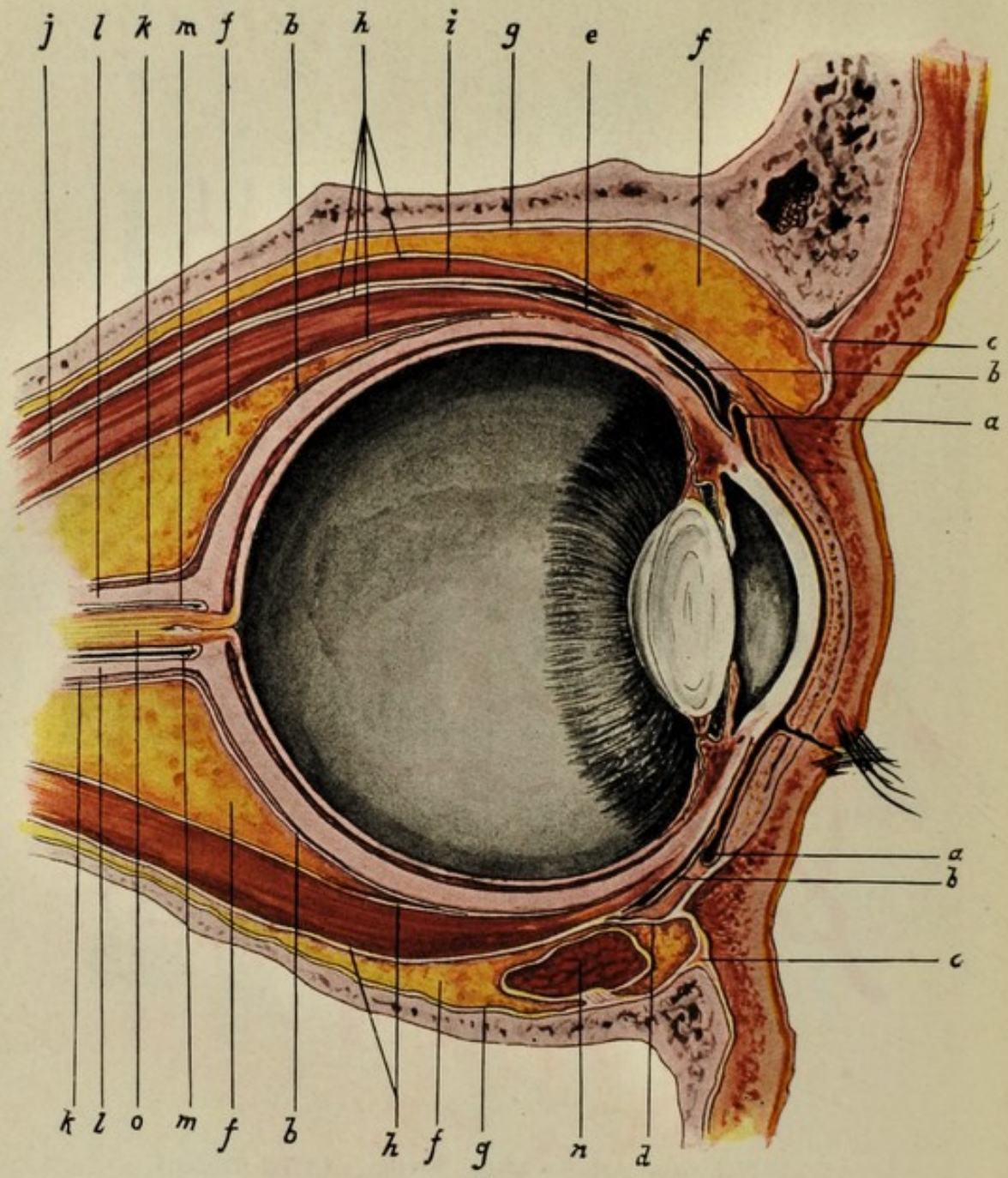
Relations of the Lachrymal Sac.

a. Meibomian glands.
b. Superior portion of lachrymal gland.
c. Inferior portion of lachrymal gland.
d. Levator palpebræ superioris.
e. Tensor tarsi.
f. Lachrymal sac.
g. Lachrymal canaliculi.
h. Orifices of ducts of Meibomian glands.
i. Orifices of the lachrymal ducts.
j. Conjunctiva.
k. Frontal sinus.



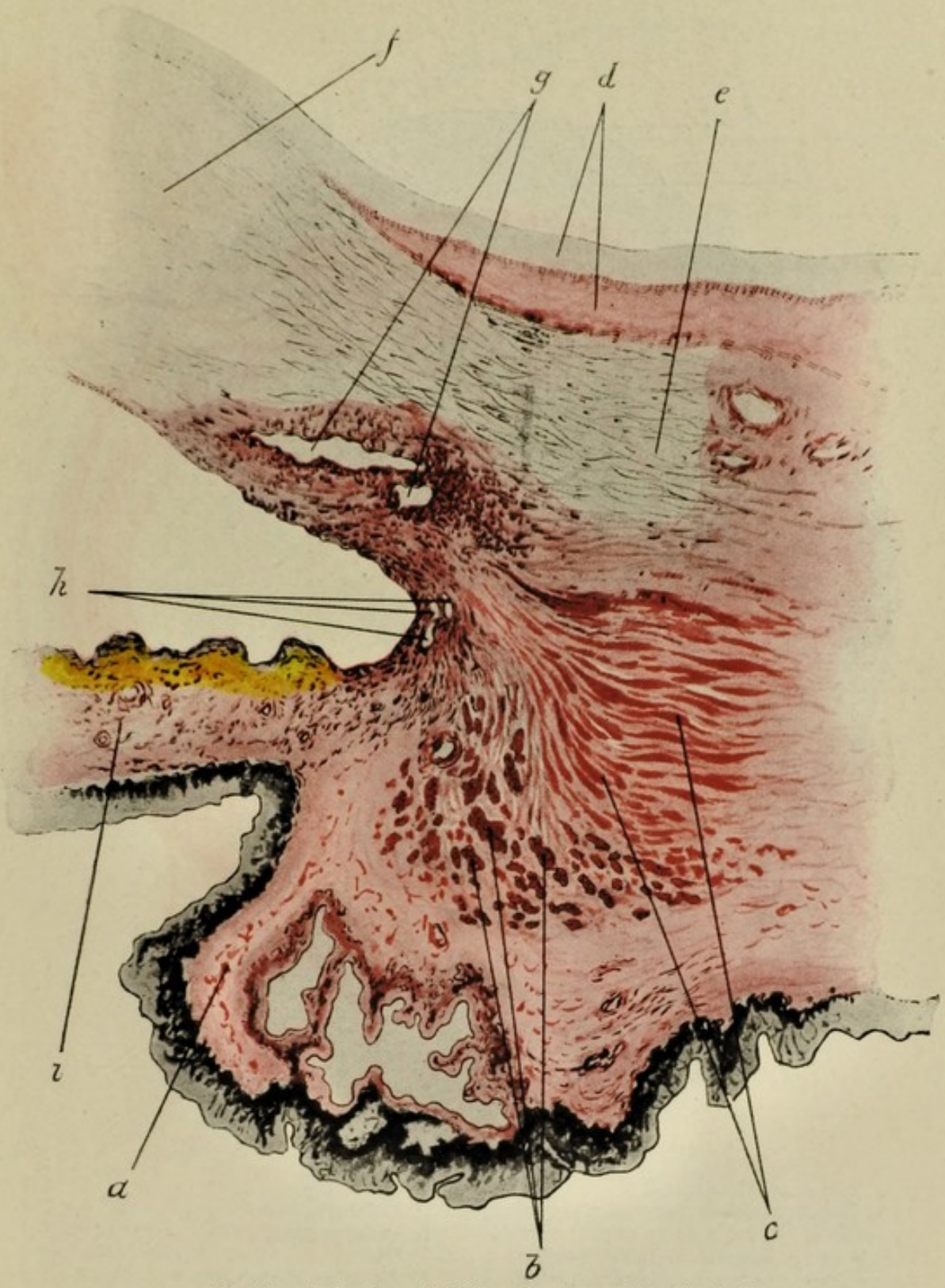
The Veins and Arteries of the Eyelids. (After Testut.)

a. Supra-orbital artery.
b. Fronto-nasal artery.
c. Superior palpebral artery.
d. Facial artery.
e. Inferior palpebral artery.
f. Infra-orbital artery.
g. Transverse facial artery.
h. Superficial temporal artery.
i. Lachrymal artery.
j. External palpebral ligament.
k. Internal palpebral ligament.



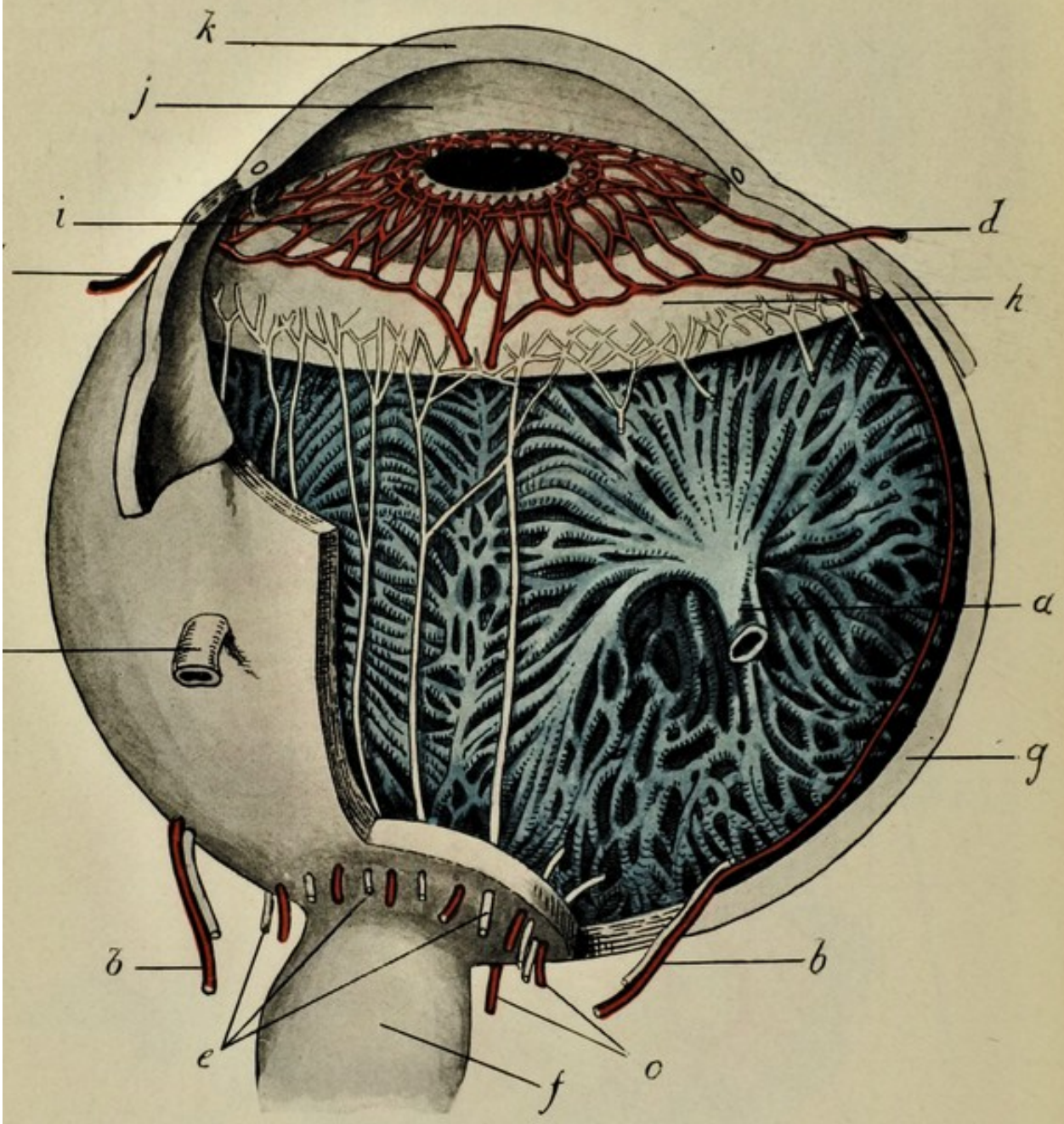
Orbital Fascia and Capsule of Tenon. Vertical Section in Line of the Optic Nerve.

a. Conjunctival fornix.
b. Capsule of Tenon.
c. Orbital septum or orbito-tarsal ligament.
d. Check ligament of inferior rectus.
e. Connection between superior rectus muscle and levator palpebræ superioris muscle.
f. Fat.
g. Periosteum of orbit.
h. Orbital fascia.
i. Levator palpebræ superioris muscle.
j. Superior rectus muscle.
k. Supravaginal lymph space.
l. Fibrous sheath of optic nerve.
m. Intervaginal lymph space.
n. Inferior oblique muscle.
o. Optic nerve.



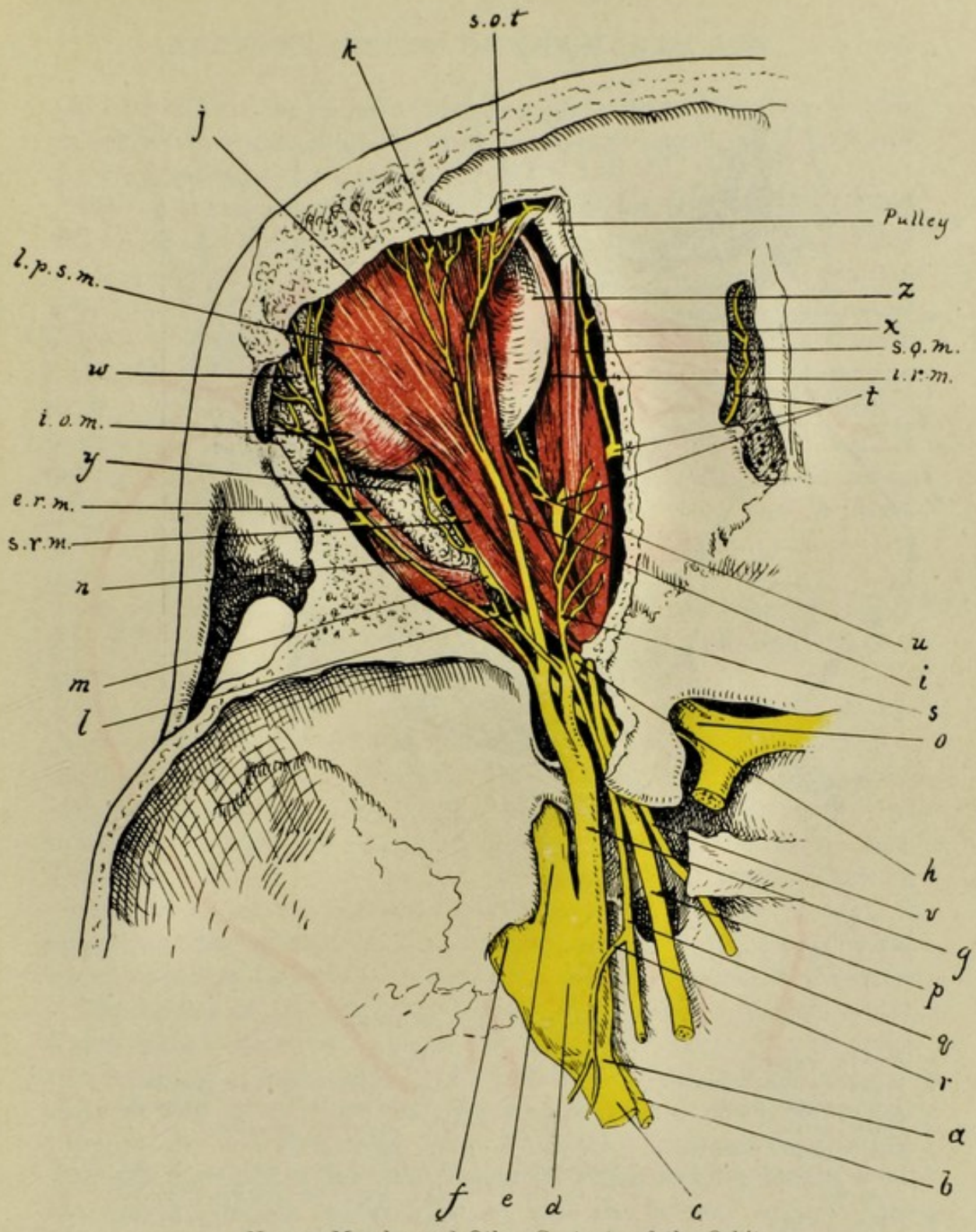
Meridional Section of Ciliary Region of the Eyeball.

a. Ciliary process.
b. Circular fibers of ciliary muscle.
c. Meridional fibers of ciliary muscle.
d. Conjunctiva.
e. Sclera.
f. Cornea.
g. Canal of Schlemm.
h. Spaces of Fontana.
i. Iris.



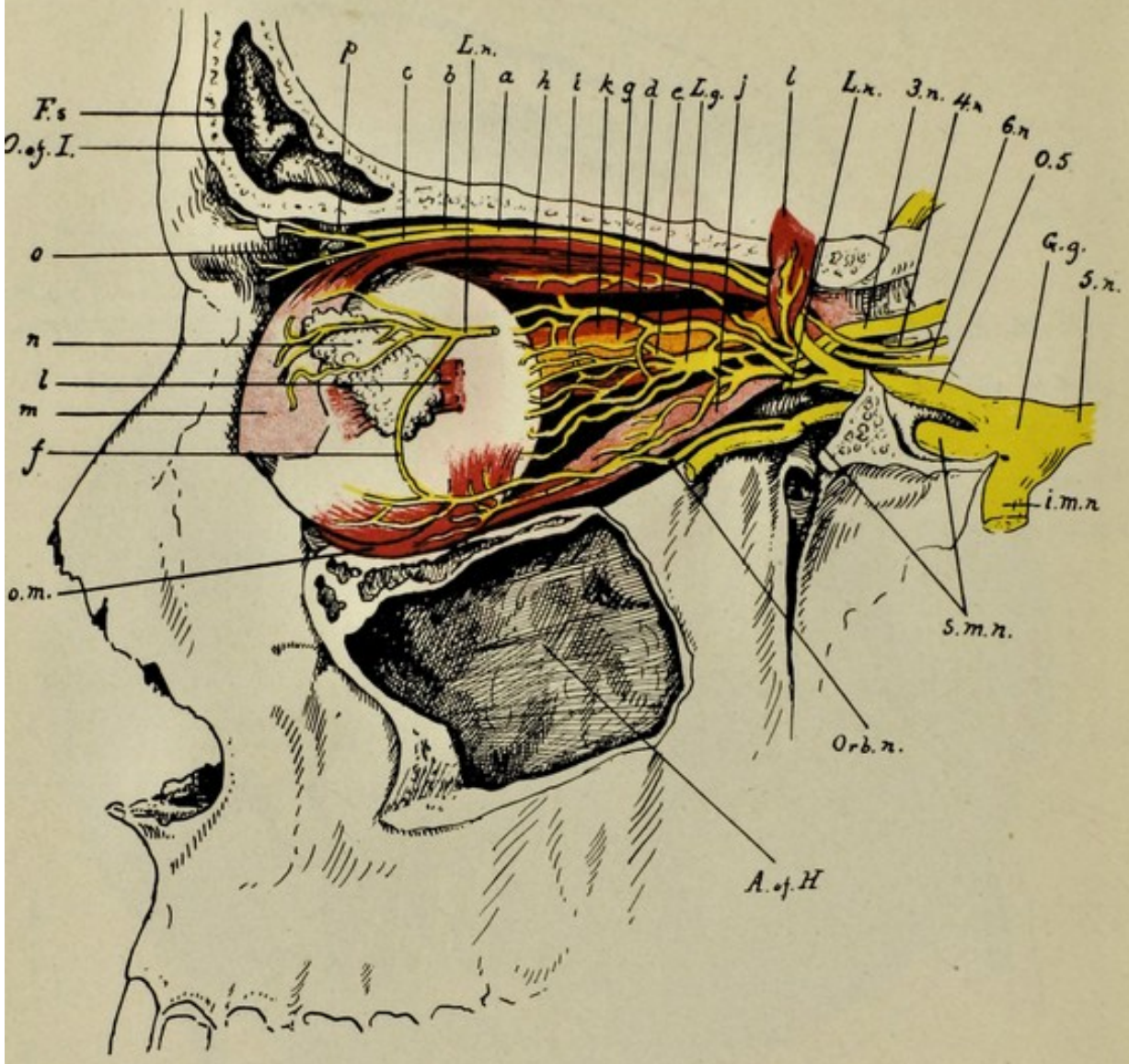
Peripheral Nerves and Blood-Vessels of the Eyeball.

a. Great vorticose vein.
a′ Great vorticose vein passing through sclera.
b.b. Long posterior ciliary arteries.
c. Short posterior ciliary arteries.
d. Anterior ciliary arteries.
e. Ciliary nerves.
f. Optic nerve.
g. Sclerotic.
h. Ciliary zone.
i. Iris.
j. Anterior chamber.
k. Cornea.



Nerves, Muscles and Other Contents of the Orbit.

a, Fifth cranial nerve; b, Motor root; c, Sensory root; d, Gasserian ganglion; e, Superior maxillary nerve; f, Inferior maxillary nerve; g, Ophthalmic division of the fifth cranial nerve; h, Nasal nerve; i, Frontal nerve; j, Supraorbital nerve; k, Supratrochlear nerve; l, Sensory root of lenticular ganglion; m, Lenticular ganglion; n, Lachrymal nerve; o, Optic nerve; p, Third cranial nerve; q, Fourth cranial nerve; r, Recurrent branch of fourth nerve; s, Branches of fourth nerve; t, Nasal nerve; u, Long posterior ciliary nerve; v, Sixth cranial nerve; w, Lachrymal gland; x, Infratrochlear nerve; y, Orbital fat; z, Eyeball; l.p.s.m., Lavator palpebræ superioris muscle; s.r.m., Superior rectus muscle; s.o.m., Superior oblique muscle; s.o.t., Superior oblique tendon; i.r.m., Internal rectus muscle; e.r.m., External rectus muscle; i.o.m., Inferior oblique muscle.



Section of the Left Orbit.

a. Frontal nerve.
b. Supratrochlear nerve.
c. Supraorbital nerve.
d. Nasal nerve.
e. Short ciliary nerves.
f. Loop between orbital and lachrymal nerves.
g. Optic nerve.
h. Levator palpebræ muscle.
i. Superior rectus muscle.
j. Inferior rectus muscle.
k. Internal rectus muscle.
l. External rectus muscle (severed).
m. Tarsal cartilage of upper eyelid.
n. Lachrymal gland.
o. Tendon of superior oblique muscle.
p. Pulley.
i.o.m. Inferior oblique muscle.
L.n. Lachrymal nerve (severed).
G.g. Gasserian ganglion.
5. n. Fifth nerve.
o. 5. Ophthalmic division of fifth nerve.
s.m.n. Superior maxillary nerve.
i.m.n. Inferior maxillary nerve.
Orb. n. Orbital nerve.
L.g. Lenticular ganglion.
3.n. Third nerve.
4.n. Fourth nerve.
6.n. Sixth nerve.
A of H. Antrum of Highmore.
F s. Frontal sinus.
O. of I. Orifice of infundibulum.

point of exit at the supra-orbital foramen. It supplies the levator palpebræ superioris, and the superior rectus muscle; also parts of the inner canthus.

The *palpebral arteries,* superior and inferior, are given off from the ophthalmic artery near the pulley of the superior oblique. They are distributed to the eyelids, where they form a superior and inferior tarsal arch. The superior palpebral anastomoses at the outer angle of the orbit with the orbital branch of the temporal, and with a branch of the lachrymal artery; the inferior palpebral anastomoses at the outer angle of the orbit with the transverse facial and a branch of the lachrymal—on the opposite side of the lid with a branch of the angular artery from the facial. From the latter anastomosis a branch is supplied to the nasal duct, and is found ramifying in its mucous membrane as far as the opening of the duct into the inferior meatus of the nose.

Other branches of the ophthalmic, which do not directly supply the eyeball or the orbit, are the anterior and posterior ethmoid arteries, and the malar branches of the lachrymal.

The *ophthalmic vein* pursues a course similar to that of the artery. Corresponding to the posterior ciliary arteries are the venæ vorticosæ, of which there are ordinarily four. The tributaries of the ophthalmic vein converge into a short, single trunk, leaving the orbit by way of the sphenoidal fissure, and empty directly into the cavernous sinus. The veins from the floor of the orbit may collect into a separate trunk known as the inferior ophthalmic vein. When present, it either joins the ophthalmic vein, or opens directly into the cavernous sinus; or it may leave the orbit through the spheno-maxillary fissure.

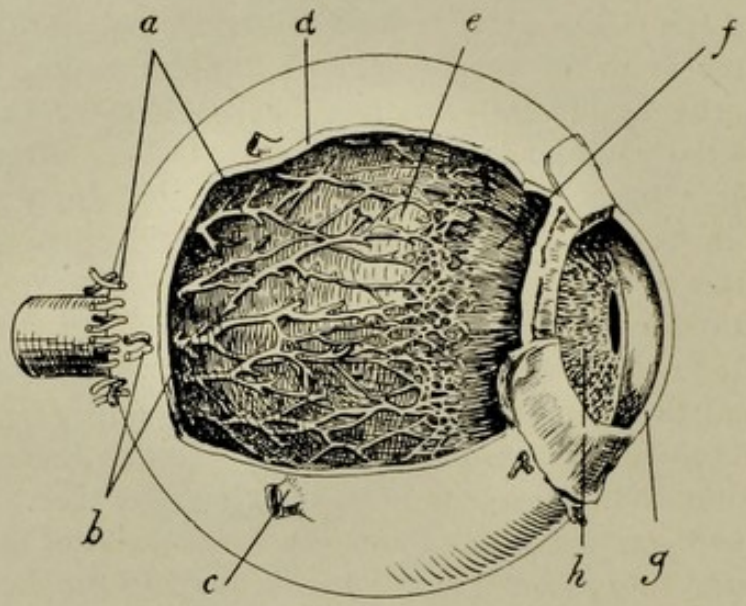
The *nerves of the orbit* include the third nerve (*oculomotorius*) which enters the orbit through the sphenoidal fissure between the two heads of the external rectus muscle. It has two divisions, a superior and an inferior. The superior division is the smaller, and supplies the superior rectus and the levator palpebræ superioris. The inferior division has three branches which supply, respectively, the internal rectus, inferior rectus, and the inferior oblique; the latter branch is the largest of the three, and gives off a short, thick branch to the lower part of the lenticular ganglion, forming its inferior, or motor, root.

The *fourth nerve* (*trochlearis*) enters the orbit by way of the sphenoidal fissure, passes above all of the other nerves, and supplies the superior oblique muscle.

The *ophthalmic, or first division of the fifth* (*trigeminus*), which is the smallest of the three divisions, furnishes the sensory supply to

the eyeball, the lachrymal gland, and the conjunctiva. It enters the orbit through the sphenoidal fissure, after first dividing into three branches—the lachrymal, frontal, and nasal.

The lachrymal branch enters the orbit in a separate tube of dura mater, and accompanies the lachrymal artery along the superior border of the external rectus. It gives off filaments to the lachrymal gland, and, continuing on forward, terminates in the skin of the upper lid.



Ciliary Nerves.

a, Short ciliary nerve; b, Long ciliary nerve; c, Vena vorticosa; d, Sclera; e, Choroid; f, Ciliary muscle; g, Cornea; h, Iris.

The frontal branch, or largest division of the ophthalmic, enters the orbit through the sphenoidal fissure above the muscles, and, in its course through the orbital cavity to the brow, lies between the levator palpebræ superioris and the periosteum.

The nasal branch enters the orbit between the two heads of the external rectus; it passes obliquely across the orbit beneath the levator palpebræ superioris and the superior rectus to its point of exit from the orbit. This division of the fifth nerve has three branches—ganglionic, long ciliary, and infratrochlear.

The ganglionic branch forms the superior or long root of the lenticular ganglion, and is a sensory root.

The *long ciliary nerves*, of which there are two or three, are derived from the naso-ciliary branch of the ophthalmic division of the fifth cerebral nerve. They pierce the sclera on the medial side of the optic nerve near its entrance into the eyeball, unite with the short ciliary nerves inside the sclera, and pass forward in the perichoroidal

space, to the ciliary plexus, from whence they are distributed to the ciliary muscle, iris, and cornea. In their course, they give off branches to the sclera and choroid.

The infratrochlear branch is given off just before the nasal branch leaves the orbit. It supplies the skin of the lids at the inner angle; also the conjunctiva, lachrymal sac, and lachrymal caruncle.

The *lenticular, or ciliary ganglion,* which lies at the back of the orbit between the external rectus muscle and the optic nerve, is about the size of a pin-head. It is quadrangular and flattened in shape, and has a grayish-red color. There are three roots or branches of communication, namely, a long sensory root from the nasal branch of the ophthalmic, a short motor root from a branch of the third nerve supplying the inferior oblique, and a third or sympathetic root from the cavernous plexus of the sympathetic. Its branches of distribution are the short ciliary nerves previously described.

The *sixth (abducens) nerve* enters the orbit through the sphenoidal fissure, passing between the two heads of the external rectus muscle, which it enters and supplies.

It will have been noticed that *most of the ocular systems appear in groups of three.*

First of all, there are *three chief vascular systems:* (1) the retinal supply from the central artery and vein of the retina—branches of the ophthalmic vessels; (2) the posterior ciliary vessels (long and short), including the four venæ vorticosæ; and (3) the anterior ciliary vessels. The accompanying diagram shows the parts nourished by each system, and illustrates the fact that the choroid is the chief intermediary through which the vascular supply of the external and anterior portions of the eye is connected with the optic nerve, retina, and other organs in the posterior segment of the globe. Infective and other agents absorbed by the vessels of the external ocular appendages may thus be carried to the iris, ciliary body, choroid, retina, optic nerve, or even into the general circulation.

Another diagram still further illustrates this circulation of the ocular fluids, and explains the intimate connection, by means of its lymph channels, not only between the internal and external tissues of the eyeball, but between all parts of the globe and the general lymphatic system. The same statement holds true of the sympathetic nerve supply to the eyeball and its appendages; so that it is easily understood not only why, for example, eye-strain may produce headache, brain-fag, nausea, vertigo, and many other distant reflexes, but also why functional diseases of the organs of the body so frequently affect the visual apparatus.

There are *three optic nerve sheaths,* corresponding to the cerebral coverings—dural, pial, and arachnoid. The optic spaces also communicate with the three brain spaces.

It may be added that this intimate connection between the blood-vessels and the lymph spaces of the eyeball, and those of other organs of the body, is largely responsible for many organic lesions of the ocular structures. The causes that underly a number of the commoner diseases of the eye are really systemic in character, and very often originate in quite distant tissues.

The *coats, or tunics, of the eyeball are three*—(1) the cornea and sclera; (2) the iris, choroid and ciliary body; and (3) the retina.

Furthermore, there are *three principal chambers*—(1) anterior chamber; (2) posterior chamber; and (3) vitreous chamber.

There are also *three refractive media*—(1) the aqueous humor; (2) the crystalline lens with its capsule; and (3) the vitreous humor.

Another ocular study in "threes,"—the *three motor nerves* which supply all the muscles of the eyeball. These are (1) the fourth nerve, supplied to the superior oblique; (2) the sixth nerve to the external rectus; and (3) the third nerve—the oculo-motor proper—supplying every other muscle, extra- or intra-ocular.

The orbicularis palpebrarum, or sphincter muscle of the lids, is, of course, not a true globular appendage; it is innervated by motor fibres from the facial nerve.—(A. N. M.)

Anatomy of the intra-cranial portion of the visual apparatus. See **Neurology of the eye**; also **Intracranial organs of vision.**

Anatripsie. (G.) Friction.

Anatropia. Also written anotropia. Upward squint. See **Muscles, Ocular.**

Anaxagoras (surnamed "MIND"). This celebrated philosopher, astronomer, and speculative physician was born at Clazomenae in Asia Minor, B. C. 500, and died at Lampsacus, 428. Friend and teacher of Pericles, he was a man of great influence, but, merely because he insisted on regarding the planets and the moon as bodies very similar to the earth, he was forthwith convicted by the Eumolpidæ of impiety, and compelled to flee for his life. Contrary to the received opinion of his time he taught that, instead of four primary substances—or, as we might say today, "chemical elements"—namely, earth, air, fire, and water, there were just as many elementary substances as there are kinds of matter evident to our senses. Thus, he thought that, in all sorts of food—bread, water, flesh, fruit—there existed infinitely minute particles of bone, hair, skin, muscle, etc., which the corresponding tissues of the body sought out from

the food (after its digestion) and appropriated to themselves. Assimilation, therefore, was, with him, merely appropriation. The cause of disease, he taught, was the penetration of the bile into the blood-vessels, the pleura and the lung. Eye diseases, of course, were so produced, as well as diseases of the other parts of the body.

Ophthalmologically, however, Anaxagoras is of interest chiefly because of his theory of the nature of vision. This philosopher believed (in common with Alcmaeon and Democritus) that from every illuminated object minute pictures, or casts, of that object are continually being detached, and that, of these casts, some, passing into the pupil, are there fixed, and so perceived by the soul. This we can verify, as he believed, by gazing into another person's eye, where we can easily discern the image of ourselves in the pupil. A very different view of the visual act was that held by Empedocles, Diogenes, and Plato. These theorists believed that rays of energy proceed both from the object and from the eye, and that, meeting at some point between the eye and the object, they beget a third variety of rays, i. e., the so-called picture-rays. These picture-rays are those which are finally perceived by the soul. More like the modern explanation of light and vision was that of Aristotle. His view, however, did not obtain general acceptance in antiquity.—(T. H. S.)

Anbohren. (G.) To puncture.

Anbohrung. (G.), n. Paracentesis, trephining.

Anchiloblefaro. (It.) Ankyloblepharon.

Anchilops. (L.), m.n. (Obs.) Lachrymal abscess.

Anchyloblepharon. See **Ankyloblepharon.**

Anchylops. (Obs.) Incorrect spelling of **anchilops,** a lachrymal abscess.

Ancients, Ophthalmology among the. See **History of ophthalmology; Charlatanism in ophthalmic practice.**

Ancubitus. (L.), m.n. An obsolete term denoting an irritable or irritated eye.

Anderfarbig. (G.), adj. Changeable in color. Not of uniform color.

Andersartig. (G.) Heterogeneous.

Andrade, Eduardo Penny. This well known specialist in diseases of the eye, ear, nose and throat, as well as excellent bacteriologist, was born at Maracaibo, Venezuela, Feb. 2, 1872, and there received his early education. He entered the Medical Department of the National College of Maracaibo in 1888, migrated next year to the University of Caracas, and finally received his professional degree at Georgetown University in 1895.

He was then a member for two years of the Venezuelan Legation at Washington. While in this city he studied bacteriology in the hygienic laboratory of the Marine Hospital Service. Next he devoted himself to diseases of the eye, ear, nose and throat. In 1901 he entered upon a course of study at the New York Ophthalmic and Aural Institute. In 1902 he went to Cuba, and graduated there at the University of Havana. Shortly afterward, he proceeded to Jacksonville, Fla., where he became director of the state bacteriological laboratory—a position which he held until his death, which occurred Sept. 20, 1906.

Andrade was a very versatile man, spoke several languages, was a fine extemporaneous orator and made many friends.

He is said on good authority to have been the first to discover the existence of Malta fever in Venezuela and the first "to find and report" a case of filariasis in the State of Florida.—(T. H. S.)

Andrang. (G.) Congestion, fluxion.

Andreae, August Wilhelm. This highly distinguished oculist and historian of ophthalmology was born at Neuhaldensleben, Germany, May 27, 1794, and died Mar. 7, 1867. His father before him was a physician of some prominence. Graduated in 1814 at the University of Berlin, August Wilhelm entered at once on the performance of his professional duties in the Chief Field Hospital of the Prussian Body Guard. In this capacity he accompanied the army on the second and the last expedition against Napoleon. Returning from the wars in 1815, he studied ophthalmology for two years at Vienna, under Beer and Jaeger. In 1817 he settled at Magdeburg for the practise of his specialty.

However, like many another distinguished oculist, he was not merely an eye-doctor. At the College of Medicine and Surgery at Magdeburg, he delivered lectures not only on ophthalmology but also on general pathology and on therapeutics, and, it would seem, with remarkable success in all three of these branches. He became also a director of the College, as well as medical adviser to the government, and, in addition to the very exacting activities implied by these positions, he performed the still more exhausting functions of a prolific and interesting general medical and special ophthalmologic writer.

Among his medical works may be mentioned the following: *Grundriss der gesamten Augenheilkunde* (in two parts, 1834 and 1837, 2d ed., 1846). This is not a large treatise but is a clear, exact and interesting monograph. It has been pronounced by no less an authority than Magnus "the best ophthalmic text-book of the pre-

ophthalmoscopic period." Others are, *Aus den Vorträgen über specielle Augenheilkunde,* Programm 1834. *Uber die Augenentzündung in Allgemeinen,* Programm, 1835. *Zur ältesten Geschichte der Augenheilkunde* Programm, 1841. The work last named, though to some extent superseded by later treatises, is still of very great interest to all who delight in the history of ophthalmology. It may be said of his *Die Augenheilkunde des Hippocrates,* Programm, 1843, that it is a work of monumental scholarship (the first of its kind after Wallroth's *Syntagma de Ophthalmologia Veterum*). Hirschberg declares "it deserves high praise, because it brings carefully together every passage of the great Hippocratic collection which deals either with the eye or with ocular diseases, or with the treatment of these affections, and has thereby rendered lighter the task of all subsequent workers in the same field, myself included."—(T. H. S.)

d'Andre's test. This is a test box for detecting simulation of unilateral blindness, a modification of the instrument of Fles, which is intended to induce the malingerer to see with his pretended blind eye an object which he thinks he is seeing with his sound eye. It is fully described in the *Recueil de Mémoires de Médicine,* 1882, p. 4.

Andrew's intracapsular cataract operation. Andrew (On the Extraction of Senile Cataract in its Capsule. *Brit. Med. Jour.,* 1883, Vol. I, p. 41-44) has described the following operation, which was performed under an anesthetic: Through an upper section with iridectomy, no speculum being used, the lens is detached with a piece of stiff wire one inch in length mounted on a handle having a point smooth and rounded, and a line to a line and a half of its extremity bent at a right angle. An instrument has been formed to be used in the following manner.

Either before or after the section a minute opening is made in the cornea close to the margin by a small bent broad needle. The instrument is passed into the anterior chamber sidewise over the lens and under the iris until it reaches its margin. The point is now turned downward and the ligament appears with ease. Following the edge as a guide it may be torn to any extent that the operator may desire. If after the section the instrument is introduced through any part of the opening found most convenient and whichever course it follows being under the iris, that structure is scarcely touched. The endeavor is to tear the ligament without the slightest injury to the vitreous body, and to accomplish this in the manner above mentioned the bent portion is of different length in order to adapt it to an arched or flat cataract. The lens, on slight pressure by a tortoise-

shell curette, may be gently eased through this one opening without the aid of any extraction instrument.—(D. W. G.)

Andrews' intraocular syringe. Joseph A. Andrews' syringe to remove cortical matter in cataract extraction is simply a half-ounce bottle, fitted with a hollow ground stopper drawn out into a tube which terminates in a smooth point and is slightly curved. A rubber nipple serves to draw up and inject the fluid contained in the bottle. (*Trans. Am. Oph. Soc.*, 1892, p. 455.)—(P. G.)

Andrew's operation for closing the interpalpebral space. When the patient cannot or will not wear a prothesis it is better to close the socket than have him wear an unsightly patch or other eye-cover all his lifetime. For this purpose Andrew, in 1885, suggested the following improvement on the Streatfeild operation:

"An incision is made with scissors into the ocular conjunctiva, half an inch from the corneal margin, and this incision is carried around the ball; the conjunctiva is now freely detached all around, until the edges of the lid-cartilages are reached, when the conjunctiva at the inner angle of the eye, with the caruncle, etc., is most carefully removed, as this is the only part where some difficulty of healing sometimes takes place; the conjunctiva of the outer angle is now similarly dealt with, the edges of the palpebral angles pared, the cartilages entirely dissected away, and a sufficient strip of the free borders of the lids removed, to include all the roots of the lashes, and lastly the ball is excised; the lids are merely brought into apposition, or the palpebral opening may be lessened by one or two sutures at each end, leaving the centre for drainage. It is advisable that the various steps of the operation should be carried out in this order, so that the bleeding may less obscure these manipulations." See, also, **Orbit, Operations on.**

Andrieu, von. A celebrated itinerant quack, who, in 1748, announced himself in Paris as "the celebrated eye-operator from Lyons." His services were much in request for a time, but little else is known about him.—(T. H. S.)

Anectasia. (L.), n.f. Lack of normal size in an organ.

Aneignung. (G.) Assimilation.

Anekkrisie. (G.) Absence of secretion.

Anel, Dominique. This distinguished ophthalmologist was born at Toulouse in 1769. According to Pansier, he was an Italian, but, as Hirschberg has pointed out, this is undoubtedly a mistake.

When a mere boy he became a kind of menial assistant to a surgeon in the St. Jacques Hospital at Toulouse, and, while serving in this capacity, made some slight discovery in connection with osteo-

malacia. The discovery was reported in a journal, and, by this incident, the young man's surgical ambitions became thoroughly aroused. After a short period of study he was accepted as surgeon on a French man-of-war. Returning from the navy he betook himself to Paris, where he expected preferment through the intervention of a rich and powerful relative. Various events, however, conspired to disarrange his plans, and the result was that, for three years and a half, he studied in the Jardin Royal, the School of Medicine, the Amphithéatre of St. Côme, the Hôtel Dieu and the Charité. Then, for a very short time, he served as surgeon major to a regiment of infantry. During this period, however, he made a number of powerful friends, and, at its close, by special invitation from the Viennese Court he journeyed to the capital of Austria to consult with the famous de Tondeur, Surgeon to the Emperor. The two years next succeeding he spent in Vienna. Then we find him, at the invitation of a friend, a German nobleman, accepting a position with the army in Italy. He accompanied the troops on three expeditions, and also spent much time in Rome, Bologna and Florence. All the while he was studying, observing, investigating.

In Mantua he was made Doctor of Surgery.

In Turin he was appointed body-physician to the queen.

On the way back to his native town—Toulouse—he was taken ill in Genoa, and there—in consequence, it seems, of the illness—he spent three years.

In 1716 he went to Paris, where he limited his practice to diseases of the eye and became famous.

He died about 1730, at the age of 51, immortal; yet, as it would seem, with his work not half accomplished.

His greatest services lay, of course, in the field of ophthalmology, especially in the surgery of the lachrymal apparatus. It was in 1712—200 years ago—that he performed the first of his long series of operations for the relief of lachrymal fistula—the nature of which will be indicated in this sketch a little later. This was in the case of the Abbé Fieschi, who was sound and well of his double-sided lachrymal troubles in exactly six weeks—a remarkable result for those days.

A brief review of the surgery of the lachrymal apparatus, as this slender branch of the healing art existed (one cannot say flourished or developed) from the earliest times until the day of Anel, will help us to appreciate the debt which we owe to this man of most undoubted genius.

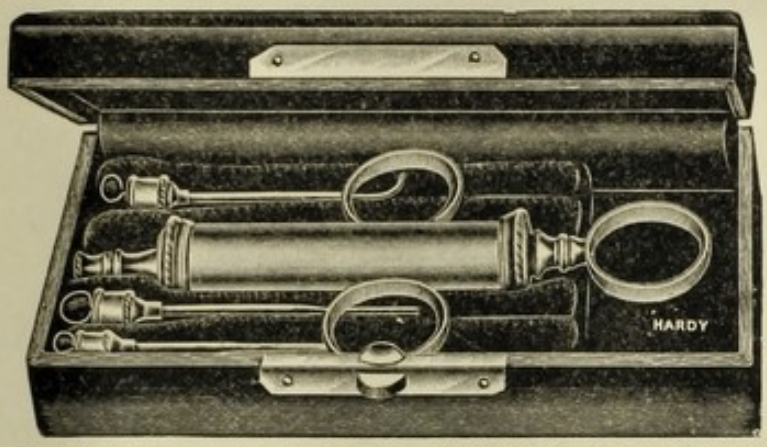
In ancient Babylonia, as we learn from the Code of Hammurabi

(2250 B. C.) the method of treating "an abscess of the eye" consisted simply and solely in the use thereon of a knife. From Hippocrates (300 B. C.)—even from Father Hippocrates—we learn practically nothing whatever concerning the subject in question. From the "*De Medicina*" of Aulus Cornelius Celsus (first century A. D.) we ascertain that "lachrymal fistulæ" were treated in three ways—viz., by excision, by cauterizing with chemicals, and by the actual—i. e., hot metal—cautery. A century later came Galen. From him, the ruling spirit, medically, of the Middle Ages, we learn of three more or less novel means of treatment, as follows: (1) Excision of the canthus, followed by the drilling of several small holes through the bone into the nose, and then the application of caustic medicines. (2) Denudation of the bone, followed by the application of the actual cautery. (3) Incision down to the bone, followed by the insertion of a metallic funnel and the pouring down on to the bone, through the funnel, of molten lead. From Paulus Aegineta, who lived in the 7th century A. D., just before the destruction of the great Alexandrian library, and who undoubtedly summed up in the ophthalmic portion of his "*Compendium of the Healing Art*" the ophthalmologic learning of antiquity, we find absolutely no further advance in lachrymal medicine or surgery. Among the Arabs—whom we mention in this connection merely for the sake of completeness—we find, as to lachrymal affairs, merely a repetition of Paulus Aegineta. In medical Christendom still no more improvements. Coming to the modern era, one would naturally suppose that the anatomical discoveries of Vesalius and Fallopia would have resulted in corresponding surgical advances. Yet such was not the case, that is as regards the lachrymal apparatus.

It was only in the 18th century that any decided improvement over the lachrymal surgery of antiquity began to be apparent. This was, in part, the result of the anatomical discoveries of Morgagni (Advers. Anat. 1706). It was, however, due in very much greater degree—not speaking of Anel as yet—to the improvements in lachrymal theory and practice made by Georg Ernest Stahl, whose little book, entitled *Programm de Fistula Lacrimale* (1702) was the first work of consequence on the subject in question since the time of Claudius Galen. The theory which Stahl laid down was, in brief, that the so-called "lachrymal fistula" was not—as all had hitherto supposed from the earliest ancients down to Stahl's time—owing to some affection—swelling or atrophy—of the lachrymal caruncle, but, very differently, to disease of the canaliculi, the lacus lachrymalis, or the lachrymo-nasal canal, resulting in stenosis, complete or partial, of one or another of these passages. The procedure which Stahl de-

scribes in his little book is very ingenious. It consists in the introduction, through the upper punctum, of a catgut violin string into the lacus lachrymalis, then the making of an incision obliquely into the wall of the sac, and, lastly, the introduction into the sac of tents, or plugs, of lint saturated with certain balsamic preparations. By this method Stahl succeeded in curing a number of otherwise incurable cases.

Now appeared upon the stage Anel—the subject of our sketch. His procedure—the most important ever devised for the treatment of these parts—was carried out as follows: Through the upper canaliculus he daily passed into the sac, and on down into the nose, a golden, or silver, sound, of about the thickness of a hog's bristle



Anel's Syringe for Irrigation of the Naso-lachrymal Duct.

and furnished at its distal end with an olive-shaped button, or knob. Then, through the lower canaliculus, he injected by means of his syringe an astringent preparation into the sac, and, when possible, on down into the nose. The procedure was repeated, as already stated, daily, until the fluid ran into the nose with ease. Then, as a rule, the patient was entirely cured.

The importance of Anel's discovery does not need to be emphasized to ophthalmologists. The Anel sound, the Anel syringe, and even the Anel procedure are (of course with numerous modifications) in use at the present day.—(T. H. S.)

Anel's lachrymal syringe. In acute and sub-acute cases, permanent changes in the sac and duct may be prevented by systematic cleansing with antiseptic and astringent solutions, injected by Anel's lachrymal syringe. The canaliculus is split, as in the preliminary described for the passage of probes, and the canula inserted as far as the wall of the sac, brought to the vertical position and the fluid injected. Too much force should not be employed, otherwise the fluid may be driven out through the upper canal, or a false passage created, with its attendant injurious complications. (H. F. H.)

Anel'sche Probe. (G.) A delicate probe for insertion into the puncta lachrymalia. It was invented about 1710 by the surgeon whose name it bears.

Anel'sche Sonde. (G.) A delicate probe for insertion into the puncta lachrymalia.

Anel'sche Spritze. (G.). Anel's syringe; fine-pointed syringe for injecting fluids through the puncta lachrymalia.

Anemia appilacas. TUNNEL ANEMIA. DIRTEATER'S ANAEMIA. HOOKWORM DISEASE. See **Ankylostomum duodenale.**

Anemia dopo perdite di sangue. (It.) Anemia from loss of blood.

Anemia in eye diseases. CHLOROSIS. PROGRESSIVE PERNICIOUS ANEMIA. These signs of a general blood change are most commonly associated with insufficiency of accommodation—inability to read, fatigue of and pains in the eyes, etc. Deposits in the retina and choroid, and even neuro-retinitis with hemorrhages are also seen now and then.

The specific new formations in the lymph glands and spleen, particularly those that mark the so-called leukemia, furnish another example of intoxication, with definite ocular changes. A bilateral retinitis, with numerous hemorrhages (resembling the albuminuric form) is the most important of these, due to fatty and other alterations in and about the minute retinal capillaries. Fundus and vitreous changes have also been discovered in the advanced stages of the disease. See **General diseases and ophthalmology.**

Anemia intertropicalis. TUNNEL ANEMIA. DIRTEATER'S ANEMIA. HOOKWORM DISEASE. See **Ankylostomum duodenale.**

Anemia latericia. TUNNEL ANEMIA. DIRTEATER'S ANEMIA. HOOKWORM DISEASE. See **Ankylostomum duodenale.**

Anemia montana. TUNNEL ANEMIA. DIRTEATER'S ANEMIA. HOOKWORM DISEASE. See **Ankylostomum duodenale.**

Anemia perniciosa. (It.) Pernicious anemia.

Aneritroblepsia. (It.), n.f. Anerythroblepsia, anerythropsia, or color blindness for red. See **Color sense and color blindness.**

Anerythroblepsia. (L.), f.n. Color blindness for red or for red and green.

Anerythropsia. Defective color perception of red.

Anerythropsie. (G.) Color-blindness, red-blindness.

Anesin. ANESON. Trade names given to a 2 per cent. aqueous solution of chloretone (q. v.) or acetone-chloroform $(CH_3)_2$:COH.CCl_3, which has been recommended as a substitute for cocain. It is much less anesthetic than a 5 per cent. cocain hydrochloride solution, but is non-toxic and not irritating to the ocular structures.

Aneson. See **Anesin.**

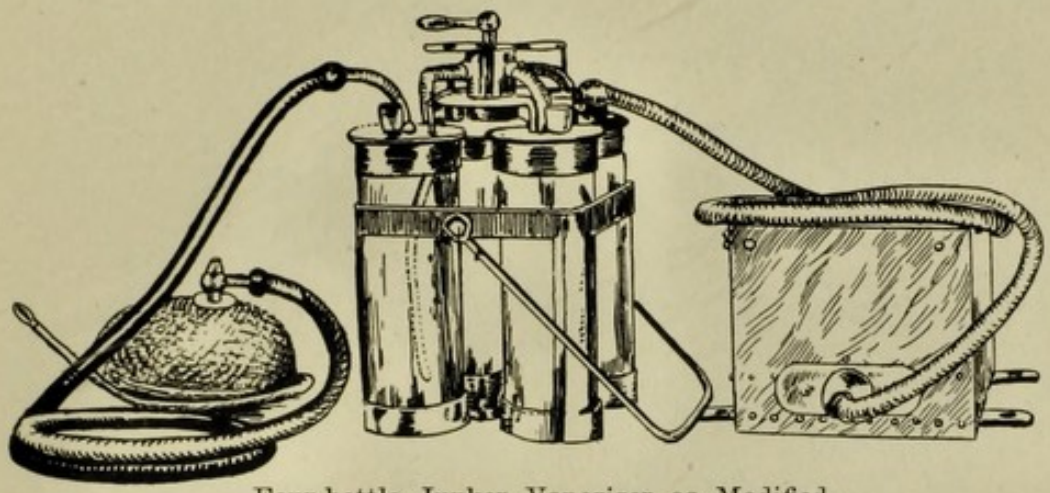
Anestesia. (It.) Anesthesia.

Anesthesia (general) by inhalation. See **Anesthesia in ophthalmic surgery.**

Anesthesia (general) by scopolamine-morphia injections. See **Anesthesia in ophthalmic surgery.**

Anesthesia, Infiltration. SCHLEICH'S LOCAL ANESTHESIA METHOD. See also, **Anesthesia in ophthalmic surgery.**

Anesthesia in ophthalmic surgery. The problem of anesthesia for ophthalmic operations is in many respects totally different from that of anesthesia for all other surgical procedures. The disagreeable and, at times, formidable after-effects of general anesthetics (such as retching, vomiting and straining) would seem too well known to need more than mention. Nevertheless they are the very



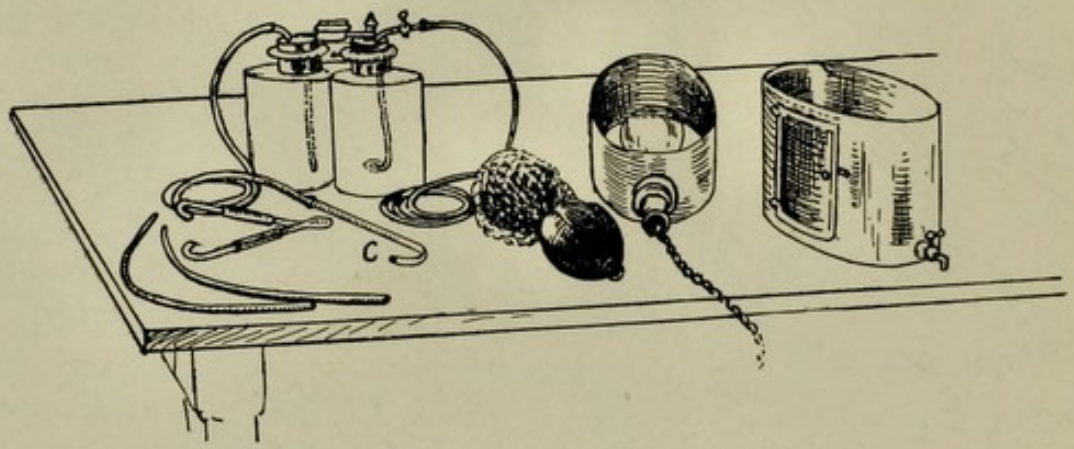
Four-bottle Junker Vaporizer as Modified.

phases of general anesthesia that make the ophthalmic surgeon long for the day when all of his operations may be done under local anesthesia. But it is when we stop to consider the relation of patient and surgeon in the intraocular operations done under local anesthesia, that the difference from general surgery becomes most apparent. The psychic state of the patient under these circumstances is the factor generally overlooked. Imagine a patient with cataract who is not only conscious but keyed to the highest point of anxiety as to the outcome. Naturally the blood pressure is correspondingly increased anywhere from 10 to 20 mm. of mercury, which of itself predisposes to complications and difficulties in the performance of an operation. The problem is not only to negotiate the operation successfully, but at the same time to quiet and calm the patient, so as to bring him under control that he shall not become panicky; in short temporarily to dominate his mental condition and

thus avert the calamities that usually attend bad behavior during the operative ordeal. The whole situation is much more dramatic than usually obtains in general surgery, except, perhaps, in grave emergency operations.

The ophthalmic surgeon is at the outset confronted with the question whether he shall choose the besetting difficulties of general anesthesia or the distressing mental state incident to an operation under local anesthesia. The choice is sometimes difficult indeed, and compels consideration of numerous factors to ensure a successful issue.

Principal among these are the patient's age, general condition, the circulatory status (especially in cataract and glaucoma), the factor of elimination, the vital resistance, the state of the nasal and



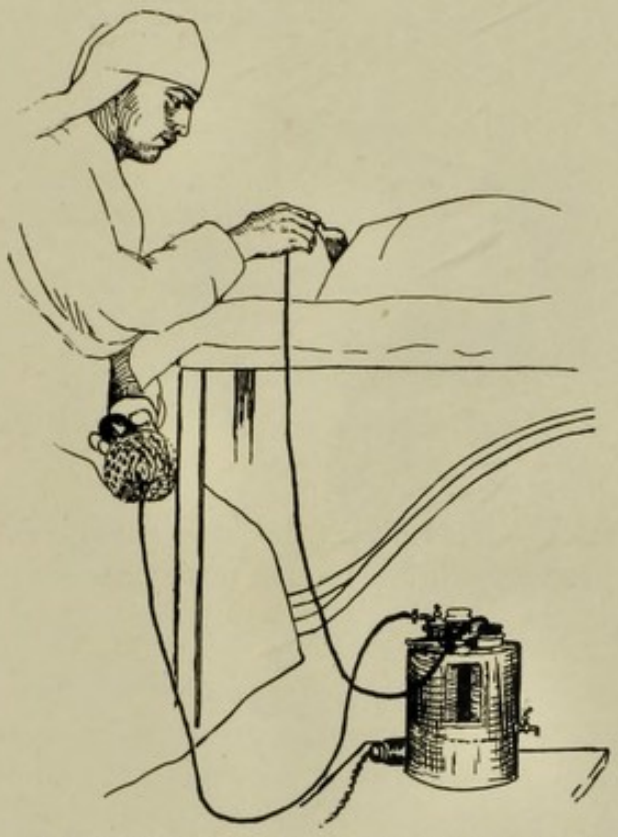
Insufflation Apparatus for Ether Anesthesia.

lachrymal passages, the temperament of the patient, his environment, the condition of the eye, etc. Thus it will be seen that the operator, in making his choice of an anesthetic method, must be first the all-wise medical man and then the surgeon who can soothe an over-excitable patient with reassuring voice cadences, or control a contrary one with a sharp word spoken in season.

Inhalation anesthesia. Prior to 1846 ophthalmic operations were performed without any form of analgesia whatsoever. The result of the operation turned largely upon the marvelous swiftness and dexterity in operating possessed by the ophthalmic surgeons of that time. Morton's demonstration, in 1846 at the Massachusetts General Hospital, made modern narcosis possible and the ophthalmic surgeon of today may choose his agent for general anesthesia or

narcosis from the following list: Ether, chloroform, ethyl chloride, ethyl bromide, nitrous oxide, somnoform and, lastly, scopolamin-morphin, either alone or in combination with ether or chloroform.

The question has been raised as to whether "anesthesia" or "narcosis" should be the term applied to loss of sensation induced by whatsoever method. We prefer to retain the term anesthesia, first coined by Oliver Wendell Holmes in 1846. Various qualifications of



Ether Anesthesia by Pharyngeal Insufflation.

the term easily follow, e. g., inhalation anesthesia, infiltration anesthesia, local anesthesia, regional anesthesia, mucous anesthesia, etc.

There is a certain group of ophthalmic operations that will probably always be done under some form of general anesthesia, such as iridectomy for glaucoma, exenteration, evisceration, enucleation (although many enucleations are today being performed under local or regional anesthesia), plastic lid operations, orbital and orbito-sinus explorations, as well as most operations on nervous patients and on children.

The choice of an anesthetic is more or less a matter of caprice with each individual surgeon, but we will consider *seriatim* the list just mentioned.

Ether. Among general surgeons the country over ether is probably the anesthetic of choice, especially for prolonged surgical interventions and for abdominal operations, largely because of its relative safety and the familiarity of the general profession with its proper administration. This is evidenced by the report of the Committee on Anesthesia presented to the 1910 meeting of the American

Easy Way of Applying Nasopharyngeal Airway.

Medical Association. This committee was commissioned to make research on the best anesthetic to use under varying conditions. In

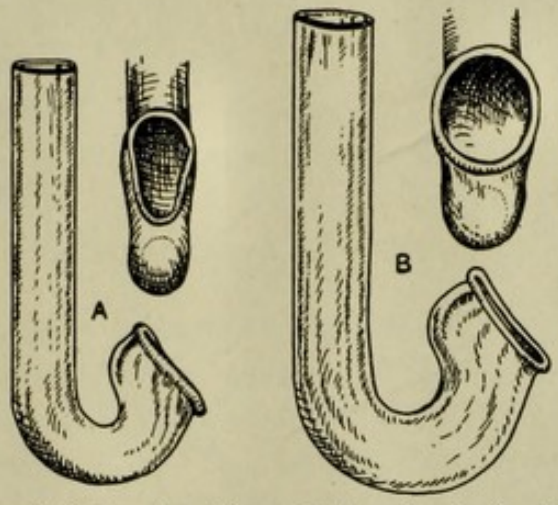
Nasopharyngeal Airway.

the report alluded to they insisted on the wide distinction between anesthetics proper for use by the general practitioner and anesthetics employed by experts. They finally recommended that for the general practitioner not especially skilled or experienced, ether administered by the open, or drop, method should be the anesthetic

of choice, and that the use of chloroform, particularly for so-called minor operations, should be discouraged, unless given by an expert.

Hare (Keen's *System of Surgery*, Vol. V, 1910) observes that there is probably only one state which distinctly contra-indicates a general anesthetic, namely, diabetes mellitus, in which diabetic coma nearly always ensues.

Disadvantages of ether anesthesia from the ophthalmic view. From the standpoint of the ophthalmic surgeon, ether has some marked disadvantages, chief of which is the vomiting that so frequently follows its use. The straining that goes with the vomiting may



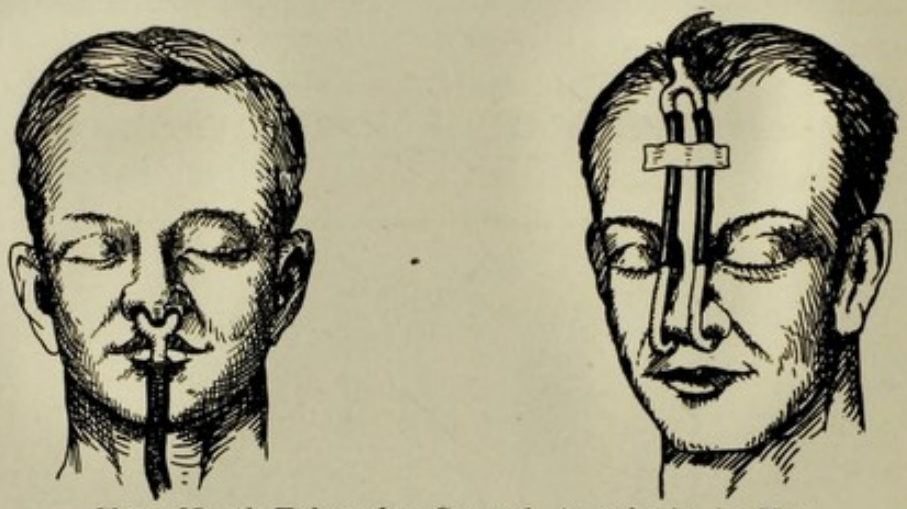
Glass Nasal Tubes for General Anesthesia in Head-surgery.

be fraught with the direst consequence as far as the eye is concerned. We have knowledge of several cases in which there occurred a large intraocular hemorrhage during the vomiting following etherization for cataract extraction in nervous individuals. Boskerville (*Jour. Am. Med. Assocn.*, Nov. 23, 1912) wisely says, "Idiosyncrasy has served to account in large part for untoward after-effects of anesthetics (such as nausea) and interference with some of the normal organic functions such as glycosuria and albuminuria. These have often been regarded as natural results of anesthesia and taken for granted. They may now largely be obviated and in many cases entirely avoided by the use of anesthetics that are free from impurities and by improved methods of administration. These statements are based on clinical evidence."

Next in importance to this objection is the possibility of the vomitus reaching the field of operation and infecting it, which is always a nasty complication at best. There is also the weighty objection that with any inhalation anesthetic the anesthetist and gauze are very much in the way of the operator; and, not infrequently, the an-

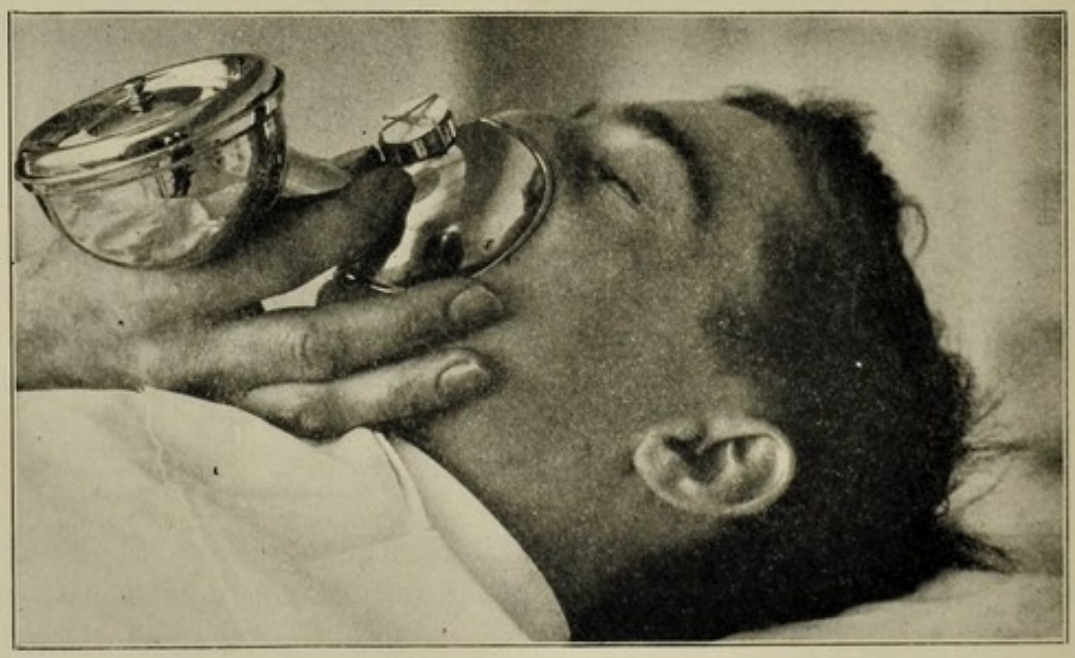
esthetist inadvertently allows the anesthetic to drop or flow into the patient's eye. This has happened several times in our experience.

To avert both difficulties, numerous extension masks have been devised of which Lefever's is quite as good as any we have seen.



Glass Nasal Tubes for General Anesthesia in Use.

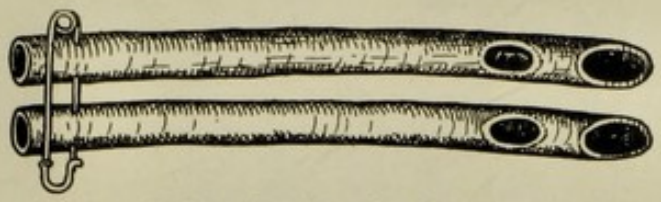
The claims of this inventor are: 1, that it removes the anesthetist from the field needed by the operator and his assistant; 2, that it assures an aseptic field; 3, that it does away with the ether fumes that often arise in the operator's face; 4, that it lessens the amount of ether used; 5, that the breathing of the patient is perfectly registered by the continual movement of the light aluminum valve, so that the



Lefever's Device to Permit the Use of a General Anesthetic and at the Same Time Afford the Ophthalmic Surgeon the Greatest Possible Free Field.

surgeon may always know just how the patient is breathing without asking the anesthetist.

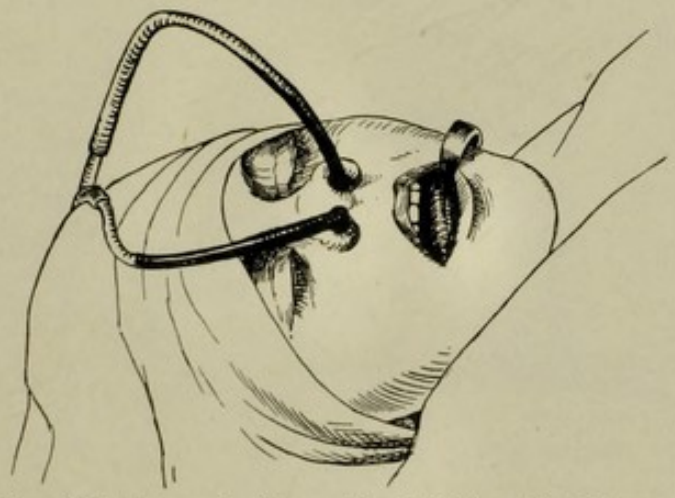
All these claims we endorse from personal use of the device, with the exception of No. 2. No operator can ever be absolutely sure that any patient may not vomit during the operation, no matter what the anesthetic agent may be.



Tubes for Mouth Airway.

Miller's (*Jour. Amer. Med. Assocn.*, Vol. LIII) apparatus, we have also used but we do not look upon it with as much favor as Lefever's.

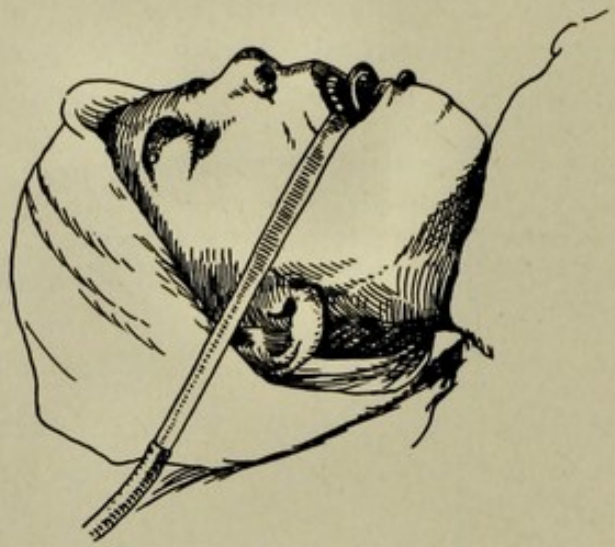
Finally, we are obliged to consider the objections brought forward by Crile (*Southern Med. Jour.*, Jan., 1910) who in discussing the effects of ether on the vital forces, contends (a) that it contributes to post-anesthetic depression, and (b) that it impairs immunity.



Nasal Catheters in Use. Mouth Tube Also Shown.

The most recent statistics as to general anesthesia are those offered by Gwathmey (*Jour. Amer. Med. Assocn.*, Nov. 23, 1912) who quotes Hewitt's European statistics as follows:—In over 1,000,000 administrations the death rate equalled one in 16,302 for ether and one in 3,162 for chloroform. At St. Bartholomew's Hospital (London) in the years 1875 to 1900 there were 80,255 administrations of ether and chloroform, showing a fatality of one in 9,319 for ether and gas-ether, and one in 1,300 for chloroform. Hewitt considers these reliable figures, concluding that ether is about seven times as safe as

chloroform. American statistics collected by Gwathmey from 99 hospitals show that in 278,945 administrations the fatalities from



Mouth Tube in Position.

ether were one in 5,623 and from chloroform one in 2,048, with one in 6,905 for the nitrous oxid-ether sequence, to which reference will be made later on.

Rubber Ether Holder and Elastic Mask Holder.

It is our own feeling that if all the circumstances surrounding many cases that die within 24 to 48 hours after operation were searchingly analyzed, the corrected mortality percentage would be much higher.

The use of chloroform in ophthalmic operations. In most of the large Continental and British clinics, chloroform is still resorted to largely for inhalation anesthesia when a general effect is needed. In this country, however, a strong sentiment against chloroform has sprung up in the last few years, due, perhaps, to the insistence of the East-

ern schools on the danger of chloroform. The statistics quoted by H. A. Hare (Keen's *System of Surgery,* Vol. V, 1910) are as follows:

Chloroform .....1 death in 2,500
Ether .....1 death in 16,000
Nitrous oxide.....1 death in 200,000

Hare *(loco cit.)* goes on to say, however, that there are times when chloroform, because of its known physiologic effects, is often the agent of election, as in arterial spasm with high tension and cardiac hypertrophy. Also in nephritis, new or old, it is the drug of choice in most instances. He pleads for the most careful examination of the urine and the circulatory apparatus before administering any inhalation anesthetic. When it is remembered that the average ophthalmic operation seldom requires more than 20 minutes for its performance, it can be readily understood why many ophthalmic surgeons who enjoy the services of an expert assistant, prefer chloroform for their operative work. So high an authority as Haab (*Ophthalmoscope,* Feb., 1905) has urged that inhalation anesthesia should be used very little in ophthalmic surgery because of his conviction that local anesthesia whenever in any way possible, is much to be preferred by reason of its safety. Chaldecott (*Ophthalmoscope,* Aug., 1905, p. 386) agrees with Haab that it is not justifiable in minor eye operations to take the risk of chloroform, yet he thinks that "when anesthesia is induced by gas or ether, and continued by chloroform, the risk in skillful hands is so infinitesimal that it is not worth taking into account." Just why ether should be used to induce anesthesia that is to be continued under chloroform does not appear clear to us. Gwathmey (*Jour. Amer. Med. Assocn.,* Nov. 23, 1912), after reviewing the European statistics embracing 1,000,000 administrations and the American ones embracing 278,945 administrations, makes the following trenchant suggestions:—"In full harmony with the report of the Committee on Anesthesia of the American Medical Association just published and from a careful study of the accompanying table (see his communication in full) I would recommend that those using the drop method of ether should improve their technique and statistics by (a) preliminary medication of morphin and atropin or some similar drug or combination: (b) commencing the anesthesia with 2 to 4 drops of essence of orange (25 per cent. U. S. P.); (c) the drop method of anesthol. This agent was first described by Meyer (*Jour. Amer. Med. Assocn.,* Feb. 28, 1903) and is a chemical combination of ethyl chlorid, chloroform and ether. Anesthol should be continued until the patient reaches surgical anesthesia and then a change taken to the drop method of

ether. (d) The drop method of anesthesia by some form of vapor anesthesia. This last recommendation is made because judging from statistics this method would be safer and more satisfactory than the straight use of ether as practised in some of our leading clinics."

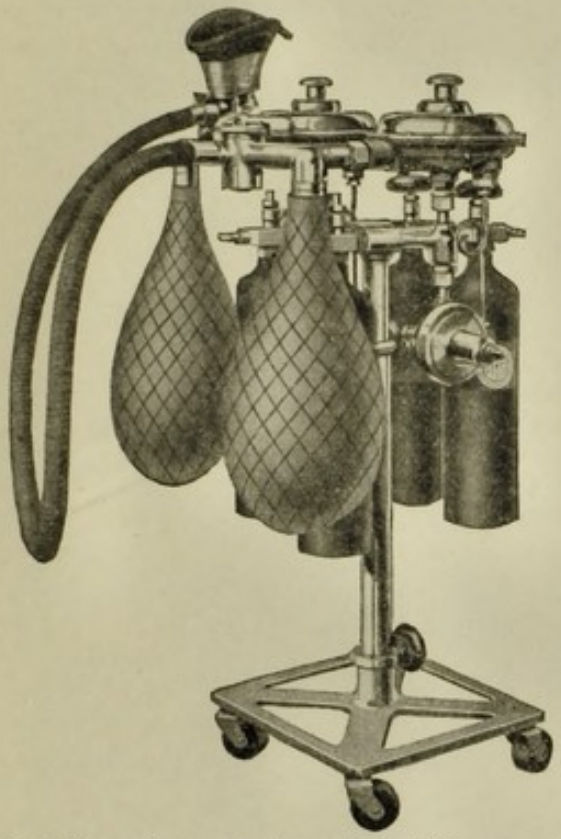
Ethyl chloride anesthesia in ophthalmic operations. Within the last decade ethyl chloride has been heralded as the agent that would solve the problem of general anesthesia for the ophthalmic patient. But the testimony as to its safety and efficiency is very conflicting. Albert E. Miller (*Jour. Amer. Med. Assocn.*, Nov. 23, 1912) collected 43 reported deaths from this agent, showing a death rate varying from one in 2,000 (Hare) to one in 150,000 (Luke). At present it is difficult to calculate its mortality rate, although one in 13,265 is the closest compromise estimate. In some of the British clinics it has largely replaced nitrous oxide and to some extent chloroform. Hird (*Ophthalmoscope*, Mar., 1906) claims for it rapid anesthesia, quick recovery and slight after-effects and believes its use will steadily increase. He reports one case of death from it, but it must be admitted that the patient could hardly have been in a worse condition for the use of any inhalation anesthesia. He was a man of 67, suffering from epithelioma of the cheek, with a swelling in the neck causing severe dyspnea and general distress; to relieve which the operation was undertaken. Kayser (*Klin. Monatsbl. für Augenhlk.*, Sept., 1905, p. 300) says that of 16,000 narcoses thus induced this is the only fatal case; and, although it has been but little used in Germany, he strongly recommends it.

Because of the fatalities attending the use of chloroform for ophthalmic operations, Gendron and Servel (*Clin. Ophthal.*, May 25, 1906) have resorted to ethyl chloride, followed by chloroform. About 3 cc. of ethyl chloride are placed in a rather small, close cone and more added, (how much not mentioned) until general anesthesia is produced, when the change is quietly made to chloroform. Absence of the stage of excitement, less chloroform and diminished unpleasant effects seem to them the advantages of the combination. We can see no reason why chloroform alone would not be as efficient as the foregoing combination. As to ethyl chloride alone, we have seen one person so near death's door under the influence of ethyl chloride (and that in the hands of a very careful anesthetist) as to make us forever apprehensive of it.

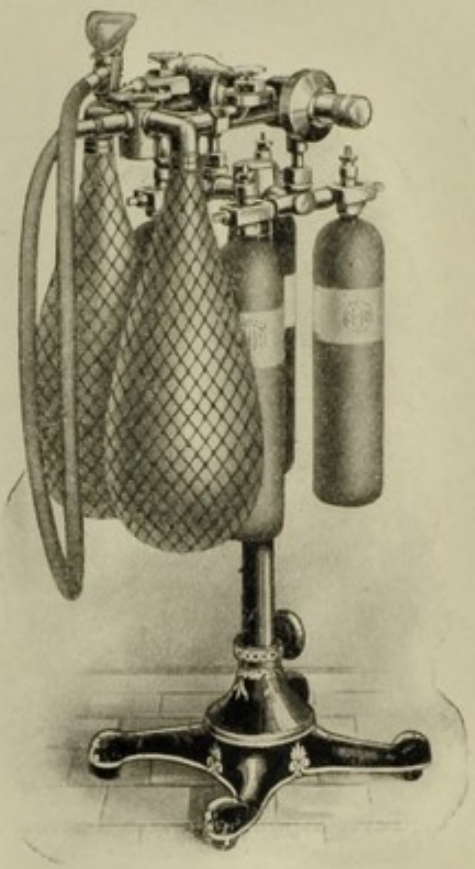
Ethyl bromide has been used instead of the chloride by some, on the assumption that it is superior because of its bromide content, but there seem to be no facts to substantiate these claims.

Somnoform in ophthalmic surgery. Somnoform is a combination

of 60 per cent. ethyl chloride, 35 per cent. methyl chloride and 5 per cent. ethyl bromide. The reports thus far to hand indicate that under proper precautions it is a safe anesthetic. Hess (*Colorado Medicine*, May, 1905) reports its use in 62 operations, including 2 enucleations, the remainder being rhinologic operations. Usually, it induces a narcosis of from two to three minutes, with subsequent analgesia. Occasionally the narcosis is simply transitory. Hess has had the anesthesia terminate in less than a minute, necessitating the



Ohio Monovalve (automatic) Nitrous Oxide and Oxygen Apparatus.

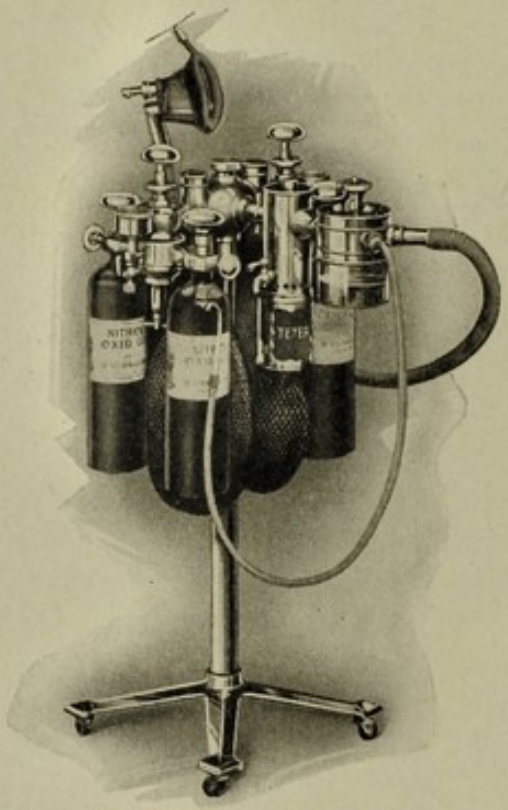


Ohio Monovalve (semi-automatic) Nitrous Oxide and Oxygen Apparatus

use of chloroform to complete an enucleation. The dose is usually 5 cc., but this must be increased for large, robust persons and for alcoholics. The anesthesia can be prolonged only by repeating the dose, but this robs it of its safety and freedom from unpleasant after-effects. Our own comment is that, judging from the unsatisfactory manner in which the human economy bears methyl compounds and its greater tolerance to ethyl compounds, somnoform will in the end be found an undesirable agent. This conclusion voices the opinion of Peterson (See Wood's *System of Ophthalmic Therapeutics*, p. 381), who says of this anesthetic in ophthalmic operations that:

"It is not suitable for ophthalmic operations, as the ocular muscles (especially the powerful orbicularis palpebrarum) are among the last to yield to its influence and to become thoroughly relaxed. When this necessary condition is finally obtained, the patient has inhaled so much somnoform that he has entered the dangerous stage. Even then the duration of the anesthetic is not more than 90 seconds.

Vomiting is a frequent sequel, thus rendering it still more unsatisfactory for ophthalmic operations."

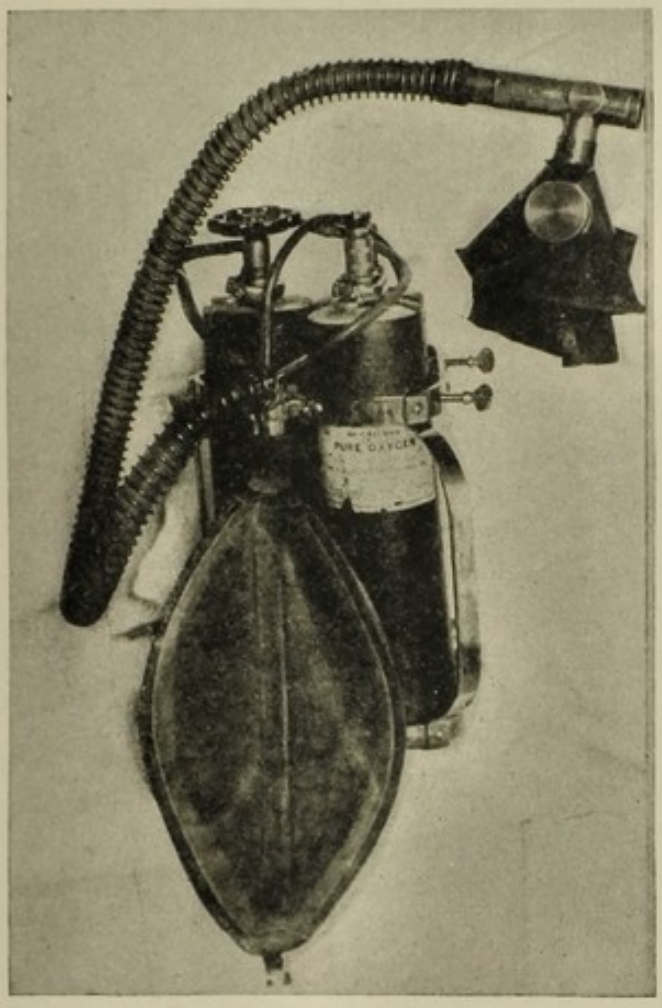


Teter Apparatus for the Administration of Nitrous Oxide and Oxygen.

Nitrous oxide in ophthalmic surgery. Nitrous oxide, discovered in 1776 by Joseph Priestly, was the first gas found to have the property of suspending consciousness; but for many years it was used only in chemistry, before its valuable anesthetic properties were appreciated and put to practical application. Since the publication of Colton's series of 20,000 successful cases (Keen's *System of Surgery,* Vol. 5, 1910), the whole dental world has made daily use of this agent. Present day statistics, showing only one fatality in 200,000 dental administrations, mark it as easily the safest inhalation anesthetic in use for brief operations. Miller (*Jour. Amer. Med. Assocn.,* Nov. 23, 1912) records 32 deaths from nitrous oxide of which 19 seem to have been directly due to the anesthetic. Within the past few years

surgeons have also been much attracted by the safety of this anesthetic.

Crile (*Jour. Amer. Med. Assocn.*, June 11, 1910), who with his associates, has been pursuing the research on nitrous oxide (with and without scopolamin-morphin) under the Committee on Anesthesia of the American Medical Association, reports the use of nitrous oxide



Gatch's Apparatus for the Use of Nitrous Oxide by Rebreathing.

combined with oxygen in 1,130 cases, of which 1,000 were major operations. Of these 1,000,139 had nausea (9 of them severe, and of these 9, nausea lasted 2 to 3 days in 4 of them). He is satisfied that in the hands of highly skilled anesthetists the method is the best yet devised. Haggard is practically of the same opinion.

The Teter apparatus is primarily a nitrous oxide-oxygen apparatus (see, also, *Jour. Amer. Med. Assocn.*, Nov. 23, 1912). It may also be used for ether and chloroform, either alone or with nitrous oxide and oxygen or in sequence. As all vapors pass through the

vapor warmer, there is an added factor of efficiency with any agent used.

Gatch (*Jour. Amer. Med. Assocn.*, March 5, 1910) has recently devised a nitrous-oxide-oxygen apparatus for anesthesia by rebreathing, which has been used in Halstead's clinic in 700 cases. It has not only proved its usefulness as an apparatus, but has shown that in many cases rebreathing is beneficial in that it causes deeper respiration, slower pulse and rise of blood pressure. The cost is about 1½ cents per minute of anesthesia.

It seems rather strange that so safe an inhalation anesthetic has not found its way more into ophthalmic practice. For transitory anesthesia involving such minor precedures as the slitting of a canaliculus, opening a hordelum or a lachrymal abscess, passing a probe, etc., in nervous or apprehensive patients we have utilized a dental surgeon's assistance in the use of nitrous oxide and have been highly gratified with the results. A brother ophthalmic surgeon has long since employed it in the same way. It is our own feeling that the nitrous oxide-oxygen apparatus may yet become a portion of the ophthalmic surgeon's armamentarium.

The various views above set forth simply emphasize what we have previously said, that the choice of an inhalation anesthetic is today (and in all likelihood will continue to be) largely a matter of caprice with each individual surgeon. There is no gainsaying the fact that it is well for a surgeon and his assistant to become expert with some one form of inhalation anesthesia and to hold fast to that method as the safest for him and his staff.

Scopolamin-morphin anesthesia in ophthalmic surgery. The plan of inducing general anesthesia by repeated hypodermic injections of scopolamin-hydrobromate and morphin sulphate has been used more or less extensively by certain general surgeons.

Suker (*Annals of Ophth.*, Jany., 1907) has resorted to it in acute glaucoma, cataract extraction, keratectomy and enucleation. He notes absence of excitement either before or after the operation, absence of muscular rigidity, with sufficient consciousness on the part of the patient to obey the surgeon's orders. Insufficient anesthesia was supplemented by cocain or chloroform, of which but very little was needed. Three injections of scopolamin, $\frac{1}{150}$ grain, and morphin, $\frac{1}{6}$ grain, are made one hour apart, beginning 2¾ hours before the time set for the operation. This method seems safer than either chloroform or ether anesthesia in patients with renal or cardiac lesions, but it is not entirely free from danger, 6 deaths in 3,000

anesthesias having been reported. His feeling is that should the first injection develop any idiosyncrasy against the drugs, the others should not be given but some other plan adopted.

Segelken (*Klin. Monatsbl. für Augenhlk.*, July, 1907, page 75), from an experience extending over four years, is convinced of the value of this method in cases in which ether or chloroform anesthesia portends especial danger. In the preparation of the patient, Segelken allows them to have fluids freely.

Stuelp's (*Klin. Monatsbl. für Augenhlk.*, July, 1909, page 74), experience with this method in 100 cases leads him to state that despite occasional failures, it is to be recommended. In glaucoma, iridectomies, complicated cataract and other operations on the eyeball, it makes the operation easier by quieting the patient. No bad effects on the general condition were observed even in systemic diseases in which inhalation anesthesia was undesirable; and where chloroform was subsequently found necessary, it seemed to act very favorably in the presence of the scopolamin-morphin state. He also used $\frac{1}{150}$ scopolamin and $\frac{1}{6}$ morphin three times one hour apart. In the cases in which successful narcosis was obtained, consciousness was much obscured but not abolished, so that correct answers were given to energetic questions. After the instillation of cocain in infiltration anesthesia (which was never omitted) no expression of pain occurred during corneal incision, iridectomy, cutting the muscles or inserting sutures. On the other hand the movements of the eyeballs were usually carried out correctly and in a quiet and certain manner.

In Stuelp's 100 cases, good narcosis obtained in 45; in 29 it was incomplete but sufficient to carry out the operation; and in 26 it failed. In some cases it produced slight mental excitement and marked increase of sensibility so that chloroform was required to finish the operation.

Hare (Keen's *System of Surgery*, Vol. V, 1910) insists that this anesthetic is not devoid of danger and its use alone for surgical narcosis is not justifiable, while H. C. Wood, Jr., (Quoted in the *Annals of Ophthalm.*, Jan., 1906) goes so far as to say that "the method is scientifically irrational, and inasmuch as it has shown a mortality of one per 1,000, and that in 69 per cent. of the cases the anesthesia has been unsatisfactory, we think it must either be a very bold or a very ignorant surgeon who will persist in its use." This is an extreme statement, however. We do not know where Wood gathered his statistics but neither Stuelp nor Segelken, both of whom have used it in over 100 cases, report any untoward results whatever.

We have ourselves used this method in 15 cases, either alone or in combination with ether. The first case was a patient with senile cataract, an apprehensive German, aged 68. Instead of anesthesia, a mental excitement was produced, and cocain was needed to complete the extraction. Even then it was a most difficult operation to negotiate. All the subsequent cases were done under scopolamin-morphin narcosis with enough ether to relax the patient (very little being usually needed) and these patients were absolutely quiet, for a 20 to 30 minute operation, without any further ether—an advantage not to be lightly regarded. We have also used the method for iridectomy in glaucoma, for enucleations and for lid operations (ptosis, entropion, etc.) and recently in about a dozen trephining operations (Elliott's) for glaucoma, combining morphia and scopolamin subcutaneously with cocain locally, and with conspicuous success. Moreover, the fact that the patients fall peacefully into deep slumber in their beds before being removed to the operating amphitheater is no small matter in dispelling all the apprehension attendant on the operation. This is a factor that compels the consideration of all serious-minded ophthalmic surgeons. We feel that in combination with just enough ether to relax the patient the method may prove of much value in ophthalmic surgery.

Preparation of patients for general anesthesia in eye operations. Before dismissing the subject of general anesthesia by inhalation it is necessary to emphasize the wisdom of reckoning with the psychologic phases of the subject. Nervous, apprehensive people need careful managing. Tactful assurance and calming measures (a little preliminary bromide, etc.) are of untold value in securing a successful issue. No patient should be anesthetized in an operating room, with all the preparations for the operation going on about him. For years some of our most prominent surgeons have been in the habit of giving a hypodermic of a quarter of a grain of morphia (and sometimes atropia) one-half hour before the operation, wholly with the idea of calming the patient and "removing the hypertension dependent upon apprehension." Moreover, any patient who is to have inhalation anesthesia should have been submitted previously to thorough examination of the urine and circulation and should have a perfectly empty gastro-intestinal tract. The latter condition is the best known preventive of post-operative nausea.

Regional anesthesia. Within a few years foreign ophthalmic surgeons, especially those on the Continent, have been searching for means and methods that will enable them to dispense with general or inhalation anesthesia. The reason for this patient search is that the ad-

vantages of local anesthesia are many, despite the fact that general anesthesia is attended with little danger. Hertzler (*Amer. Jour. of Surgery*, July, 1910) well says that "recent knowledge of the late effects of chloroform cause us to inquire anew if ether also may not have delayed deleterious effects hitherto unsuspected. One death in 16,000, now accepted as the fatality range for ether, may not express the danger if the remote effects are considered. This is not the place to enter into an inquiry as to the dangers of inhalation anesthesia, but if operators interrogate their own knowledge of fatalities after the use of ether in their own practice, or that of their friends, faith in the accuracy of the statistics above quoted will be much shaken. When we add to this list those instances in which death occurs, from causes not perfectly clear, after the patient is returned to bed, the doubt is increased. If in addition to this the operator notes the results in a large series of operations under local anesthesia characterized by freedom from such unpleasant experiences, he becomes convinced that ether is not the innocent agent statistics would have us believe."

Evidently moved by similar considerations, Elschnig (*Enzyklopädie der prakt. Medizin.* Schirmer and Vierordt, Wien, 1905, p. 1195) has made some preliminary anatomic studies, with the idea of employing what he calls ganglion or regional anesthesia. The sensitive nerves of the eyeball are the long ciliary from the naso-ciliary nerve, and the short ciliary from the ciliary ganglion. The long ciliary nerves arise from the naso-ciliary nerve shortly after the long root to the ciliary ganglion branches off. These sensitive nerves are gathered together at a point, and if a few drops of a properly prepared anesthetic solution are introduced in the region of the ciliary ganglion, anesthesia of all the structures of the orbit supplied by these nerves ensues. There is no final evidence at hand in the matter, but the probability is that the ganglion must be bathed in the anesthetic solution.

Elschnig's method is as follows: After cocainization of the conjunctiva in the ordinary way, the external canthus is stretched toward the temple and a needle (¾ of an inch long) introduced through the conjunctiva close to the external orbital margin, slightly below its middle point along the lower border of the external rectus muscle, just escaping the external orbital wall. Finally, the tip of the needle is carried inwards until the end next the barrel of the syringe is barely visible, when one-half of the syringeful is injected. By slight lever motions one guards against engaging the needle in the optic nerve or large blood vessels. The anesthesia, which ought

to be established in two minutes, is tested by slight pressure on the globe. If it is not anesthetic the needle is withdrawn about 1 cm. ($\frac{1}{6}$ of an inch) and again pushed back the same distance but in another direction and the remaining contents of the syringe driven toward the ganglion. Subconjunctival injections of cocain are made about 15 mm. from the limbus at four points in inflammatory cases. Most patients are given $\frac{1}{6}$ grain of morphin half an hour previously, which generally has a beneficial psychical effect. In quiet or slightly inflamed eyeballs the pain was practically nil, and in most of the inflamed eyeballs (11 out of 13) complete anesthesia was obtained.

Elschnig (*Klin. Monatsbl. für Augenhlk.*, June, 1908, p. 592) and Loewenstein have thus performed 23 enucleations, 7 exenterations, 2 cyclodialyses, and 1 staphyloma excision.

J. E. Brown, Columbus, O., (p. c.) writes that the following are the customs and rules observed in Fuchs' clinic in Vienna:

"General anesthesia is not used for enucleation save in children. A syringe containing 1 cm. of the anesthetic solution is employed for injection with a needle not less than 5 cc. long. One-fourth of the contents of the syringe is injected over or slightly back of the insertion of the superior, inferior, internal and external rectus. Later, one-half a syringeful is injected in the region of the ciliary ganglion, just as Elschnig advises. This method of enucleation is used in cases of inflammatory glaucoma and iridocyclitis, as well as in non-inflammatory enucleations.

At Siegrist's clinic at Berne, 1 per cent. novocain solution is used, the injection being made over the four recti muscles, making a very much deeper one over the external rectus. Later one-half a syringeful is injected in the region of the ciliary ganglion, just as does Elschnig. Siegrist does not so much emphasize the importance of getting the needle near the ciliary ganglion as do Fuchs and others in Vienna."

Brown goes on to say: "Personally I have found this method very satisfactory in a few enucleations and feel that it can be recommended as the method of choice when there are no special contra-indications."

Seidel's modification of Siegrist's method (*Klin. Monatsb. f. Augenheilk.*, p. 329, 1911) lies in the greater quantity of the injected anesthetic and its distribution all around the eyeball, not simply behind it. He lays stress upon the fact that infiltration of the tissues with large quantities of the anesthetizing fluid is much more important than the application of more concentrated solutions. Not more than 10 drops of adrenalin solution should be used.

H. D. Bruns (*New Orleans Med. and Surg. Jour.*, Dec., 1909) states that for some years all enucleations in his clinic have been done under "ganglion" anesthesia, except on children and very excitable or timorous people. He employs the following combination:

4 per cent. cocain solution	10 mm.
1 to 1,000 adrenalin solution	10 mm.
Normal saline solution	20 mm.

After the usual cocainization of the conjunctival sac, one-quarter of the above solution is injected along each rectus muscle. After eight minutes (two minutes say Fuchs, Elschnig and Siegrist) anesthesia should be complete.

E. A. Robin (*New Orleans Med. and Surg. Jour.*, Dec., 1907) has used this same method in 34 cases. He prefers to supplement the four injections of Bruns by an additional one about the optic nerve, before severing. He claims entire absence of pain during the operation and absolute safety as against the risks of general anesthesia.

D. T. Vail (*Journal of Ophthalm. and Otolaryng.*, Aug., 1911) records 4 enucleations under this method, claiming as advantages: 1. No agonizing delay after the patient has made up his mind to operation. 2. No dieting necessary before or after the operation. 3. Speedy convalescence and absence of shock. 4. Dangers of general anesthetic avoided. 5. No danger of removing the wrong eye.

Three enucleations under 4 per cent. cocain by the foregoing method are recorded by Ellis and Langworthy (*Archives of Ophthalm*, Jan., 1907, p. 39) who use a curved needle to carry the final injection back to the optic nerve. All other investigators have found the straight needle quite satisfactory and there seems every reason therefore why it should be used.

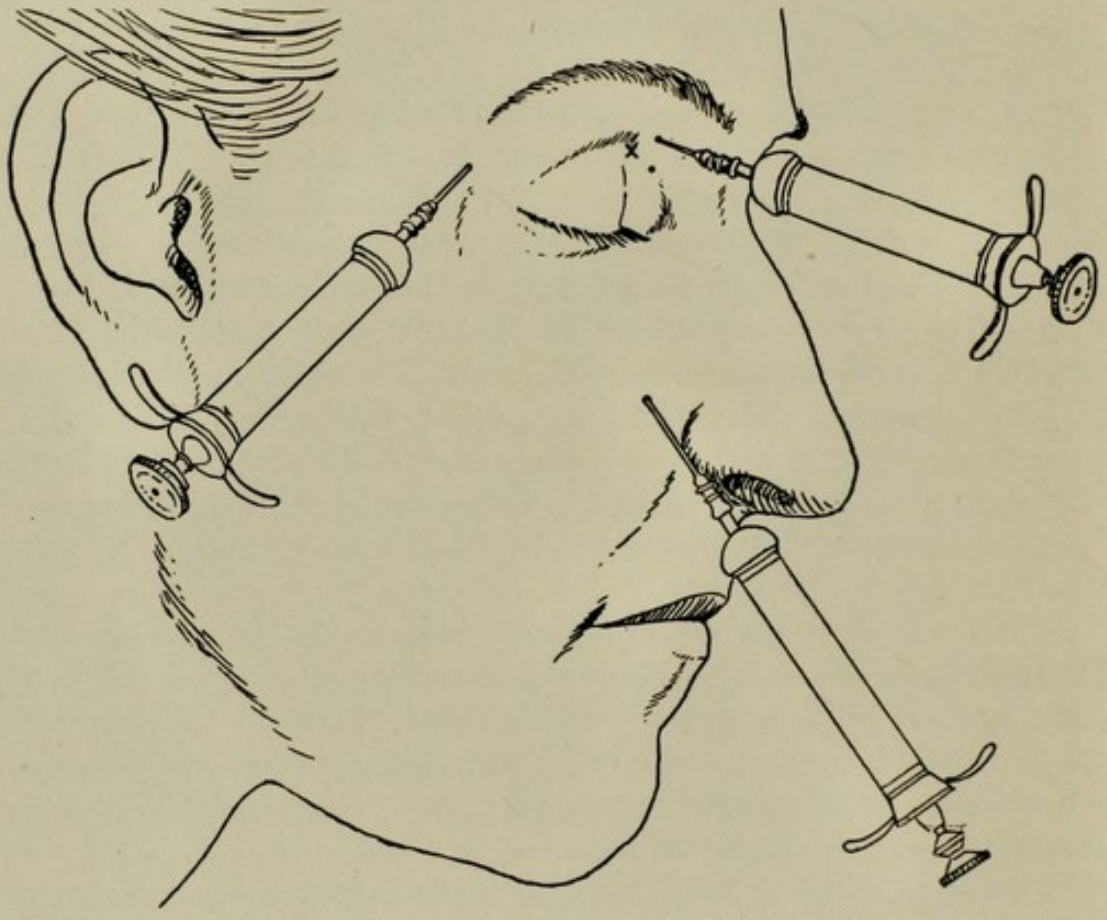
Zimmerman (*Klin. Monatsbl. für Augenhlk.*, Sept., 1906, p. 262) prefers for enucleations 5 per cent. alypin with adrenalin 1 to 1,000, two syringefuls being injected over the recti muscles. Absolutely no complaint was made by any of the patients.

Stutzer (*Zeitschr. für Augenhlk.*, June, 1907), on the other hand, feels that this method should not be resorted to for enucleation unless the globe is free from pain and irritation, or the contra-indications to general anesthesia are very strong. But Schleuter (*Klin. Monatsbl. für Augenhlk.*, Sept., 1907, p. 198) in a comparative study of the anesthetics, enthusiastically endorses Zimmerman's claims, although he prefers 1 to 2 per cent. solutions of novocain with adrenalin.

Our own feeling is that if we essayed enucleation by this method (and it appeals strongly) we should resort to novocain (which can

be boiled with impunity) rather than to cocain. The latter cannot be boiled without impairing its anesthetic properties and none but boiled solutions should be forced back into a closed cavity which, after the nerve is severed, communicates, by way of its sheaths, with the intracranial cavity.

Nerve trunk regional anesthesia. Utilizing the principal of "nerve block, as Crile calls it, Chevrier (*Gaz. des Hôpitaux,* Dec. 9, 1909) and Cantonnet, produce local anesthesia by injections in the region

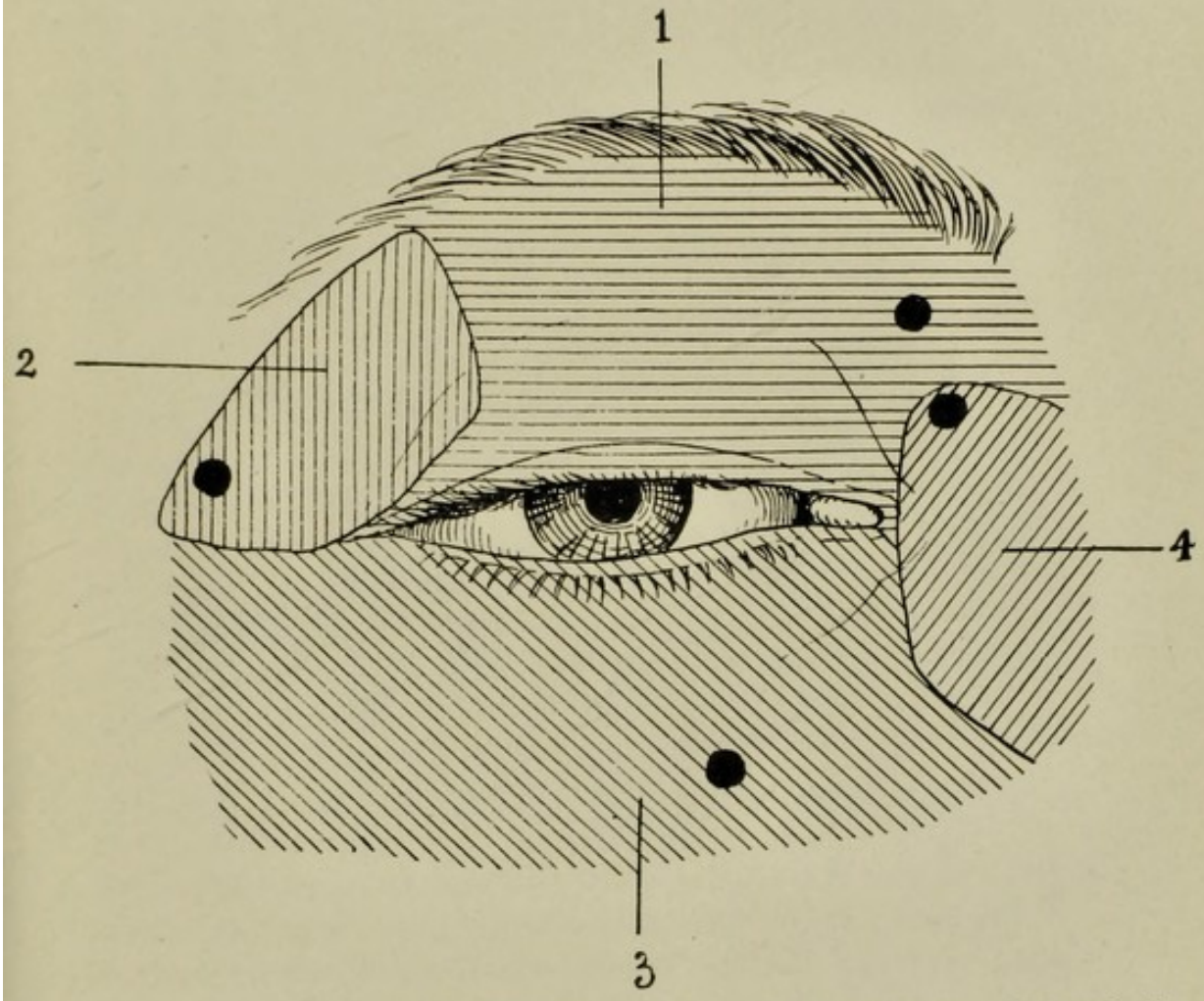


Points of Introduction of the Needle Over the Infratrochlear, Lachrymal and Infraorbital Nerves. (Chevrier and Cantonnet.)

of a nerve trunk, which they think has a decided advantage over injections directly or about the site of an operation, 1st, because less anesthetic is required, and 2nd, because there is less deformity of the part produced by the injection.

Oberst (Keen's *System of Surgery,* Vol. V, 1910) deserves credit for having introduced paraneural infiltration in 1885; while Corning, later, modified the method by injecting the nerve trunk itself with ½ to 1 per cent. cocain solution. Any of the anesthetics may be used (cocain, in ½ per cent., stovain 1 per cent., alypin 1 per cent.),

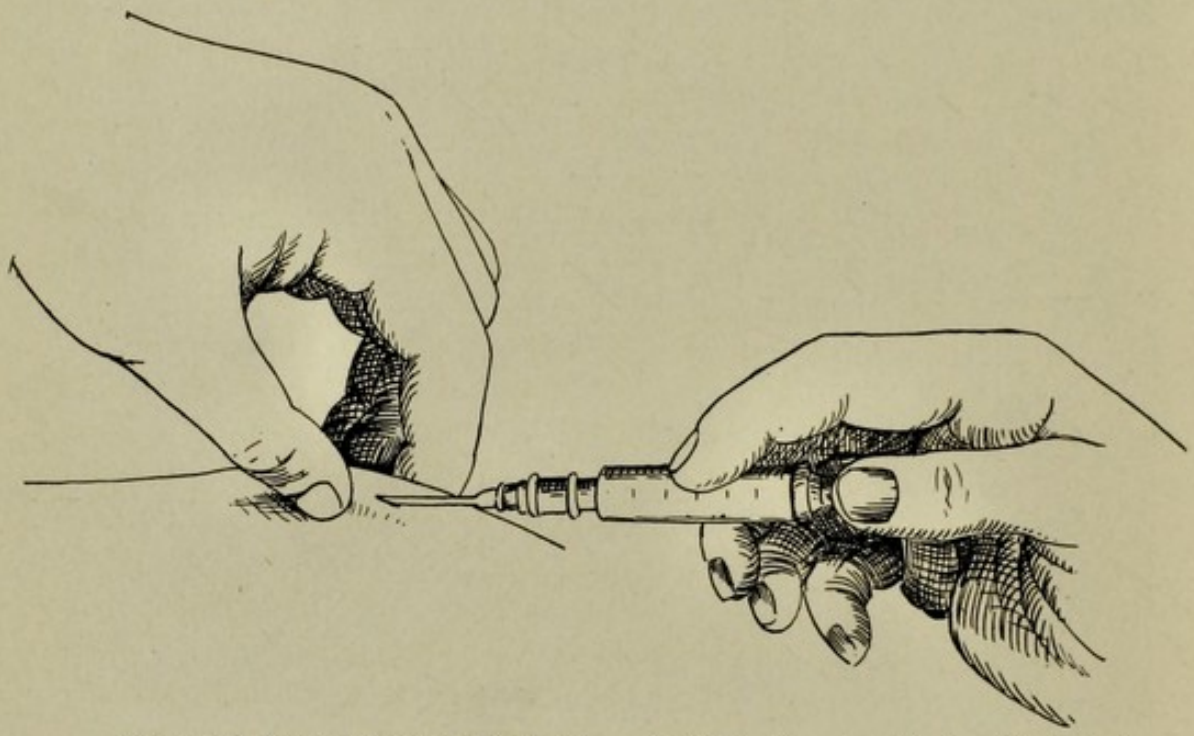
but Chevrier and Cantonnet prefer 1 per cent. novocain solution, to which is added a little adrenalin (how much not stated). Fifteen minutes is required to penetrate thoroughly the nerve trunk with the anesthetic solution. They point out that the upper lid derives



Areas of Anesthesia (regional) Produced by the Introduction of Anesthetic Solutions over the Trunk of the (1) Supraorbital Nerve; (2) the Lachrymal Nerve; (3) the Infraorbital Nerve; (4) the Infra- or Subtrochlear Nerve (Cantonnet).

most of its sensitive nerve filaments from the supraorbital—a nerve that can be easily located. Sometimes these filaments are given off, however, before the nerve emerges from the orbit. It is necessary, therefore, to approach the nerve in the orbit. The inner fourth of the upper lid is supplied by the supratrochlear, therefore one injection made along the roof of the orbit above and just external to the pulley for the superior oblique will affect both nerves. The external fourth of the upper lid is supplied by branches of the lachrymal

nerves. The lower lid receives its sensitive filaments from the ascending ramifications of the infra-orbital nerve. These anatomic considerations show the necessity of three injections to control the three sources of innervation. For anesthetizing the supratrochlear and supraorbital nerves the needle is inserted above and a little to the inside of the pulley (which is located by the finger) and passed



Proper Technique for the Production of Infiltration Anesthesia (Hertzler).

along the roof of the orbit upward and outward 1 to 1½ cm., pushing on the piston as the syringe is inserted in order to have the fluid in advance of the needle. The injection for the lachrymal nerve (not sac) is made about two centimetres (⅓ of an inch) from the external canthus, carrying the needle after entrance upwards and inwards three or four cm., when the anesthetic is deposited between the periosteum and the lachrymal gland.

The injection for the infraorbital, according to the authors, is made at the level of the infraorbital foramen with the needle of the syringe in the axis of the canal, and anesthesia of the lachrymal sac is obtained by the subtrochlear injection. The pulley having been located, the needle is inserted below and a little to the inner side of it until the internal wall of the orbit is felt.

They have applied this method in 21 cases, embracing trachoma operations, lachrymal sac extirpations, Panas' operation for entro-

pion, chalazia, tarsorrhaphy and cauterization. The results were uniformly excellent. The method really stands about half way between regional and infiltration anesthesia.

Infiltration anesthesia. By infiltration anesthesia we mean the introduction of any anesthesia solution into the skin itself (intracutaneous anesthesia); or directly under it (subcutaneous anesthesia).

Local anesthesia thus induced has been tried by many surgeons and abandoned, mainly because they did not thoroughly learn the technique of infiltration anesthesia. Being accustomed to the total anesthesia of ether and chloroform, they chafe under the restrictions imposed by the infiltration method, which calls for a more accurate conception of the finer steps of the operation and for better knowledge of the anatomy of the parts. The prime requisite is a well-made glass syringe and clean sharp needle, both of which should be boiled before using.

In 1889 Schleich (*Ueber schmerzlose Operationen*, Berlin, 1889) discovered that by adding normal saline solution to the ordinary cocain solution much less cocain was required to desensitize a part. Indeed a few investigators went so far as to use normal saline only. In some instances this suffices; but a small percentage of cocain insures the effect. All infiltration solutions should at least be made isotonic with the tissues by carrying sodium chloride in the proportion of 0.92 per cent. Latterly, it has become the custom to add 1 to 1,000 adrenalin. Hare (*loco cit.*) points out that the reason adrenalin so greatly augments and prolongs the paralyzing effect of the cocain on the nerves and the organs, is that, like freezing, a stasis bandage or an Esmarch bandage, it temporarily arrests the circulation and so "incarcerates the cocain," to adopt Corning's expression. Indeed, this very effect may be carried too far and result in localized gangrene, as shown by Foisy (*Tribune Médicale*, Sept. 18, 1904), Luke (*Scottish Med. and Surg. Journal*, Aug., 1905), and Stragardt (*Klin. Monatsbl. für. Augenhlk.*, Feb.-March, 1909, p. 213). The last named author used suprarenalin and cocain; Foisy and Luke stovaine and adrenalin. Recently the subject has been thoroughly worked out on the lower animals, for which see Le Brocq's report farther on.

It would seem to be safer not to resort to any mixture of a local anesthetic with preparations of the suprarenal gland for injection into the tissues, unless they are used in very small amount and dilute solutions.

Various methods of securing infiltration anesthesia with cocain. To Würdemann (*Jour. Med. Assocn.*, Oct. 29, 1904, and Nov. 16, 1905) is ascribed the credit of introducing infiltration anesthesia into ophthal-

mic practice in this country. [See also, in this connection, Cholewa (Casey Wood), (*Jour. Med. Assocn.*, May 26, 1894, p. 778), Schleich's solution proving in his hands most satisfactory.]

For operations on trachoma, J. Guttman (*Arch. of Ophthalm.*, May, 1904, p. 302) first uses cocain or holocain in the conjunctival sac, following this up with injections under the conjunctiva of the upper lid and well back into the fornix, of sodium chloride 0.2, cocain 0.5, distilled water 100. Not more than four to five drops of the solution are necessary. He has thus desensitized the tissues in 52 consecutive excisions or "rollings" for trachoma, the age of the patients ranging from 6 to 52 years. Thirty-six had no pain, 13 whimpered, and 8 were quite painful. As advantages over general anesthesia he claims: 1, no hospital accommodations are necessary; 2nd, no assistant is needed.

H. D. Bruns (*Trans. Amer. Ophthal. Soc.*, Vol. XI, part 1, 1906) and Robin employ for lachrymal sac extirpations the same solution they use for "ganglion" anesthesia, namely 4 per cent. cocain solution, 10 minims, 1 to 1,000 adrenalin solution 10 minims, normal saline solution 20 minims. They would not think of resorting to general anesthesia for this operation.

After ten years' experience with the same solution Stitzer (*Zeitsch. für Augenhlk.*, June, 1907) is of practically identical opinion with that of Bruns and Robin. In all operations on the lid and lachrymal sac this is the method of selection, in his opinion.

Substitutes for cocain in infiltration anesthesia. Holocain, because of its toxicity when used subcutaneously, is not to be thought of in this connection but alypin, novocain, acoin and stovaine have all been rather extensively employed.

After systematic use of alypin (5 per cent. solution), Zimmermann (*Klin. Monatsbl. für Augenhlk.*, Sept., 1906, p. 262) feels that it is undoubtedly the best substitute for cocain. Its vasodilator properties, so much dreaded by several authors, may easily be controlled by admixture with adrenalin. Moreover, it is cheaper than cocain and can be boiled with impunity. These claims of Zimmerman are supported by Sydney Stephenson (*The Ophthalmoscope*, Nov., 1905). Truc (*Révue Générale d'Ophtal.*, March 31, 1906), on the other hand has combined the effect of both alypin and cocain of the same strength for interstitial anesthesia, but could find no appreciable difference save that the tendency to toxemia is less with alypin.

As to novocain, Schleuter (*Klin. Monatsbl. für Augenhlk.*, Aug.-Sept., 1907) places it first for this purpose, in 1 per cent. solution. One fact he emphasizes is that too concentrated solutions, (especially

in combination with adrenalin) may induce local gangrene, while too dilute solutions, on account of the greater quantity of infiltration fluid, may distend the parts and disturb one's ideas of the anatomic relations. Wickerkiewicz (*Wochensch. f. Therap. u. Hyg. des Auges.*, Feb. 14, 1, 1907, p. 153) also favors novocain for interstitial anesthesia but believes its anesthetic effect is inferior to that of cocain.

Stovain in 2 per cent. solution is the favorite drug with Santos-Fernandez (*Révue Gén. d'Ophtal.*, March, 1906, p. 99) for lid operations, as he secures an especially wide area of anesthesia with it. Fifty ccs. of the solution are used along the lines of the incisions. Krauss, (*Muench, Medicin. Wochenschr.*, 1902, No. 34), (Marburg) and Marin (*Arch. de Oftal. Hispano-Amer.*, Sept., 1907, p. 487) both combine stovain and acoin as follows: acoin 0.025, cocain 0.05, normal saline solution 5.00; about 2 ccs. are used about the field of operation at each puncture point.

A special report on the local anesthetics recommended as substitutes for cocain in infiltration-anesthesia has been submitted by Le Brocq (*British Med. Jour.*, March 27, 1909), who conducted an experimental investigation on animals in the Pharmacologic Laboratory at Cambridge, England, under the auspices of the Therapeutic Committee of the British Medical Association. He investigated stovain, novocain, tropacocain, beta-eucain, alypin, beta-eucain lactate, nirvanin, holocain hydrochlorid, acoin, orthoform (new) and anesthesin, and has presented a report that commands the attention of all ophthalmic surgeons. It has been found that all of them are general protoplasmic poisons having a special predilection for nervous structures; if used in sufficiently strong solutions they depress and ultimately destroy every form of living tissue.

The points to which special attention have been paid are those laid down by Braun as essential in comparing local anesthetic action. They are: (1) a lower degree of toxicity than cocain in proportion to its local anesthetic power. (2) Sufficient solubility in water. The solutions should be stable, that is, they should keep without deterioration and be capable of sterilization by boiling. (3) Absence of any sign of irritation. There should be no injury to the tissues, the local anesthetic should be easily absorbed without causing any after-effects, such as hyperemia, inflammation, infiltration, or necrosis. (4) Compatibility with adrenalin. (5) Rapid penetration of the mucous membrane, and suitability for medullary anesthesia. The only exception made to these postulates is that dealing with absorption, it is not obvious that easy absorption is desirable; if absorbed slowly, the drug produces more prolonged action. For this reason

adrenalin is injected with these substances, producing local vasoconstriction and thus giving the anesthetic a longer time for action. If a drug can be obtained which fulfills the above conditions, it may safely be said that it will supersede cocain.

A drug which is not soluble in water to the extent of 2 per cent. has been regarded as unworthy of competing with cocain. This throws out acoin, holocain, anesthesin, orthoform (new) and beta-eucain.

Cocain, stovain, novocain, tropacocain, beta-eucain lactate, alypin, and nirvanin are freely soluble in water; their solutions are stable, and as a 2 per cent. solution they will keep for a short time without deterioration. Cocain cannot be boiled, as decomposition occurs, and the drug loses its activity and is gradually destroyed. Stovain, novocain, beta-eucain lactate, tropacocain, alypin and nirvanin can be sterilized at 115° C., if necessary, as they withstand this temperature without change and are as active after as before sterilization.

Regarding local anesthetic properties, it was found that stovain has a more powerful anesthetic action, weight for weight, than any of the other local anesthetics. Alypin, beta-eucain lactate, novocain and tropacocain have anesthetic properties about equal to cocain. Nirvanin as a local anesthetic is inferior to cocain.

"Concerning toxicity, as determined by the smallest dose which will kill frogs, mice and rabbits, it was found that alypin has anesthetic powers equal to cocain, but a higher toxicity, and so does not comply with the conditions enunciated by Braun. Nirvanin has not the anesthetic power of cocain, and it is only slightly less toxic. As, however, we have found four drugs equal to or stronger than cocain in anesthetic power, and considerably less toxic than nirvanin, no further experiments with this drug were deemed necessary. From this it will be seen that only four drugs, namely, stovain, novocain, tropacocain and beta-eucain lactate, have complied with the first two conditions. With these four drugs further experiments were performed to discover how they fulfill the other conditions laid down for the perfect infiltration anesthetic.

Next, the irritant action on the tissues was investigated, and it was found that the irritant action of stovain, beta-eucain lactate and tropacocain is far greater than that of cocain; novocain is the only drug which is superior to cocain in this respect.

All the local anesthetics are compatible with adrenalin if the solutions are fresh and kept only for a short time. After a day or two

the adrenalin decomposes unless it is kept in a stoppered, opaque bottle.

The main conclusion reached is "*that of the drugs which have been investigated, novocain is most satisfactory for general use. Its anesthetic action is equal to that of cocain, and its toxicity and general destructive power on the tissues are very much less.*"

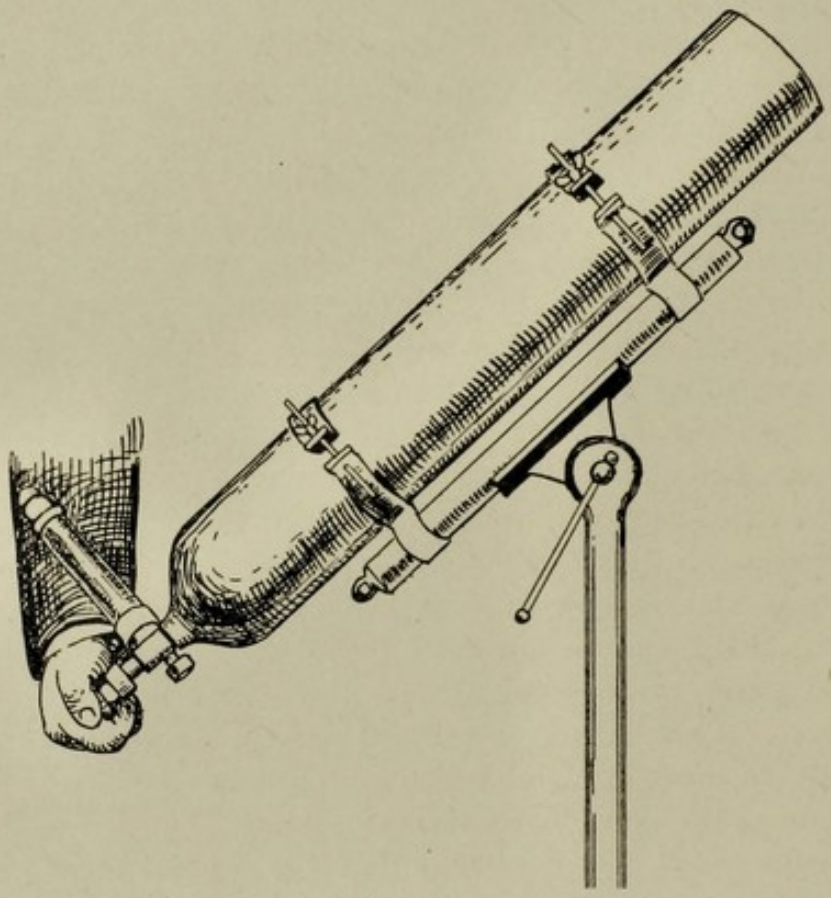
If this laboratory result, which apparently has been very carefully and very definitely arrived at, is supported by practical everyday work, it seems probable that in novocain we have nearly the ideal anesthetic for infiltration anesthesia.

Quinine and urea bimuriate is among the latest aspirants for local anesthetic honors. It is soluble in its own weight of water and is non-irritating hypodermically. E. J. Brown (*Jour. Amer. Med. Assocn.*, Aug. 8, 1908) experimented with 3 per cent. solution for the removal of tonsils and secured perfect anesthesia for a number of hours. Severe sloughing after deep infiltration was observed by J. A. Wyeth (*New York Polyclinic Jour.*, Jan., 1908) and he is now experimenting with a different formula. McCampbell's (*Jour. Amer. Med. Assocn.*, Oct. 23, 1909) experiments indicate its power to induce temporary paralysis in animals. Hertzler (*Jour. Amer. Med. Assocn.*, Oct. 23, 1909), Brewster and Rogers confirm Thibaut's (*Jour. Amer. Med. Assocn.*, Sept., 1907) claims, but they feel that 1 per cent. solutions delay healing somewhat and suggest ¼ to ½ per cent. solutions for hypodermic use. They all agree that 10 per cent. solutions may be applied locally to mucous membranes, and prefer sterile water as a vehicle because of the more lasting anesthesia.

Intracutaneous anesthesia. A remedy that was in great favor with the older surgeons but that has practically fallen into disuse, is the local application of carbolic acid solution (2 to 10 per cent.) over the cutaneous areas to be attacked. That it does the work and does it well cannot be denied. Its ease of use and accuracy of application commend it as a method that might well be revived. To create a starting point for the hypodermic needle in subcutaneous anesthesia it is ideal.

Freezing mixtures. From time to time meagre reports have come to hand concerning various freezing mixtures that may be used in ophthalmic surgery, such as the rhigoline spray introduced by Richardson. This method has been variously modified, but because the vapor liquefies and easily runs into the eye it is not practical for ophthalmic operations. Freund (quoted by Elschnig) has employed liquid air for local anesthesia and a few surgeons have tried the

"carbon dioxid snow," in the form of ice pencils, but the office apparatus for the production of the pencils is rather costly and may make it prohibitive. However, it has been found of value in the desensitizing and removal of cutaneous growths and may become useful in the treatment of rodent ulcer.



The Grossman Company's Office Apparatus for the Preparation of Pencils of "Carbon Dioxid Snow."

Mucous anesthesia. This is the phase of local anesthesia that is of most interest to all ophthalmic surgeons. And the same caprice that manifests itself in the choice of a general anesthetic is even more in evidence in the choice of a local one. Ever since Koller's (*Bericht der Ophthal. Gesell.,* 1884) epoch-making discovery in 1884 of the local anesthetic power of cocain upon the eye, it has retained its place as the anesthetic of election with the majority of ophthalmic surgeons the world over, in spite of its drawbacks and the host of later discovered anesthetics.

As cocain is the type of all the other anesthetics we shall treat of it first.

Cocain. The anesthetic action of cocain upon the tissues of all warm-blooded animals is due to its paralyzing action on the terminals of the sensitive nerves. The eye, because of its large sensory nerve supply, represents a most perfect tissue for the action of cocain. In consequence of this action anesthesia usually appears ½ to 1 minute after the instillation of a 2 to 4 per cent. solution.

If 2 or 3 instillations are employed, the cocain (by its influence on the inter-epithelial cement substance) diffuses through the cornea and in about ten minutes produces moderate mydriasis by stimulating the fibres of the sympathetic nerve in the iris. About this same widening of the inter-palpebral fissure is noted, probably due to the stimulating effect of the cocain upon the fibres of Müller's muscle. In many individuals a more or less transitory reduction in the amplitude of accommodation accompanies the mydriasis above noted. Within two minutes the eye is quiet enough to permit the removal of foreign bodies from the cornea or conjunctiva, or to allow inspection of the same as well as the fornix of the conjunctiva, and in sensitive persons to make any kind of application to the palpebral conjunctiva or cornea. Surgical anesthesia, however, is usually not established in less than five or more minutes after the instillation.

The usual method of application in this country is to use two drops of a 2 to 4 per cent. solution in the conjunctival sac every three minutes for four or five instillations (9 to 12 minutes), by which time the deep-lying intraocular tissues are generally pretty well desensitized. The eye should be kept closed during all this time to prevent as much as possible the desiccation of the corneal epithelium that often constitutes one of the contra-indications to the use of cocain.

The chief advantages of cocain are: 1, ease of obtaining it anywhere; 2, its cheapness; 3, prompt, trustworthy anesthesia, because of its diffusibility through the cornea; 4, hemostatic action on all the blood vessels of the eye; 5, it is perhaps less irritant when instilled (warm) than any of the other anesthetics.

The disadvantages of cocain are: 1, its deleterious action on the corneal epithelium, which is said by some to favor post-operative infection, and by others to delay the healing of the wound. (At the same time it must be remembered that all local anesthetics are more or less protoplasmic poisons and if used in sufficiently strong solutions are almost sure to affect the corneal epithelium unfavorably.) 2, its accompanying mydriasis. 3, the occasional partial cycloplegia, (none of the foregoing objections, however, seem to us to weigh very heavily when surgical anesthesia is sought). 4, reduction of the intraocular tension. This may sometimes prove an annoying com-

plication by disturbing the operator's tactile sense with the instruments. 5, its solutions cannot be boiled. This is thought by many a grave objection, particularly as to its use in intraocular operations, but if solutions freshly prepared from sterile water are used, little danger need be apprehended. For some years we have had our cocain solution prepared with sterilized saturated boric solution, which is filtered after the solution is made. Such solutions have remained free from penicillium as long as three months at a time and for all office operations are safe.

For intraocular operations freshly prepared solutions, as just specified, are safest. Cocain solutions might well be made isotonic with the ocular tissues, as urged by Cantonnet (*Arch. d'Ophtal.,* Oct. 1908, p. 617), who employs 14 parts of sodium chloride per 1,000 parts of water as the basis of all solutions.

To avoid desiccation of the cornea often produced by cocain and to render the solution less irritating Scrini (*De l'emploi des alcaloides en solution huileuse,* Paris, 1906) has for some years past resorted to oily solutions of the pure alkaloids and claims longer anesthesia with the same strength solution. He prefers olive oil, first washed for several days with half its volume of 95 per cent. alcohol to free it from fatty matter. It is next decanted and filtered, and then sterilized with a sand bath for about 10 minutes at 120 degrees. Darier and v. Pflugk endorse every claim Scrini has made for the oily solutions.

We have personally tried the oily solutions only recently. Unfortunately they almost immediately cause a thin oily film to form over the cornea that may well obscure the fine details in any operation.

Substitutes for cocain. Holocain, the first substitute offered for cocain, was introduced into ophthalmic work in 1896. It is a synthetic derivative of phenetidin. The alkaloid is feebly soluble in water (1 to 160) and is of neutral reaction.

The hydrochloride, which can be boiled without affecting its anesthetic qualities, is soluble to almost 2 per cent. in water, and has quite displaced the alkaloid for surgical purposes. Anesthesia of the eye supervenes in one to three minutes after one drop of a 1 per cent. solution, and lasts ten minutes.

J. Hirschberg (*Centrabl. f. prakt. Augenhlk.,* June, 1899) in 1899 performed several hundred major and minor operations under holocain without accident and preferred it for all operations save enucleations. In the same year the elder Knapp (*Archives of Ophthalm.,* May, 1899, p. 315) announced that he was using holocain almost entirely in

all operations on the anterior part of the eye, instead of cocain, and recently we have been favored with a personal communication from Arnold Knapp to the effect that they "are still using 1 per cent. holocain with satisfaction on account of its antisepsis, its slight effect on the corneal epithelium, and the absence of effect on the pupil."

In 1898 R. L. Randolph (*Jour. Amer. Med. Assocn.*, May 14, 1898) conducted elaborate laboratory experiments with various bacilli and showed that 1 per cent. holocain solutions not only have an inhibitory effect upon these organisms but kill them after a certain length of time. Since then this drug has grown steadily in ophthalmic favor, having been endorsed by many foreign and home investigators, who have used it in a large series of cases, and are entirely satisfied with it as an anesthetic and as an agent superior to cocain. There are, however, a few dissenting voices; among them Haskett Derby. [Derby. Holocain in Ophthalmic Surgery; Its Superiority over Cocaine; Its Therapeutic Value. (*Archives of Ophthalm.*, Jan., 1899, p. 45) and Holtz (*Amer. Jour. Med. Sciences*, Feb., 1898), who insist that it is painful and much more irritating and less benumbing to the deeper structures.]

Eucain and beta-eucain. A rival to both cocain and holocain was brought out by Schering in 1896 and called eucain-b. It was clinically reported on by Silex (*Deutsch Med. Wochensch.* No. 6, 1897), who found it: 1, 4 to 5 times less toxic than cocain; 2, unchanged by boiling; 3, solutions kept perfectly four months; 4, possessing a feeble bactericidal power; 5, without effect on the pupil and accommodation; 6, cheaper than cocain.

Beta-eucain lactate has recently been brought forward as an improvement on eucain-b, and has been tried by two or three investigators with indifferent results thus far.

Tropacocain was discovered by Giesel in 1891 and was soon after prepared synthetically. According to various investigators its virtues (in 3 per cent. solution) consist in its slight toxicity, its more rapid and enduring anesthesia, its slight influence on the pupil and accommodation, the permanence of its solutions and its improved qualities when made isotonic by the addition of sodium chloride. We have never tried it.

Stovain. This solution belongs chemically to the benzol group. It crystallizes readily, is extremely soluble in water, and its aqueous solutions show no alteration after prolonged boiling. Four per cent. solutions produced considerable smarting (we should say a good deal more than cocain from its use in our own eyes) and anesthesia occurs in from two to five minutes. Stephenson (*loco cit.*) thinks the dis-

comfort is no greater than after cocain, and finds it without effect on the blood vessels. In his hands the duration of the anesthesia was from 10 to 30 minutes. He observed slight dilation of the pupil but no effect on the accommodation. It is used chiefly in 2 to 4 per cent. solutions, de Lapersonne having resorted to the latter strength for 18 cataract extractions and 4 iridectomies. Slight disturbance of the corneal epithelium was noted by him several times.

Alypin. We are indebted to Impens (*Deutsch. Medicin. Wochenschr.*, No. 29, 1905) for the introduction of alypin. It is a glycerin derivative, extremely soluble in water, not precipitated by the alkaline fluids of the body and can be boiled indefinitely. It is less toxic than cocain, and is employed in 2 per cent. solution conjunctivally. Sydney Stephenson (*loco cit.*) believes there is less smarting with alypin than with cocain, but Jacques, using alypin in one eye and cocain in the other, says that patients complained more of the alypin.

Novocain. Braun (*Die Lokalanesthesis, ihre wissenschaftliche Grundlage and prakt Anwendung,* Leipsig, 1905) offers this agent as another addition to our list of local anesthetics. It occurs in needle-like crystals, soluble in their weight of water. The hydrochlorate is the best for ophthalmic use. Verderame's (*Zeitschr. für Augenhlk.*, Sept., 1907) tests on the corneas of rabbits show that 2 to 10 per cent. solutions produce irregular erosions of the epithelium and in the stronger solutions extensive loss of corneal substance. The evidence seemed to be that strength for strength the deleterious action of novocain is greater than that of cocain, while the anesthesia is less intense.

In our own hands novocain has proven fairly satisfactory for anesthesia of the mucous surfaces.

Acoin was introduced in 1899 by Trolldenier and in the same year was investigated by R. L. Randolph (*Ophthalmic Record,* July, 1899, p. 401). With ⅓ to 1 per cent. solutions he secured satisfactory anesthesia in uninflamed eyes in about the same time as with cocain. He also noted no influence on the pupil, the accommodation or the cornea. Darier (*La Clinique Ophtal.*, Oct., 1899) has been its chief advocate, but more for subconjunctival than for conjunctival use.

Led by his favorable experience in a painful erosion of the cornea, v. Pflugk (*Wiener Medicin. Presse,* March 17, 1907) employed 1 per cent. solutions of acoin in olive oil in over 100 cases, and cannot speak too highly of its properties. At times patients did not know it had been instilled. The effect of two to three instillations varies in duration for one-half hour to 5 to 6 hours. Along with Darier, Scrini and others, he lays great stress on the way the olive oil is treated

before being used as the vehicle. "It should first be washed for several days with half its volume of 95 per cent. alcohol, to free it from fatty matter, then decanted and filtered and lastly sterilized over a sand bath for ten minutes."

Some years ago we experimented with 1 per cent. solutions of acoin (base) and were very favorably impressed with it.

Yohimbin. Chief among the less known substitutes is yohimbin, introduced by Magnani of Turin. The alkaloid is derived from the yohimbehe tree of West Africa. It is soluble in water only to 2 per cent. but freely so in alcohol. The hydrochlorate (now procurable and more soluble in water) will doubtless prove more popular than the base. Unfortunately its solutions deteriorate very rapidly. Claiborne (*Medical News,* July, 1904) and Coburn observed that the congestion produced by yohimbin must label it inferior to cocain as an anesthetic in all operations on the eye.

Frynin. This is an alcoholic extract obtained from the parotid glands of toads, which Popow (*Ophthalmic Review,* Jan., 1906) has employed for optical iridectomies and discission of cataract. One per cent. solutions set up considerable irritation and hyperemia and some disturbance of the corneal epithelium.

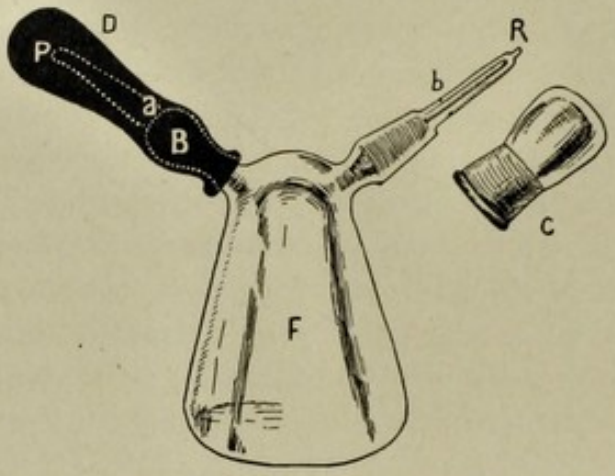
Aneson has been employed by Sternberg in 2 per cent. solutions for various ophthalmic operations.

Oil of guaiac, as a 6 per cent. solution in olive oil, is reported by Bellencoutre (*Journal de Médicine de Paris,* Dec. 22, 1895) as producing sufficient anesthesia for all operations save those of opening the anterior chamber.

Quinine and urea bimuriate. Lastly, we refer to this preparation, recently brought forward as an ideal agent for subcutaneous anesthesia. On mucous surfaces, however, it does not seem to work so well. Solutions weaker than 5 per cent. do not produce trustworthy mucous anesthesia, and 5 to 10 per cent. solutions are extremely irritant (proved by instillations in our own eyes) and induce a hyperemia of 15 minutes to one-half hour's duration. The anesthesia of the anterior structures seems of about 1 hour's duration, but our observations only embrace a few cases.

Recently, Unger (*Semaine Médecale,* Jan. 22, 1913) has drawn attention to some of the new derivations of quinine, such as hydroquinine and cupreine. Cupreine is an alkaloid occurring naturally in the so-called "false" cinchona tree, *Remijia pedunculata,* and is closely related to quinine, from which it differs in containing one less methyl group. The following derivatives have been prepared artifically: Ethyl-hydro-cupreine, iso-propyl-hydro-cupreine and iso-

amyl-hydro-cupreine. Unger claims that the last named alkaloid is no less than 32 times as strong a local anesthetic as cocaine, and that it is the most powerful substance of this class at present known. These statements are based upon experiments made on the conjunctivas of rats and mice. The procedure was to ascertain the lowest percentage of solution which would cause local anesthesia lasting from 30 to 90 minutes. The experiments indicated that with cupreine derivatives, the anesthesia appeared less rapid than with cocaine but that it was possible by using high concentration to secure anesthesia lasting several days.



Modification of the "Undine," both for the Sterilization and Keeping Sterile of Anesthetic Solutions.

Thus it will be seen that the *ideal local anesthetic* for mucous surfaces, a non-toxic, non-irritating substance that can be boiled, whose only action would be to paralyze the terminals of the sensory nerves without influence on the tension, the corneal epithelium, the pupil and accommodation—has not yet been found. No one anesthetic meets all these requirements. Holocain seems to approach the ideal most nearly and yet cocain in 2 per cent. solution presents so few disadvantages and so many excellent qualities that it is today, as before remarked, probably the local anesthetic of election among ophthalmic surgeons the world over.

A receptacle for sterile, local, anesthetizing solutions is pictured, herewith. Its purpose is evident at a glance and we believe it to be one of the best containers in the market.

Combined mucous and sub-conjunctival infiltration anesthesia. This method, which is of use mainly in operations on the ocular muscles, deserves much wider acceptance than has yet been accorded it. Until the last few years advancement operations have been done largely under general anesthesia, one disadvantage of which is the subse-

quent vomiting. Much strain was thus laid upon the sutures which would sometimes tear out during this straining. The chief disadvantage, however, of general anesthesia during muscle operations is that the normal innervation of the muscles is set aside and the surgeon is thus much disturbed in his estimate of how much effect to produce by the operation. Under local anesthesia the most precise adjustment of the muscles is feasible and the method about to be described affords such an opportunity in all patients over 12 to 14 years of age.

Adopting the method of Siegrist, conjunctival anesthesia is secured by the ordinary method of instilling 1 drop of 4 per cent. cocain solution every 3 minutes for 5 instillations. The conjunctiva is then picked up by forceps and the needle of a hypodermic syringe filled with a solution of cocain, normal saline solution and adrenalin, introduced over the insertion of the muscle or muscles to be attacked. Three to 5 mm. of the solution should be used over each muscle insertion, after which constant hard pressure with massage is employed through a piece of sterile gauze. In this way the anesthetic solution is diffused all about the muscle insertion and the anterior expansion of the capsule of Tenon. In about 8 minutes the tissues can be manipulated with ease and little if any disagreeable sensation to the patient, so that the operation may be approached with the greatest confidence. It must be understood that the slight chemosis produced by the infiltration of the anesthetic solution under the conjunctiva may at first disturb the surgeon's ideas of the topographic anatomy of the parts but due allowance in this regard will be learned easily in the first operation thus attempted.

With this combined anesthesia there are few advancements which cannot be performed under local anesthesia even on the most phlegmatic adults. The formula for the usual anesthesia solution is:

Sol. cocain muriate, 4 per cent.,	2 fluid drams.
Normal saline solution,	1 fluid dram.
Solution adrenalin, 1 to 1,000,	1 fluid dram.

For the cocain any of the local anesthetics may be substituted, such as novocain, stovaine, alypin or beta-eucain. Novocain is of the least toxicity and has been used with the most complete success. If prolonged anesthesia is required 1 per cent. acoin solution may be resorted to. In one case anesthesia for one hour and a quarter was thus induced. For the adrenalin, any preparation of the suprarenal glands may be used—such as supracapsulin or suprarenin.—(W. R.)

Anesthesia, Local. Although this subject will, in several of its phases be considered under **Anesthesia in ophthalmic surgery** (q. v.), it will

not be out of place to give here a list of the better known (local) anesthetic agents. These include acoin, alypin, anesin, brenzcain, cocaethyline, cocaine, ecgonine and its other salts, erythrophleine, eucaine with its salts Alpha-eucaine and Beta-eucaine, the latter being more effective, Beta-eucaine lactate, helleboreine, holocaine, homocaine, nirvanin, novocaine, stovaine, tropacocaine, yohimbin, orthoform, subcutin, anesthesin, and strophanthin.

Reichmuth (*Zeitschr. für Augenheilkunde,* September, 1906) has investigated most of the local anesthetics and concludes that cocaine is the least harmful of them all. Dropped on to the cornea they produce similar appearances—all more intense than cocaine. Tropacocaine resembles cocaine most in this respect; cocaine alone constricts the blood vessels, all the others dilate them. For subconjunctival injections and washing out the anterior chamber, cocaine does least damage to the epithelium and tissues, while acoin and holocain in the rabbit produces severe inflammatory and necrotic processes, from which the eye is sometimes lost.

Darier (*Thérapeutique Oculaire,* p. 90) employs in every case where an anesthesia of short duration is required alypin or stovaine (q. v.). Indeed, he believes these anesthetics to have identical therapeutic powers. If he desires anesthesia by infiltration he combines one of these agents, or both of them in equal doses with cocaine. He also prefers cocaine in cataract extraction, and, on the whole feels sure that when cocaine is employed with proper knowledge of its advantages and disadvantages it is the best local anesthetic for surgical purposes.

Before the discovery of stovaine and alypin as local anesthetics, Schmidt arranged the principal local anesthetics in order of merit from the following points of view: First, rapidity of anesthetic action. Of these he places first in order tropacocaine, then holocaine, then cocaine, then eucaine A., then eucaine B., and finally orthoform. Second, duration of the anesthesia:—orthoform, cocaine, eucaine B., eucaine A., holocaine, tropacocaine. Third, intensity of the anesthesia:—cocaine, tropacocaine, eucaine B., eucaine A., orthoform. Fourth, analgesia when the eye is inflamed:—cocaine, tropacocaine, eucaine B., eucaine A., orthoform. Fifth, mydriatic action:—cocaine tropacocaine, eucaine A., eucaine B., holocaine. Sixth, blanching of the conjunctiva:—cocaine, tropacocaine, eucaine A., eucaine B., holocaine. Seventh, scleral congestion:—eucaine A., eucaine B., tropacocaine, holocaine. Eighth, amount of local irritation:—orthoform, eucaine A. and B., cocaine, tropacocaine. Ninth, antiseptic properties:—Orthoform, holocaine, eucaine B., tropacocaine, cocaine.

Tenth, poisonous qualities:—holocaine, cocaine, eucaine A., tropacocaine, orthoform.

As intradermic, subcutaneous or subconjunctival injections, Darier uses a weak (one per cent. solution) of cocaine with or without acoin. The latter agent being non-toxic he has found this combination very effective and has never seen any complications from its use.

G. E. de Schweinitz refers to ocular anesthetics as follows:

"The ocular anesthetics with which one is best acquainted are cocain, holocain and eucain. Cocain is very advantageous for temporary anesthesia, but not good for continuous use, as it is apt to produce drying and wrinkling of the corneal epithelium, and, if anything, tends to increase the corneal ulceration if it is too constantly used. Holocain is an admirable anesthetic in a 1 per cent. solution. It causes anesthesia in from fifteen seconds to one minute, and maintains this anesthesia for about ten to fifteen minutes. Its instillation is followed by a temporary burning sensation. It differs from cocain inasmuch as it does not enlarge the pupil, increase intraocular tension, and is distinctly bactericidal. Its direct application to corneal ulcers has often in my hands proved most beneficial. I frequently add it to the various antiseptic collyria—for example, boric acid lotion—and sometimes apply it directly, by means of a cotton mop, to the ulcerated surface, and have never had occasion to regret a practice of this character."

Although numerous local anesthetics, especially eucaine (q. v.) and holocaine (q. v.), have been advised as substitutes for cocaine it is still the favorite agent in operative procedures. I prefer (as giving the maximum anesthesia with the least cocain) for the average ophthalmic operation the following formula:

℞

Cocain. hydrochlor.	gr. xx.
Holocain. hydrochlor.	gr. v.
Aquæ dest. et steril.	℥j.

Instil one drop every three minutes for 12 minutes.

Although several observers believe that the anesthetic action of solutions of cocain, both of the alkaloid and of the salts, is lessened or destroyed by boiling, this view is not held by C. R. Holmes, who always sterilizes his solutions in this way, and has used it for operations upon the eye, ear and nose thousands of times. In his experience it is the rarest thing to find that the drug is not efficacious, and in these rare cases he has attributed its lack of action to the idiosyncrasy of the patient.

The combination of cocaine, eucaine and other anesthetics with

adrenaline, suprarenine and other hemostatics to obtain the local effects of both without the inconvenience, especially during operations on the eye, of instilling these agents separately, is not to be forgotten. To supply the demand for them a number of compounds have been marketed by various chemists, although it seems hardly worth while to have dignified them with trade names. It may be observed, in passing, that Darier (*Thérapeutique Oculaire*) set the example by giving the name cocarenaline (q. v.) to a mixture of cocaine and adrenaline and a very effective compound it is, anesthetizing and blanching the conjunctiva and other ocular tissues, thus clearing and keeping clear the field of operation.

Verderame found that the rabbit's cornea was decidedly affected by 2 to 10 per cent. solutions of novocain (q. v.). Not only did the anterior epithelium become irregular but there were distinct erosions with marked loss of corneal substance. He found the injury to the cornea to be greater than with the use of cocain and believes its anesthetic effect to be less.

I. Frank speaks favorably of his experience of alypin. He finds it in 4 per cent. solution, free of many of the drawbacks one experiences in the use of cocain; it does not dry the cornea, there is no mydriasis and no impairment of accommodation.

Sydney Stephenson makes the following emphatic statement regarding alypin: That he had never seen a bad result from 2 per cent. alypin, despite the fact that from 1905 to August, 1908, it had displaced all other local anesthetics in his practice.

Subcutin is an ethyl ester or para-amidobenzoic acid and occurs as a white crystalline powder soluble in 100 parts of cold and 40 parts of hot water. As a local anesthetic it is employed—generally in hypodermic form—in twelve and a half per cent. strength, dissolved in physiological salt solution.

Anesthesin is a white, odorless, tasteless powder, very slightly soluble in water but easily dissolved by alcohol and olive oil. As a local anesthetic it is valuable and employed as an ointment and in 10 per cent. strength is used as a dusting powder. In a limited way it is empolyed hypodermically in minor ophthalmic surgery.

Snellen (*Graefe-Saemisch Handbuch*) regards the following substitutes for cocain as comparatively useless in practice, owing to defects in their action: Arecoline (q. v.), carpeine, convallarine, drunine, erythrophleine (q. v.), haya poison, helleborein (q. v.), stenocarpin and strophanthin. The majority are mostly the results of laboratory experimentation and are either very irritating to the ocular structures or their anesthetic action is not as lasting or as

prompt as that of the cocaine salts. On the other hand, he puts forward the following claims of eucaine (q. v.): It is 4 to 5 times less poisonous than cocaine; it is not decomposed by boiling; the solutions remain fresh and active for months; it is slightly germicide; it produces neither accommodative paresis nor mydriasis; it is cheaper than cocaine.

Bruns and Robin (*Annals of Ophthalmology*, October, 1906), employ a mixture containing 10 drops each of a 4 per cent. solution of cocaine and of adrenaline chloride (1:1000), and 20 drops of normal saline solution for inducing anesthesia in painful operations, especially excision of the eyeball. Each 40 drops of the mixture therefore contains $\frac{2}{3}$ grain of cocaine. Ten drops of the mixture are injected deeply, behind the equator of the eyeball, along each rectus muscle. An interval of five minutes is then allowed to elapse before the operation is commenced. The method, however, is not entirely devoid of pain. Three of Bruns and Robin's patients only evinced no evidence of suffering throughout the entire operation. Those who complained of pain referred it to the last stage of the enucleation—that is to say, the division of the optic and ciliary nerves. The authors noticed that robust and full-blooded men appeared to suffer more than the frail and delicate. According to Bruns and Robin, the advantages of local over general anesthesia are:—the consciousness of the patient, thereby affording a safeguard against removing the wrong eye; the safety to life; and, finally, the fact that most of patients seem to prefer local anesthesia.—(Ed.)

Anesthesia, Medullary. SPINAL ANESTHESIA. See **Anesthesia in ophthalmic surgery.**

Anesthesia, optical. Hysterical or functional amblyopia, or amaurosis.

Anesthesia retinæ. This is a form of amblyopia of the visual field due to some general neurosis—almost always hysteria.

Anesthesin. PARAAMIDOBENZOIC-ACID ETHYLESTER. This compound is a white, odorless, tasteless powder, very slightly soluble in water, but easily dissolved by alcohol and olive oil. As a local anesthetic it is valuable and is employed in 10 per cent. strength as an ointment, and used as a dusting powder. In a limited way it is employed hypodermically in minor ophthalmic surgery. See **Subcutin.**

Anesthol. A clinical combination of chloroform, ethyl cloride and ether, used for general anesthesia (q. v.).

Anestile. A proprietary mixture for use as a general anesthetic; probably a mixture of ethyl and methyl chlorides.

Aneurysma der Netzhautgefässe. (G.) An aneurysm of the retinal vessels.

Aneurysma der Netzhautarterien. (G.) An aneurysm of the retinal arteries.

Aneurysm of the aorta, Eye symptoms of. Becker observed in these cases pulsation of the retinal vessels similar to that occurring in aortic insufficiency. Among other signs noted by authors are slight ptosis, pupillary contraction, and slight enophthalmus.

Treatment of the eye-symptoms is involved in that of the underlying disease.

Aneurysm of the cavernous sinus, Eye symptoms of. Of the two forms of cavernous aneurysm, the genuine, in which there is spontaneous rupture of a previously degenerated vessel-wall, is the rarer. The commoner variety is due to traumatism in connection with cranial injuries. In this instance the aneurysm is the direct result of rupture of the internal carotid within the sinus itself. This severe trauma is followed by dilation and pulsation of the orbital veins, with protrusion and pulsation (pulsating exophthalmus) of the eye. Aside from neuritis optica, with subsequent atrophy of the optic nerve and congestion of the retinal veins, paresis and paralysis of those nerves may occur which run in the wall of the sinus, i. e., the oculomotor, abducens, trochlear and trigeminus. These nerves suffer according to the amount of pressure exerted upon them. The same is true of the chiasma and optic tracts, so that various forms of hemianopsia and atrophy of the nervus opticus may occur. Finally, papillitis of one or both sides may be caused by increased intracranial pressure.

The treatment of this serious condition is mainly surgical and operative. Therapy depends upon the peculiarities of each case. Sometimes compression, digital or other, may diminish the exophthalmus. If temporary digital compression proves beneficial, it is well to continue it daily (once or twice for a few minutes to several hours) over a period of weeks until recovery is obtained. If this is not successful, ligature of the corresponding internal or common carotid is called for, if all the other indications for such an operation are present.

Spontaneous recoveries of pulsating exophthalmus (q. v.) are known, but they occur so seldom that surgical intervention should not be too long delayed, while waiting for it to supervene. See **Exophthalmus, Pulsating.**

Aneurysm of the internal carotid artery and the ocular symptoms dependent upon it. True aneurysm of the internal carotid occurs within the cranium. The dilated and pulsating sac, through pres-

sure upon the surrounding structures, induces amblyopia and amaurosis from atrophy of the optic nerve, and hemianopsia from interference with the functions of the chiasma and optic tracts. Paresis and paralysis of the eye-muscles (trochlearis, abducens) and nerves (oculomotor and trigeminus) may occur. Strümpell found that a severe, chronic trigeminal neuralgia resulted from an aneurysm of the internal carotid, which pressed upon the Gasserian ganglion.

If the tumor reaches a certain size it may set up a choked disk on one or both sides. In the differential diagnosis of this disease from basal intracranial tumors, the stethescope is of great value and attention should be paid to the sounds propogated from the arterial vessels. (See **Auscultation.**)

The prognosis is unfavorable unless it is possible to bring about recovery through compression or ligature of the vessels themselves or of the common carotid. Otherwise the therapy is purely symptomatic. The continued use of such remedies as iodide of potassium in large doses, ergot, injection of gelatine, etc., may occasionally result in complete recovery, through the formation of thrombosis in the dilated sac. When the lesion of the arterial wall is probably due to syphilis anti-luetic medication may give good results.—*(Encyklopädie der Augenheilkunde.)*

Aneurysm of the ophthalmic artery, Eye symptoms of. This is a rare condition, but when it does occur we find it in one of two situations, either within the orbit or in the cranial cavity just before the artery enters the foramen rotundum. Sattler's monograph on pulsating exophthalmus (Graefe-Saemisch *Handbuch*), speaks only of two cases of the first and one of the second form. Since then a few additional examples of the disease, verified by anatomical investigation, have been reported. The first is that of a woman, aet. 22, who after parturition developed the symptoms of orbital aneurysm, and who died of hemorrhage after several unsuccessful operations had been performed in an attempt to relieve her. The autopsy showed an aneurysm of the internal carotid, beginning at the cranial entrance and extending to the origin of the ophthalmic artery at the clinoid process. The latter vessel was found dilated to about four times its normal diameter. In the orbit there was a saccular enlargement of the same vessel to the size of an orange. The other case is that of a man who, after a fall, developed exophthalmus, for which an orbital exenteration was done. The post-mortem examination revealed an aneurysm of the ophthalmic artery of the size of a walnut. The vascular

tumor was entirely within the orbital cavity. The symptoms, treatment, etc., of this disease will be discussed under **Exophthalmus, Pulsating.**

Aneurysm of the retinal arteries may be single or multiple. It may occur in spindle-shape or sacular form, or as a cylindrical dilatation of the arteries of the papilla or retina. Occasionally it is of the pulsating variety; while miliary aneurysm has also been observed. The causes are pathological changes in the vessel walls, especially arterio-sclerosis.

Aneurysm, Retinal arterio-venous. In this vascular anomaly there is direct communication between the arteries and veins of the retina with a marked dilatation of the intervening capillary system. This may appear in the form of an aneurysmal varisc, when the anastomosis occurs without an intervening sacculation between artery and vein; or it may show itself as a varicose aneurysm in which the artery and vein communicate by means of new-formed blood-sacules. The former type is nearly always congenital; the latter mostly of traumatic origin.

Anévrysme. (F.), n. Aneurysm.

Anfall. (G.) An attack, a relapse or shock.

Anfressen. (G.) To corrode.

Anfrischen. (G.) To refresh.

Anfrischung. (G.) Animation.

Angeboren. (G.) Congenital.

Angeborne Anomalien. (G.) Congenital anomalies.

Angeborene Anomalien der Bindehaut. (G.) Congenital anomalies of the conjunctiva.

Angeborene Anomalien der Chorioidea. (G.) Congenital anomalies of the choroid.

Angeborene Anomalien der Cornea. (G.) Congenital anomalies of the cornea.

Angeborene Anomalien des Glaskörpers. (G.) Congenital anomalies of the vitreous.

Angeborene Anomalien der Iris. (G.) Congenital anomalies of the iris.

Angeborene Anomalien der Lider. (G.) Congenital anomalies of the lids.

Angeborene Anomalien der Linse. (G.) Congenital anomalies of the lens.

Angeborene Anomalien der Muskeln. (G.) Congenital anomalies of the muscles.

Angeborene Anomalien der Netzhaut. (G.) Congenital anomalies of the retina.

Angeborene Anomalien des Sehnerven. (G.) Congenital anomalies of the optic nerve.

Angeborene Anomalien der Sklera. (G.) Congenital anomalies of the sclera.

Angeborene Anomalien der Thränenorgane. (G.) Congenital anomalies of the lachrymal apparatus.

Angeborene Ptosis. (G.) Congenital ptosis.

Angeburt. (G.) Hereditary quality.

Angegriffen. (G.), adj. Attacked.

Angeienchyma. (L.), n.n. A tissue composed entirely of blood-vessels.

Angeiokeratodeitis. (L.), n.f. An old name for keratitis vasculosa.

Angeioma. (L.), n.n. An angioma, or tumor made up chiefly of blood-vessels.

Angell, Henry C., one of Boston's noted ophthalmologists and one of the first to practice that specialty in the United States, was born in Providence, Rhode Island, January 27, 1829. He was a graduate of Hahnemann Medical College, Philadelphia, class of 1853, and later studied three years at Vienna University, after which he settled down to special practice in Boston at 16 Beacon street, where he died from a complication of diseases on May 28, 1911, in his 83d year.

Angell joined the American Institute of Homeopathy in 1853, the year of his graduation in medicine, thus making his period of membership the phenomenal one of fifty-eight years.

He became a member of the Massachusetts Homeopathic Medical Society in 1856, his name being on its roll at the time of his death. His loyalty to and interest in the cause of homeopathy as well as his literary tastes and qualifications are shown by his assuming the editorship of the *New England Medical Gazette* in 1866. He thus became the first editor of this journal, although he later relinquished the post to Dr. I. T. Talbot and devoted himself to his specialty. For many years he was a member of the staff of the Massachusetts Homeopathic Hospital as its first ophthalmic surgeon.

He was one of the small band of homeopathists interested in the evolution and establishment of Boston University School of Medicine. He was a member of its first Faculty and remained its Professor of Ophthalmology until 1893, a period of twenty years, when he was succeeded by his associate in the department, John H. Payne. Those who were privileged to sit under his instruction well remember his perfect ease and grace as a lecturer. He seemed

to take his students into his confidence, assuming that they were as interested in the eye and knew as much about it as he did.

In person he was small and slight, with piercing, twinkling eyes full of kindliness and alertness. He wore a full beard trimmed to a point, and was especially neat in his attire. He was very urbane, never showed impatience and was always ready with his counsel and kindly advice. Withal he was nature's gentleman.

His interest in art was a real and vital thing, and was due to the possession of considerable artistic skill, particularly in water colors, though his works in oils were full of tender feeling, especially in the portraying of landscapes. He was a considerable collector of paintings, and a visit to his home was like going into a choice art gallery.

He was in fact not only well known to the medical profession but was prominent in the artistic and literary circles of Boston when the Hub was in its prime as an artistic and literary centre. His chief contribution to medical literature was a text book on *Diseases of the Eye,* for students and general practitioners, which went through at least seven editions and was noteworthy as being the first on the homeopathic treatment of these diseases.

With all his culture and his general and special ability, he was modest, quietly positive and attractive, and his influence was that of the scholar and connoisseur rather than that of the man of affairs.

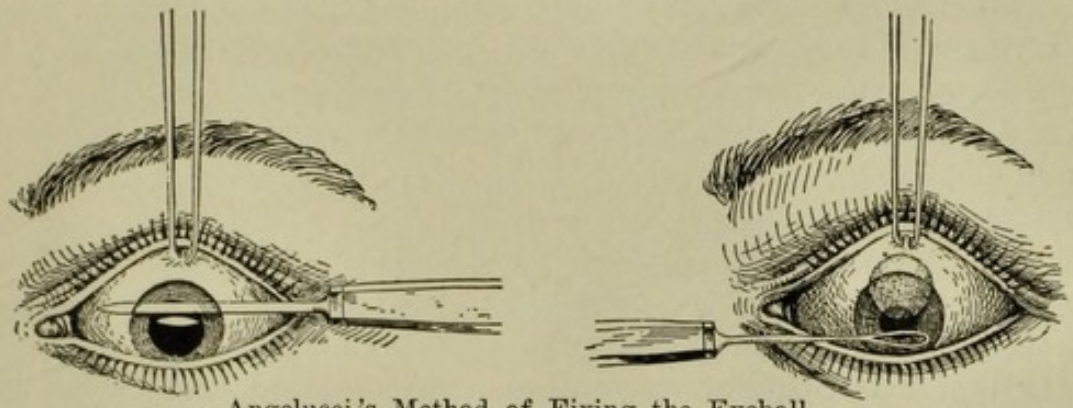
The following appreciation indicates the regard in which he was held by those who were fortunate enough to know him intimately. It was written by his close and long-time friend, Professor Arlo Bates, of the Massachusetts Institute of Technology, in response to an inquiry as to the details of his life:

"I knew Dr. Angell for many years, and was very fond of him. He was a man of marked character, of the greatest refinement, of strong artistic bent, of most charming humor, and of an uprightness which bound all these together.

"Of the details of his early life I know nothing. I knew him at first as the friend of William Hunt and that set of painters, as the generous friend of musicians and the appreciative critic of literature. Howells was among his warm personal friends. He was a collector of paintings, and one of the richest outside of France of the work of the Barbazon School is in that queer, little brown house on Beacon Hill. Indeed, few in Paris approach it. The French Government tried, half a dozen years ago, to buy a number of his pictures, but he said he bought them for his pleasure and not to speculate in, and refused their handsome offers.

"He went abroad frequently when I first met him, but of late years he has passed his life between Boston and Medfield, where he had a cottage. Many years ago he suffered severely from meningitis, and he never fully recovered from the attack. For the past ten years he had been so delicate that only his wife's devotion and constant watching kept him alive, yet he has always been cheery, always interested and interesting. We who knew him and loved him can only feel that the memory of such a friend is more vital and lasting than the companionship of the many."—(John H. Payne.)

Angelucci fixation method. A mode of fixation of the eyeball devised by Angelucci. (See the figure.)



Angelucci's Method of Fixing the Eyeball.

During the Corneal Incision. During Delivery of the Lens.

This surgeon rotates the eyeball downwards and seizes with strong fixation forceps the tendon (with the overlying structures) of the superior rectus. By this means the globe is not only perfectly fixed but the upper lid is held out of the way. In sunken eyeballs, or when the patient attempts to squeeze the lids together or to rotate the eyeball upwards, these efforts do not cause gaping of the wound. Moreover, the grasp of the forceps can be loosened in an instant at any critical moment during the operation and the lids closed at once. This method is very useful in several forms of cataract and is extensively employed.

Angesicht. (G.), n. The face or countenance.

Angewachsen. (G.) Adherent, attached.

Angewachsenes augenhäutchen. (G.) Ocular conjunctiva.

Angewohnheit. (G.) A practical habit, habitually.

Angioeremia of the retina. Atrophy of the retinal vessels is a sign of certain previous or concurrent atrophic diseases of the retina and, generally, of the optic nerve.

Angioid streaks in the retina. This condition is also known as "retinal

pigment striæ,'' that occur as black-brown areas behind the central vessels of the retina. Ward Holden considers them the remains of hemorrhages diffused in a linear direction through the layers of the retina. According to Lister, they are vestiges of new vessels along whose course exudates (that have undergone secondary pigmentation) are arranged.

In a case of Zentmayer's the ophthalmoscope showed in both fundi ramifying and anastomosing pigment bands, dark red to black, extending throughout the fundus in each eye. In the right eye there was also a horizontal extravasation of blood.

Pagenstecher reports two cases showing the same ophthalmoscopic appearances, including in one eye streaks of bright red hemorrhage, which subsequently developed into typical pigment streaks. He favors Lister's explanation of these lesions, viz., that they are connected with new-formed vessels. These vessels may be developed in connection with a chronic inflammatory process in the retina or choroid.

Angioma. See **Angeioma.**

Angioma conjunctivæ. Angioma of the conjunctiva.

Angioma venenosum of the orbit. Although this important neoplasm will be further described elsewhere (See **Tumors of the ocular apparatus; Orbit, Operations on the**) it may be said here that it is a benign neoplasm although it may be converted into a malignant form of sarcoma. Indeed, these blood-vessel tumors may form combinations with other neoplasms producing, for example, angiocarcinoma, angiosarcoma, angioadenoma, angiofibroma or angiolipoma. They may disappear after various forms of inflammation affecting the tumor mass; or, on the other hand, may give rise to septic phlebitis and end fatally from pyemia. An orbital angioma may destroy vision and even bring about caries of the orbital bones by pressure. According to Moores Ball excision is the more desirable treatment of angioma. This, in deep-seated orbital angiomata, is often impossible without an amount of destruction which might be considered scarcely justifiable in dealing with a tumor the natural tendency of which is innocent.

Such means as will cause coagulation of the blood and obliteration of the tumor are to be considered. With these comes the great danger of septic thrombophlebitis. As coagulating injections should never be employed without ligature, their use in the treatment of orbital angiomata is to be condemned. Repeated electrolysis is of value in the treatment of superficial angiomata, and might be successfully tried in certain of the more deeply situated ones. Igni-

puncture, or puncture with a red-hot Paquelin cautery-needle, is excellent treatment for superficial angiomata which are readily accessible to the needle.

Ligation of the arteries supplying the tumor, or of the main trunks going to the part of the body containing the tumor, has not proven satisfactory. The collateral circulation soon causes a return of the growth. In excising an angioma care should be taken not to cut into the tumor, as troublesome hemorrhage is apt to follow such a procedure.

Inasmuch as it involves the therapy of these new growths the following account of a case by J. F. Klinedinst (*Ophthalmology,* April, 1911) is reported: M. R., aged 31, an employe in a wall-paper factory, gave a history of marked swelling of his right lower eyelid whenever he stooped forward to tie his shoe-laces or for any other purpose. The swelling also occurred when he lay on his right side or carried a heavy weight on his left shoulder and bent the neck to the right, thus compressing the right jugular vein. Examination by palpation showed a soft, compressible tumor of the external half of the lower, right eyelid, including the external canthus, with obliteration of the conjunctival sac, due to a bluish swelling like an enlarged vein, about one-fourth of an inch in diameter. There was no bruit nor any pulsation perceptible. There was some slight exophthalmus when the tumor was swollen, but no enophthalmus. Vision of both eyes was 15/xx, there being a low grade of hypermetropia. An ophthalmoscopic examination revealed nothing abnormal; neither was there any heterophoria. The patient had had no constitutional diseases and enjoyed good health. The nose, throat and rhinopharynx were normal.

An operation for excision of the veins was positively declined. Electrolysis was then tried, five treatments being given; the needle was plunged about one-half inch into and along the floor of the orbit toward the outer canthus. The negative current being used during the first three treatments without any effect upon the tumor, the positive current was then tried during the last two treatments, also without effect. These treatments were followed by some soreness which lasted several days. The author then conceived the idea that if an inflammation could be produced in the vessel walls, the vascular tumor might be obliterated. Alcohol was selected as a drug that would produce a periphlebitis, as well as for its antiseptic qualities, and because it is non-toxic in small doses. After anesthetizing the conjunctiva with cocaine, three drops of absolute alcohol were injected into the orbit by means of a hypodermic syringe. The needle

was plunged through the conjunctiva, close to the floor of the orbit, under the vascular tumor (so as to avoid puncturing the veins) toward the external canthus, to the depth of half an inch, and the contents quickly injected. There was a sharp pain felt in the orbit for a few seconds, which soon subsided without any reaction, followed by a feeling of soreness for a few days. One week later the swelling was not so great when the patient stooped forward. A second injection of five drops was given at this time in the same manner as the previous one. This injection was followed by sharp pain, with slight swelling of the tumor; this subsided in a day, followed again by soreness within the orbit for several days.

One week later the tumor did not seem to bulge so much as formerly, and was slowly becoming smaller. A third injection of six drops was given; this was followed by pain for a few seconds, which lessened before the patient left the writer's office. He returned in about three hours, complaining of some soreness in the orbit and of severe, intermittent pain. There was great swelling and bulging of the whole lower right eyelid from the outer to the inner canthus, with obliteration of the tarso-orbital sulcus; the conjunctiva and skin of lid were of a bluish color; there was some exophthalmus, but no impairment of vision. Under applications of ice the swelling subsided the following day, but there was continued soreness within the orbit for several days. One week later there were no signs of the tumor. The patient could then bend or stoop forward without bringing on swelling or bulging of the eyelid. To make a more thorough cure Klinedinst gave another injection of five drops of alcohol into the same region of the orbit, which was followed by the usual pain and soreness.

It is now more than a year since the writer gave the injections, and he feels reasonably sure that a cure has been effected without any impairment of the functions of the eye. A recent examination of the patient showed no evidence of the former tumor.—(Ed.)

Angiom der Bindehaut. (G.) Angioma of the conjunctiva.

Angiom der Orbita. (G.) Angioma of the orbit.

Angiomegaly. According to deSchweinitz *(Diseases of the Eye,* p. 221), this disease is characterized by an increase in the volume of the skin of the lid. The palpebral skin becomes folded and falls over its margin, but appears atrophic and may be transiently red, like the color of the cheek. It symmetrically affects the upper lids, and has been attributed to a structural or functional anomaly of the vascular system.

Angiomi delle palpebre. (It.) Angiomata of the eye-lids.

Angiopathia retinæ traumatica. A name given by Purtscher to peculiar fundus changes in which there is (probably) extravasation and organization of lymph in the retinal tissues as the result of severe injury—generally fracture of the skull.

Angiosclerosis. Arteriosclerosis; hardening or degeneration of the blood-vessels.

Angiosclerosis, Ocular. Alterations in structure of the blood-vessels of the eye. See **Arteriosclerosis, Ocular.**

Angioscope. An instrument for examining the capillary vessels of animals and plants.

Angle. In *geometry,* the space included between two intersecting lines. The point where the lines meet is called the *vertex of the angle.*

Angle of chromatic deviation, the angle through which the refracted ray of definite wave-length (color) has to be turned in order to bring it into coincidence with the normal to a surface at the point of refraction. See **Achromatism.**

Angle of deviation, the angle through which the refracted ray has to be turned in order to bring it into coincidence with the corresponding incident ray. The angle of deviation (δ) of rays that are perpendicularly incident to one face of a prism is dependent upon the apex-angle (β) of the prism and the index (n) of refraction, these bearing the following relation to each other: $n = \frac{\sin(\beta+\delta)}{\sin\beta}$. This equation may also be given the convenient form: $\tan B = \frac{\sin\delta}{n-\cos\delta}$. The angle of deviation produced by any prism of the dioptral system (q. v.) is found in the table of goniometrical tangents, simply through dividing the power of the prism by 100. For instance, to find accurately the angle of deviation that is produced by a prism of 9 prism-dioptres, when exposed to perpendicular incidence, the tangent value is equal to 0.09. The nearest tangent value in the table is 0.08749, so that 0.09000 less the tan 5° = 0.08749 gives a difference in the tangent value = 251. In the table, between the tangents for 5° and 5° 10′, is found a difference of 29.3 produced by 1′. Hence, 251 is to be divided by 29.3 in order to ascertain the number of minutes contained in the tangent difference of 251, and which gives 8.56′. This must be added to 5°. Hence, 5° 8.56′ = 5° 8′+0.56 +60″ = 5° 8′ 33.6″. Consequently 9△ produces an angular deviation of 5° 8′ 33″+. *Angle of incidence,* the angle through which the incident ray has to be turned in order to bring it into coincidence with the normal to a surface at the point of incidence. When rays are reflected at a surface, the angle of reflection is always equal to

the angle of incidence, but if the rays are refracted at a surface, the angle, (r) of refraction depends upon the index (n) of refraction of the medium and the angle (i) of incidence, when sin i/sin r = n.

Angle of minimum deviation, the least deviation sustained by a ray in passing through a prism. It is known to be minimum when the incident ray and the refracted ray form equal angles with the line that bisects the apex-angle of the prism, in other words, when the ray traverses the prism symmetrically. The ray itself is then also called the *ray of minimum deviation.* The critical value of the angle δ of minimum deviation is dependent upon the angle ß of the prism and the index n of refraction, which bear the following relation to each other:

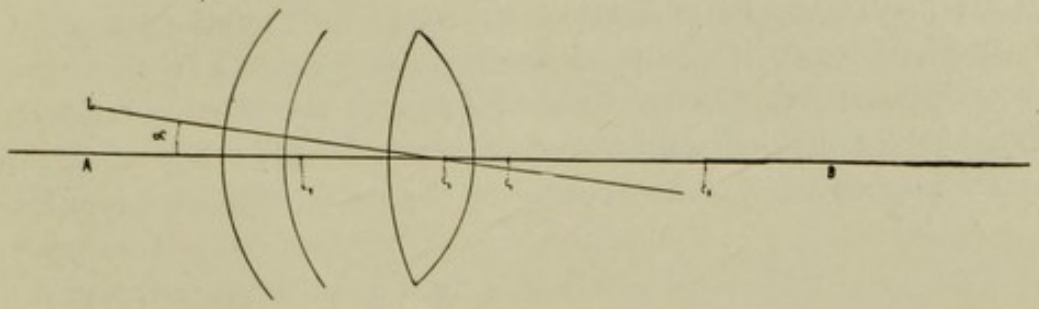
$$n = \frac{\sin \frac{ß+\delta}{2}}{\sin \frac{ß}{2}}.$$

See also **Prism.**

Angle of polarization, the angle of incidence giving the most complete polarization of light (q. v.) for any given substance. Also called polarizing angle. *Angle of prism,* the angle included between the refracting surfaces of a prism (q. v.). Also called the *refracting angle;* the *apex-angle;* the *apical angle. Angle of reflection,* the angle through which the reflected ray has to be turned in order to bring it into coincidence with the normal to a surface at the point of reflection. The angle of reflection at a surface is always equal to the angle of incidence. *Angle of refraction,* the angle through which the refracted ray has to be turned in order to bring it into coincidence with the normal to a surface at the point of refraction. The angle (r) of refraction and the angle (i) of incidence are connected by the relation sin i/ sin r = a constant (the index of refraction), this relation being known as Snell's Law, from its discoverer, Willibrod Snellius.—*Angle-true,* see **Orthoscopic.** *Critical angle,* the limiting angle of incidence which, within a medium more dense than air, separates the totally reflected rays from those which, at least partially, escape into air. (C. F. P.)

Angle alpha. This angle, generally written angle α measuring from 5° to 7°, is formed by the junction of the visual axis and the optic axis. The visual axis, or visual line, is the ray which passes through the first nodal point of the eye to the fovea after having been refracted so as to pass through the second nodal point. The location of this axis is not constant, being dependent upon the varying fixing

point of the fovea. Nor is the optic axis a constant, for this is the line passing through at least three of the four centers of curvature of the cornea and lens. Congenital anomalies of these structures



Angle Alpha.

displace the linear position of the points; consequently this decentering must be neglected.—(H. G.)

Angle, Bi-orbital. The angle subtended by the axes of the orbits.

Angle, Co-orbital. In craniometry, the angle made by the anatomical plane, where it crosses the bi-orbital plane.

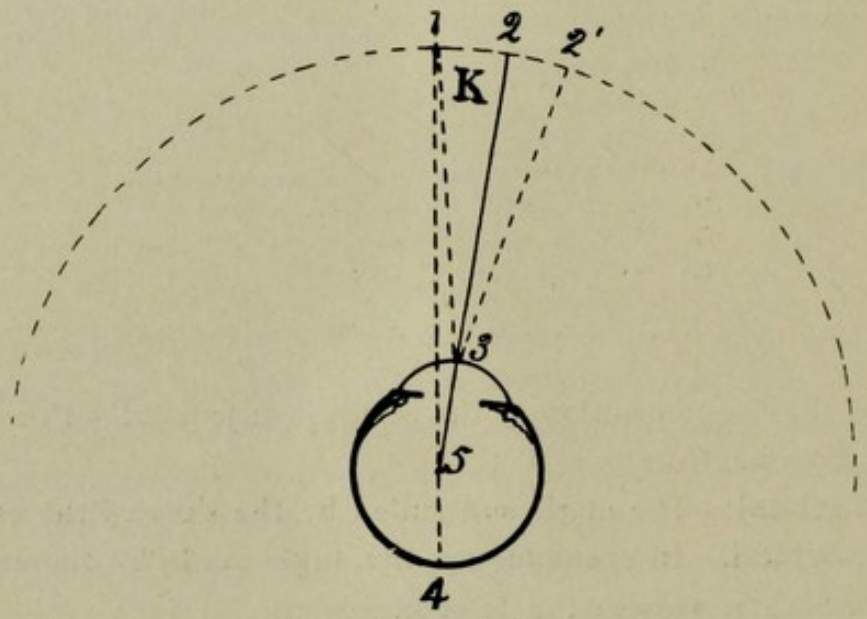
Angle epsilon. Landolt's name for the angle included between the macular axis and the papillary axis. It is usually greater in hyperopes than in myopes.

Angle gamma. This term, usually written, angle γ, is merely another name for the angle alpha (q. v.). It is also known as the angle beta, (ß), according to the individual author's definition. See **Physiological optics.**

Angle, Great, of the eye. The inner canthus, or angle formed by the junction of the upper and lower lids.

Angle kappa. In *physiologic optics,* the angle between the line of fixation and the normal to the cornea that passes through the pupillary center. As the latter is usually nearer to the nasal side of the center of the cornea, the angle kappa (γ) is not equal to the angle gamma (γ), but being much easier to measure than γ, is far more convenient to make use of in the measurement of strabismus.—(C. F. P.)

Landolt describes it in the *Traité complet d'Ophtalmologie,* iii., p. 815, 1887; and the *System of Diseases of the Eye,* Vol. 4, p. 46, In the latter work he gives its measurement, and refers to the method of determining it as follows: The affected eye being placed at the centre of the perimeter, we cover the sound eye, and have the patient fix the flame at the summit of the arc. In this case the visual line is necessarily directed towards this zero-point. If the visual line coincided with the pupillary axis, the reflex of the flame would appear to be at the centre of the pupil, when we look at the



Landolt's Angle Kappa.

observed eye from the summit of the arc. This may occur, but it is not the rule; in general, the pupillary axis passes to the outside or to the inside of the visual line.

To find at once the direction and the degree of the angle kappa, we leave the flame immobile at the zero-point, and we move our eye along the arc until we have found the point at which it is necessary to view the observed eye in order that the reflex of the flame may appear at the centre of the pupil. The corresponding degree on the arc then represents *twice* the angle kappa.

The explanation of this is very simple: If 4 — 1 (See the figure) be the visual line of the eye and 5 — 2 the pupillary axis, then 1 — 5 — 2 will be the angle kappa. If the flame remain at 1, I am obliged to move my eye to 2 [1] in order to see, at the centre of the pupil, its reflex formed by the portion 3 of the cornea. Now, the

angle $1-3-2^1$ represents the sum of the angle of incidence $1-3-2$ and the angle of reflection $2-3-2^1$, which are equal. The angle of incidence $1-3-2$, being nearly equal to the angle kappa, may be regarded as the double of the angle kappa.

It might seem that it would be simpler to have the patient fix the zero-point of the arc, and to carry the candle along the arc, in order to find, at 2, directly, the angle kappa. But this angle is usually so small that we are glad to possess, for its rapid determination, a method which gives a precision double that of this direct method.

Usually the pupillary axis passes without—that is to say, at the temporal side of—visual line (positive angle kappa, + X). This condition produces for the spectator (who has for his guide only the pupils which he sees, and not the visual lines which he does not see) the appearance of a divergent strabismus, even when the eyes of the person observed are normally directed. Thus, in case of positive angle kappa, a real divergence appears exaggerated, while a convergent strabismus is apparently diminished—indeed, often entirely concealed.

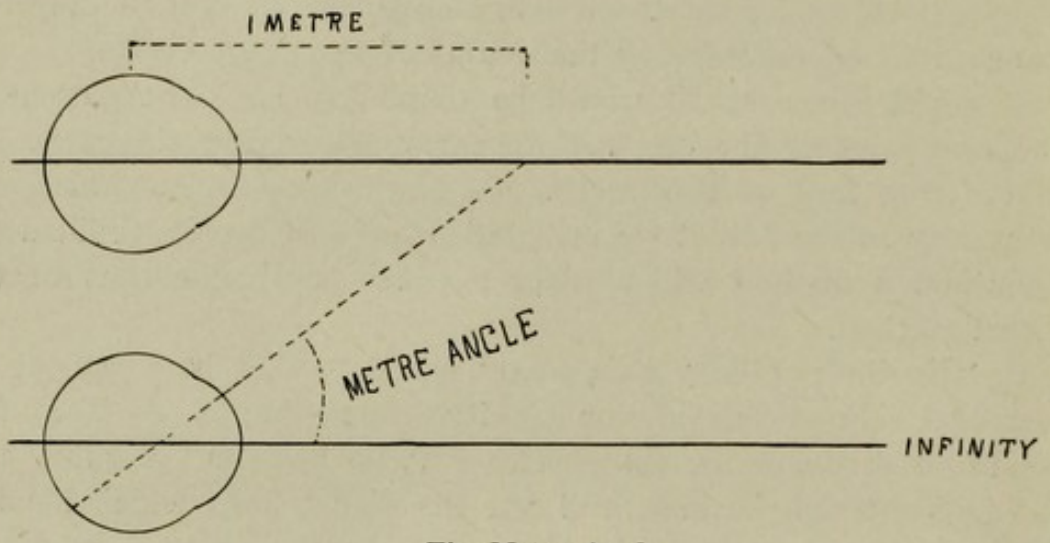
To find the real angle of strabismus it is, therefore, necessary to subtract the positive angle kappa from the apparent divergent strabismus, and to add it to the apparent convergent strabismus.

The angle kappa takes the negative sign (— X) when the pupillary axis passes to the inside—to the nasal side—of the visual line. In this case there is an apparent convergence during the normal direction of the gaze. Hence the *negative* angle kappa ought to be added to the angle of the apparent divergent strabismus, inasmuch as the lines of sight diverge even when the eyes have the appearance of being parallel. It ought to be subtracted from the angle of the apparent convergent strabismus, which it causes to appear unduly great.

Angle louchant. (F.) Squinting angle, as measured on the perimeter.

Angle, Metre. The meter, or metre, angle is the expression of an attempt by Javal and Nagel to standardize the measurement of convergence, analogous to the dioptric measurement of refraction. If both eyes fix for an infinite distance, the visual lines are parallel. If the eyes then fix a point one meter distant along the visual line of one eye, the visual line of the other eye will form an acute angle with the visual line of that same eye when fixing for infinity. This

is the meter angle, although the term is now nearly obsolete. The value of this angle is about 3½°.—(H. G.)



The Metre Angle.

Angle, Nasal (of the eye). The inner angle, or internal canthus.

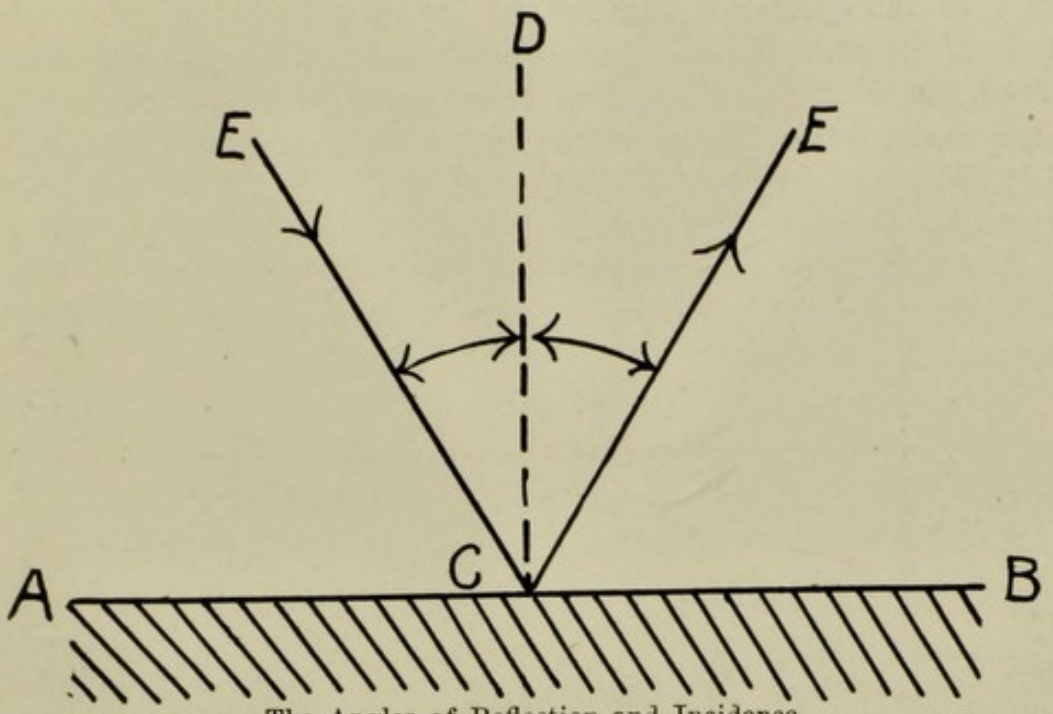
Angle of aperture. In optics, the angle formed by lines joining two opposite and peripheral points of a lens with the lens focus.

Angle of deviation. This term indicates the angle made by the visual lines of both eyes in cases of heterotropia. It is usually determined by employing the perimeter arm, to the carrier of which is attached a small light, behind which the surgeon stands. The patient regards the fixation point of the perimeter (in the examination for near) with the fixing eye, while the light reflex from the cornea is observed by the examiner. The carrier is moved back and forth until the reflex is seen in the centre of the deviating pupil, the amount of deviation being read off the perimetric arc. The patient now looks at an object 6 metres distant, and directly in front, and a similar observation is made.

Worth (*Ophthalmic Year-Book,* 1904, p. 52) also uses the corneal reflex. He employs a "deviometer" which consists essentially of a horizontal arm that can be swung either way, carrying a slide with a white spot towards which the child is induced to look. An electric lamp opposite the pivot of the arm can be flashed on or off, to give the corneal reflex. The surgeon watches the cornea from just above the electric light, and a tangent scale on the back of the arm indicates the amount of deviation. See **Examination of the Eye; Muscles, Ocular.**

Angle of incidence. The angle at which light striking a denser medium becomes reflected or refracted. (See figure.)

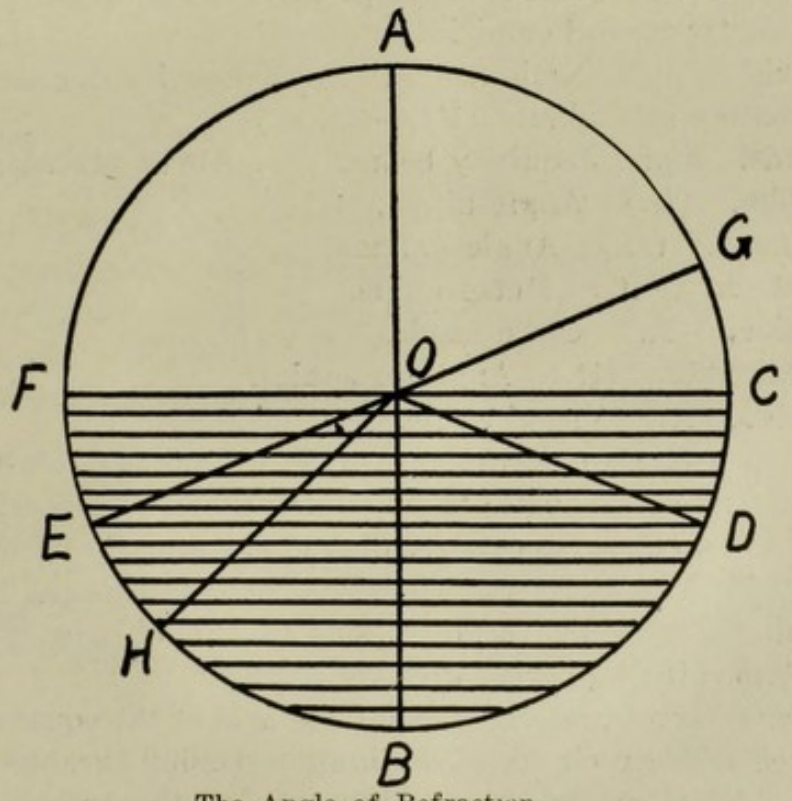
Angle of reflection. The angle which a reflected sound or light-wave makes with a perpendicular let fall upon the reflecting surface at



The Angles of Reflection and Incidence.

the point of reflection. The angle of reflection is always equal to the angle of incidence (q. v.). (See figure.)

Angle of refraction. The angle made by a refracted ray of light with

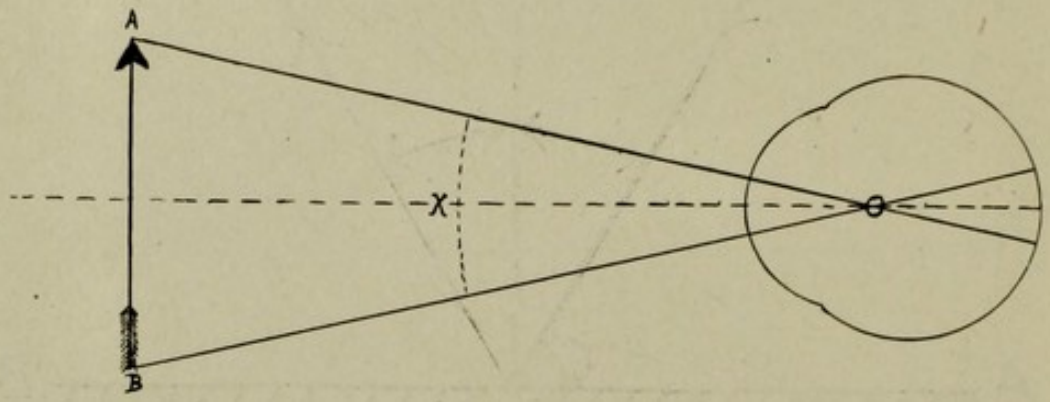


The Angle of Refraction.

a prolonged perpendicular let fall upon the surface at which the point of refraction. (See figure.)

Angle of the eye. See **Canthus.**

Angle of vision. The angle of vision is formed by the rays that pass from the terminal points of an object through the nodal point of the eye to the retina. Thus, in the figure, the angle AOB, or simply X,



O- NODAL POINT
X- VISUAL ANGLE

Angle of Vision.

is termed the visual angle. Snellen utilizes this angle in constructing his test types, and empirically placed the value of this angle for normal vision at five minutes (5′), although its minimum value is approximately one minute (1′).—(H. G.)

Angola seeds. n.pl. Jequirity beans. See **Abrus precatorius.**

Angolo alpha. (It.) Angle alpha.

Angolo gamma. (It.) Angle gamma.

Angolo metrico. (It.) Metre angle.

Angolo ottico. (It.) Optic angle.

Angolo stralunato. (It.) Angle of squint.

Angolo visivo. (It.) Visual angle.

Angular. In *geometry,* having an angle or angles; measured by an angle; subtending an angle; having a divergence expressed in degrees, minutes, and seconds: as *angular* distance; *angular* velocity. *Angular aperture of a lens.* (See **Aperture.**) *Angular distance,* the angle of separation included by the directions of two objects from a given point. Also called *apparent distance.*

Angular intervals, in *astronomy,* those arcs of the equator which are intercepted between circles of declination passing through the objects observed. They are measured by means of the transit instrument

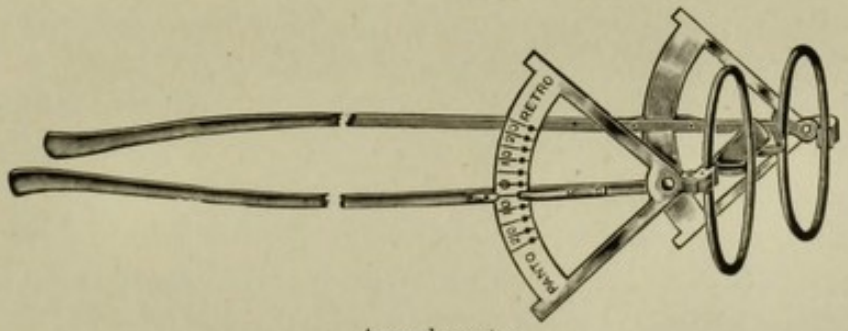
and clock. *Angular magnification,* in *optics,* the *ratio of conjugate slope-angles,* in which the tangent of the slope-angle of the image-ray, divided by the slope-angle of the object-ray proceeding from the conjugate axial object-point, is a constant. Also called the "Convergence ratio," which is an important magnitude in the theory of optical instruments. *Angular measure,* the system of units employed for measuring angles. It is based on the measurement of the circumference of a circle described with the vertex of the angle at its center. The circumference is regarded as divided into 360 equal parts called degrees; a right angle is thus the angle subtended at the center by the fourth part of the circumference, or is 90 degrees. The table is:

60 seconds (60″)	= 1	minute (1′)
60 minutes	= 1	degree (1°)
360 degrees	= 1	circumference or circle.

Angular motion, in *physics,* the motion of any body which moves about a fixed or relatively fixed point: as, the angular motion of a pendulum or a planet: so called because such motion is measured by the angle contained between lines drawn from the fixed point to the successive positions of the moving body. *Angular perspective,* in *drawing,* that kind of perspective in which neither of the sides of the principal object is parallel to the plane of the picture, and therefore, in the representation, the horizontal lines of both converge to vanishing-points. Also called oblique perspective. *Angular velocity,* in *mechanics,* the angle which a line perpendicular to the axis of rotation sweeps through in a given unit of time: the speed or rate of revolution of a revolving body: usually expressed in circular or angular measure (q. v.).—(C. F. P.)

Angular conjunctivitis. See **Morax-Axenfeld conjunctivitis.**

Angulometer. Also called Crest Measurer. An instrument for measuring the "angle of crest"—i. e., the inclination which the dorsal plane of a patient's nose (at the so-called "normal posi-



Angulometer.

tion'') makes with the plane of the horizon, or with the ''plane of average inclination.'' The operation of the instrument is sufficiently obvious from the accompanying illustration.—(T. H. S.)

Angulus iridis. The space between the cornea and the iris near the iridic ligament. It is generally called the irido-corneal angle, or angle of the iris, or angle of the anterior chamber. See **Anatomy of the eye.**

Angulus ocularis. (L.) CANTHUS. The angle formed by the junction of the upper and lower lids.

Angulus oculi externus. (L.) The external canthus or outer angle of the eye.

Angulus oculi internus. (L.) The internal canthus or inner angle of the eye.

Angulus oculi lateralis. External ocular canthus.

Angulus oculi medialis. Internal canthus.

Anhalonium Lewinii, Oculo-toxic symptoms from. In Northern Mexico, especially in the state of Tamaulipas, a common cactus, called ''Mescal (or Muscal) buttons,'' is used by several native tribes in the preparation of an intoxicant. The plant contains a strychnia-like alkaloid, *anhalonin,* together with a depressing substance, *pellotin.* After using two to five of these cacti, for the purpose stated, rapid dilation of the pupils occurs, which lasts from twelve to twenty-four hours and is accompanied by ptosis and loss of accommodation. Visual hallucinations follow, which are said to be even more remarkable than those produced by haschisch. These consist of distinct panoramic color effects and rapid kaleidoscopic color changes. The mind is clear and the intoxicated person is able to concentrate his thoughts. Those addicted to this habit describe the sudden appearance in the field of vision of ''tubes of glistening lights which carry green or red balls that roll about continually.'' Other forms—letters, figures—show themselves, lighted by the most brilliant colors of the spectrum. Objects at first appear violet, then green and golden yellow! By gas illumination there is an increased perception of light, and shadows are violet colored; in electric illumination there are peculiar wavelike movements of objects.—(Lewin and Guillery.)

Anhalten. (G.) To stand still, to hold on, to submit without interference.

Anhaltungsmittel. (G.) An astringent.

Anhänglich. (G.) Slight attachment; adherence to.

Anhäufung. (G.), n. An accumulation in or congestion of a part.

Anheftung. (G.), n. Attachment.

Anheilen. (G.) To heal on, to heal by adhesion.

Anilin. (G.) Aniline.

Anilinblau. (G.) Aniline blue.

Anilindämpfe. (G.) Aniline vapors or gases.

Aniline colors. See, also, **Pyoktanin, Toluidine blue, Methyl violet.**

These brilliant color derivates are highly complex, mostly hydrocarbon compounds obtained by the destructive distillation of coal or lignite and associated with tar products. A number of them have been used for various ophthalmic purposes, especially in ocular therapeutics. They will be described under their various headings.

Most of the aniline coloring compounds afford a good example of a combined stain and cauterant, and while some are (with equal staining powers) more irritant and poisonous than others, yet remarks of the oculo-toxic relations of one color hold fairly true of the others. The biological effect is determined by the penetrability of the dyes into the tissues, and that varies with different dyes.

Anilin black, on account of its insolubility, is not used as a dye, but is precipitated on the threads of cloth from mixtures containing aniline. Thus, any insoluble aniline compound may affect in a similar fashion any living tissues or surface with which it comes in contact.

Vogt gives the results of an elaborate series of researches upon the action of the aniline colors upon the conjunctiva.

His experiments, made upon rabbits, embraced over seventy different colors. He came to the following conclusions: If a small quantity of an acid, neutral or mordant color, or colors insoluble in water, be placed on the conjunctiva, little or no inflammation of the mucous membrane results, but if an equal quantity of a basic color is applied, intense inflammation, which may even lead to panophthalmitis, results. The various basic colors differ as to the intensity of the inflammation set up.

As regards relief, his experiments showed that the action of even the most caustic basic colors may be neutralized by irrigating the conjunctival cul-de-sac with a 5 per cent. tannin solution. If solutions of sodium chloride, boric acid, or sodium bicarbonate (the very solutions most likely to be at hand) are used, they only intensify the caustic action, and do more harm than if nothing at all be used. These practical points are important, for with the modern development of the aniline industries, these accidents are becoming more frequent.

Aniline, Oculo-toxic symptoms from. Of 35 employees in a wool-

dyeing factory, 17 showed no changes in the eyes. Of these, 11 were under 30 years of age and had not worked more than 4½ years in that occupation. The other 6 were from 50 to 60 years old and had nothing to do with the dyes directly. Ten of the workers exhibited only conjunctival irritation, and one man, who was employed for 10 years, had conjunctivitis and corneal changes. Aniline amblyopia usually occurs in those who have been employed in dyeing houses for a long time and are over 50 years of age.

The direct cause of the corneal disease is the hot vapors rising from the dyeing troughs at the end of the dyeing process, to which the workers are exposed several times during the day. Corrosive substances are produced while the yarn is being drawn through the dyeing material, which is very hot and steaming. These chemicals are chiefly color mixtures of anilin hydrochloride, copper chloride, potassium chlorate, etc., that act powerfully on the eyes. The resulting compounds are oxidation products of aniline—quinones. They are deposited in the eyes of the workmen at the sclero-corneal junction; they abrade the sensitive epithelium of the cornea and produce minute epithelial defects which form roughened areas upon which additional chemical material settles, or into which the workman, under the influence of the itching and other ocular discomfort, rubs dye-stuff from his hands. Accompanying this injury is staining of the cornea. In the course of a year or two the corneal epithelium is undermined and the parenchyma, cloudy and stained, becomes a sepia brown. Vision is reduced and all the symptoms of a severe corneal inflammation result. In some cases corneal swellings resembling vesicles, with a brown base, appear. The bulbar conjunctiva itself may also become intensely yellowish-brown at the intermarginal space. In one patient the corneal epithelium, over an area of 2½ by 6 mm., showed small vesicles; the vision was 0.2 in the right and 0.45 in the left eye.

After a change of occupation and treating the corneal disease in the usual manner, the keratitis slowly improves. In from a few months to a year the epithelium regenerates, the staining becomes less marked and the vision improves.

Lewin and Guillery *(Die Wirkungen von Giften auf das Auge)* say that aniline when taken internally is, like nitrobenzol, an active blood poison, chiefly because of the formation of methemoglobin from the oxyhemoglobin. The disturbances of the visual apparatus, like its general effects, are readily understood and may be deduced from our knowledge of the blood changes. When the

skin appears "cyanotic," as it is improperly called (it is really colored a grey-violet) in cases of aniline poisoning, and the blood is found to be darker than normal, one of the decomposition products of the blood can be detected by the spectroscope (q. v.). Ocular disturbances occur most frequently among aniline workers. The local action produced by the fumes of aniline or by contact with the fingers produces ciliary injection and photophobia. If the changes in the blood are very severe, as, for example, after drinking aniline oil, then the eye-vessels themselves contain methemoglobin, which produces a brownish-yellow discoloration of the conjunctiva and sclera. This is one source of the discoloration, but from our observation not the most important. The other results from a hematogenous icterus. In a 44-year-old aniline worker such a coloration was seen on the lids and cornea, with a slight reduction of vision.

Aniline has a mydriatic action after a local application to the eye of solutions of 1 to 500. It is also found associated with the systemic symptoms after poisoning with aniline oil, or after exposure to aniline vapors. If the pupils are of medium size at the beginning of the intoxication, they dilate sometimes during the course of the poisoning. There is, however, no uniformity in the action of this intoxicant on the pupils. A distinct contraction of the pupil can be made out after cases both of internal, cutaneous and aniline-vapor poisoning of workers. Other eye symptoms have been noted, among them weakness of accommodation and hemeralopia.

The therapeutic use of aniline oil, formerly much in vogue, resulted in glaucoma in a case of hypopyon-keratitis. After several paracenteses the eyesight improved until fingers could be counted at 1 m.

In an aniline worker there was noticed a bilateral iritis with amblyopia. Accommodative fatigue, blurring for near-work, and some slight reduction in distant vision have been frequently observed among aniline workers; but a more serious derangement of the visual apparatus also occurs. The cause of this is, in our opinion, a more or less acute disturbance of nutrition of the posterior portion of the eye, due to inability of the poisoned blood to nourish the tissues. While many of the acute symptoms of poisoning, due to the same cause, disappear with the passing of the methemoglobin, the eye changes may remain. The first to suffer in such a case is the optic nerve.

A dyer was obliged to weigh aniline salts in a poorly ventilated

room. He developed narrowing of the field of vision for white and colors, and a triangular scotoma for red and green, the apex central, the base 20° to the periphery. The mirror showed an optic neuritis, the margins of the papilla and the arteries were obliterated and the veins swollen. In another case, a dyer, 35 years of age, whose work was with aniline oil, took no precautionary measures. He became dizzy, had headache, faintness and paleness of the skin (methemoglobinemia). Fifteen days later, a marked narrowing of the field of vision showed itself in the temporal half, with green and blue blindness. The contour of the papilla was obscured, the veins somewhat swollen and the arteries empty.

Aniline oil amblyopia. Only a few cases are on record, and these have resulted from inhalation of aniline oil in factories where that agent is made or used. Its effects on the eye are asthenopia, photophobia and a form of amblyopia associated with narrowing of the visual field, with peripheral scotomata. Discoloration of the conjunctiva has also been seen. The prognosis is generally favorable.

Anilinfarben. (G.) Aniline dyes.

Anilinfarben, Einfache. (G.) Simple aniline colors.

Anilinfarbstoff. (G.) Aniline staining material.

Anilingelb. (G.) Aniline yellow.

Anilingrün. (G.) Aniline green.

Anilinölvergiftung. (G.) Aniline oil poisoning.

Anilinroth. (G.) Aniline red.

Anilinschwarz. (G.) Aniline black.

Anilintrübung der Hornhaut. (G.) Aniline staining of the cornea.

Anilinviolett. (G.) Aniline violet.

Anilinwassergentianaviolett. (G.) Gentian violet in aniline water.

Anilinxylol. (G.) Aniline xylol.

Animal (lower) eyes, Operations on. See **Veterinary ophthalmology.**

Animals, Domestic, Eye diseases of. See **Veterinary ophthalmology.**

Animal eyes, Uses of, in ophthalmology. Apart from the use of the rabbit's cornea in the treatment of blindness from leucoma (see **Transplantation of the cornea**) and for the reduction of an outer staphyloma (q. v.) whole eyes of the pig, dog, rabbit, etc., are employed both in the living and dead animal, as well as when removed from the body, for the teaching and learning of ophthalmology and the steps of operations. The method employed for all these purposes will be described elsewhere in this *Encyclopedia.*

The transplantation of the whole of a rabbit's eye into the human orbit has up to the present time resulted in little more than the ex-

ploitation of a surgical curiosity, but extending some slight encouragement for future investigation. While a few experiments have produced movable, and more or less prominent, stumps by such procedures, no case has as yet been reported where vision has been produced and in the very nature of things it is exceedingly improbable that such a result will ever be attained. It must be mentioned, however, that S. Zervos, (*Grèce Médicale*, Vol. XII, No. 1 and 2, 1909) narrates some wonderful results in transplanting testicles, kidneys, spleens and eyeballs from one animal to another. He claims that eyes from young animals can be successfully transplanted and that they will resume their functions. Certainly, further proof is necessary before such astounding claims will be accepted. It is difficult to see how the stump-producing results of these experiments are really superior to a well-performed enucleation, where the muscles, conjunctiva, etc., are all sutured together, since under the most favorable circumstances the implanted eyeball shrinks to one-half or one-third of its original volume. The results certainly cannot be compared in their cosmetic quality to a Mules' operation.

Some operators merely adjust the rabbit's eyeball into the space just vacated by the human globe and attach the muscles, conjunctiva, etc., to the implanted sphere; others also unite the ends of the two optic nerves. See **Enucleation of the eyes.**—(F. A.)

Animo (cecità dell'). (It.) Psychic blindness.

Aniridia. IRIDEREMIA CONGENITA. ANGEBORENER IRISMANGEL. One of the most interesting of all congenital defects is that of aniridia or congenital absence of the iris. It is in this condition that hereditary tendency in its relation to congenital defects most prominently reveals itself. It is strange and utterly unintelligible why this is so.

As clinically seen it is generally complete, though less frequently partial aniridia is met with. The defect is as a rule bilateral. Anatomical investigation always reveals a stump of iris even where clinically a diagnosis of complete aniridia had been made.

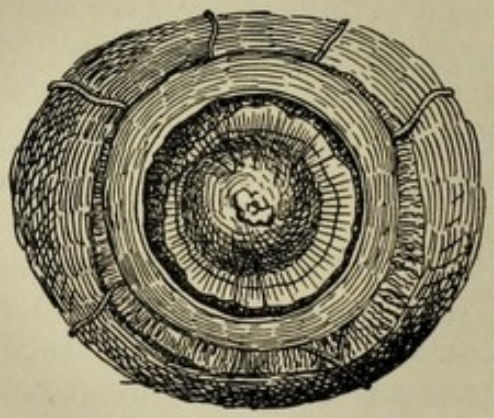
Total aniridia may occur in one eye simultaneously with a large iris coloboma of the other eye.

The very large, apparently black, pupil on close inspection gives a grayish reflex. The edge of the lens can be clearly distinguished. As a rule the ciliary processes are not visible, due either to poor development or to the fact that they are pulled backwards. The ciliary muscle may show perfect development, and accommodation as a consequence be up to the normal. The anterior chamber may be normal, or abnormally deep. Less frequently it is shallower than normal. Acuity of

vision is generally much reduced. There is, as is obvious, a strong aversion to bright light. Complications are frequent accompaniments; among them may be mentioned anterior and posterior polar cataract, total cataract, dislocation of the lens, atrophic choroidal spots, vitreous opacities, and detached retina, the latter three conditions of less frequency than the others.

Aniridia Section through Cornea and remains of Iris.

The cornea may show anomalies of shape and transparency. It is impossible to say whether any cloudiness of the cornea is congenital or acquired. Often nystagmus and, less frequently, strabismus occur as a complication. Dislocation of the lens, which is usually upwards, may be present at birth or occur subsequently. The fibres of the suspensory ligament are usually intact, but may be missing wholly or in part. They may be overlooked as it is difficult to distinguish them unless thickened.



Aniridia.

The most interesting and seemingly paradoxical complication is glaucoma, to which these eyes are more or less predisposed. Anatomical investigation reveals the fact, however, that in these cases the iris stump is closely adherent to the posterior corneal surface at the iris angle, which effectually shuts off Schlemm's canal and thereby prevents the normal filtration of intra-ocular fluids. In other cases the concomitant lens luxation is a contributing factor in the causation of glaucoma. Aniridia may be looked upon in a way as a total coloboma of the iris.

Aniridia has been described as a congenital mydriasis. This view has, however, been abandoned. The cause of aniridia is also explained by the theory that the lens remaining unduly long in contact with the cornea prevents the ingrowth of the iris tissue. This must be held as unproved, since the process of embryonal development at the time of the formation of the iris is such as to make this view quite doubtful.

The theory that aniridia is due to inflammatory causes is untenable, as shown by Von Hippel. Inasmuch as the defect is nearly always bilateral and the tendency to hereditary transmission so prominent, these militate against the acceptance of inflammation as the causative factor.—(W. F. H.) See **Injuries of the ocular apparatus. Congenital defects.**

Aniridia, Glasses for. Königshöfer (*Clinique Ophtal.,* October, 1901.) describes glasses for eyes that have been deprived of the iris. These are fitted with an iris diaphragm by means of which the amount of light entering the eyes may be controlled, thus avoiding the difficulties that are incident to sudden changes in the amount of illumination.

Anisochromatic. Lacking in uniformity of color; of unequal coloration.

Anisochromia. Of unequal or irregularly distributed color; in ophthalmology this term is generally associated with the coloration of the iris.

Anisocoria. Inequality in the diameter of the two pupils.

Anisokorie. (G.) Anisocoria; inequality of pupils.

Anisometric, adj. Of unequal measurement: a term applied to crystals which are developed dissimilarly in the three axial directions.

Anisometropbrillen. (G.) This is a new form of cataract glasses recommended for unilateral aphakic patients when one wishes to obtain binocular vision. Hegener (Uber ein neues Brillensystem zur Korrektion einseitiger Aphakie. *Klinische Monatsblätter für Augenheilkunde,* 1912, (2), Heft 13, p. 237-278.) and Wolff (Korrektion der Anisometropie bei Aphakie mittels eines Zeissschen zweigliedrigen Linsensystems, *Zeitschrift für Augenheilkunde,* Bd. XXVIII. Heft 2 und 3.) have fully described them.

Anisometropia. (L.), n.f. Inequality of the refraction of the two eyes. Jackson believes that anisometropia will always have, in practical use, a somewhat indefinite significance. At best, it is used to designate a condition with variable limits. We do not in practice speak of eyes as anisometropic when they differ but slightly in refraction; if we did so nearly all our refraction cases would be cases

of anisometropia. Nor can we set a limit, as 1, D., above which the term should be applied, while for smaller differences it should not. Such a difference would in one case give rise to those phenomena which require the use of this special term; while in other cases it would not. Neither is difference of refraction an essentially different thing when the two eyes happen to fall on opposite sides of emmetropia, from what it is when both are hyperopic or myopic. See **Refraction and accommodation of the eye.**

Anisometropia, Glasses for. See **Anisometropbrillen,** and **Refraction of the eye.**

Anisometropie. (G.) Dissimilar refraction in both eyes.

Anisopia. Difference in the visual acuity or power of the two eyes.

Anistropic, adj. In *optics,* not having the same properties in all directions with respect to light—a characteristic of all crystals of the isometric system; aelotropic.

Ankilops. (Obs.) Incorrect spelling of **anchilops,** a lachrymal abscess.

Ankleben. (G.) To stick to, to adhere.

Ankyloblepharon. In this condition there is an adhesion of the eyelids along the palpebral margin, which may be partial or total. It results from the growing together of two raw surfaces. It is rarely congenital. See **Ankyloblepharon adnatum.** As an acquired affection it follows ulcerations, burns and other injuries. It is sometimes observed after croupous conjunctivitis. Anklyloblepharon may exist alone, but more frequently symblepharon also is present. The prognosis is favorable in uncomplicated ankyloblepharon, an operation (cutting the adhesions) serving to restore the palpebral opening. When associated with symblepharon the case will require also one of the symblepharon operations (q. v.).—(J. M. B.)

Ankyloblepharon adnatum. (L.) Congenital ankyloblepharon.

Ankyloblepharon adnatum. Congenital ankyloblepharon is a union of the eyelids at their edges throughout part or all of their extent. In the former case it is designated as a blepharophymosis; in the latter as a true ankyloblepharon. Where the union is simply a failure of the normal separation of the lids to occur in the latter part of intra-uterine life, such union is purely epithelial.

Where the lids are firmly adherent it is usually the result of a pre-existing ulcerative condition. In blepharophymosis there is diminution in the breadth of the palpebral fissure, as a rule at the expense of the outer angle. It is worthy of note that in the latter condition enophthalmos and nonophthalmos are frequently present. It is manifestly improper to confuse ankyloblepharon and cryptoph-

thalmia, for in the case of cryptophthalmia there is no differentiation of the lids except, possibly, a thin horizontal line or depression marking the site where the lid margins should have been. No Meibomian glands or cilia are present in cryptophthalmia.

Occasionally there is found a string or thread of varying size and length connecting the margins of the upper and lower lids, to which the name of *ankyloblepharon filiforme adnatum* has been applied. These bands are usually extensile, but may limit, more or less, the movements of the lids. Such bands are made up of connective tissue and blood vessels with a covering of epithelium and have been proven to be of undoubted inflammatory origin.—(W. F. H.)

Ankyloblepharon filiforme. (L.) An incomplete form of ankyloble-

Ankyloblepharon Filiforme.

pharon in which union has taken place by a thread-like band, the lids being elsewhere free from adhesion.

Ankylops. (Obs.) Incorrect spelling of **anchilops,** a lachrymal abscess.

Ankylostomiasis. WURMKRANKHEIT. The ocular and general symptoms of this disease (as seen in Europe) are due to the *Ankylostomum duodenale* (q. v.), or, often written, the *Ankylostoma duodenalis,* a parasite having close affinities with the *hookworm (Uncinaria americana).* The presence of this nematode in the human body sets up almost identical signs and symptoms. *Uncinariasis* (q. v.) is the term used to indicate the conditions brought about by the action of the hookworm in and on its human host. In the admirable report, 1911, by Ashford and Igaravidez (Members of the Porto Rico Anemia Commission) to the United States Senate on hookworm disease in Porto Rico, the eye-symptoms of uncinariasis and ankylostomiasis are in part referred to as follows:

"In the Ponce series of 1902, 15 complained of 'colored images before the eyes,' 11 of blurred vision. Of this series 16 gave symptoms referable to the eye.

In the Utuado series of 1904, 43 had visual disturbances, 34 blurred vision, 7 blurred vision with excessive dilatation of the

pupil, 1 of excessively dilated pupil, blurred vision, and night blindness, and 1 of blurred vision and night blindness.

In the Rio Piedras series of 1906, 5 had blurred vision.

Thus, of 92 cases, 64, or 69.5 per cent, had more or less serious disturbances of the eyes. We cannot doubt that much of this was due simply to the degree of anemia, but there remains a considerable percentage both of these cases and among a large number seen in the clinic who had more or less marked visual affections with very little anemia.

Maj. W. F. Lippitt, United States Army, examined the eye grounds of 10 of our cases in 1904 and found evidence of old retinal hemorrhages in 2, which he very kindly demonstrated to us. The fundus is generally very pale and the retinal arteries small.

Loebker and Bruns remark on the pallor of the eye grounds and state that there may be pulsation of veins, lowered intraocular pressure, pronounced convolution of veins, and, commonly, retinal hemorrhages.

Siccardi notes nystagmus, diplopia, amblyopia, muscular and accommodative asthenopia and restriction of the field of vision. He states that Rampoldi, who first called attention to the changes in the eye grounds, found exudative retinitis of the same variety as that described by Liebreich in leucemia. Rampoldi observed a case of sudden blindness in a young subject (19 years of age) with the usual signs of atrophy of the papilla.

Lutz mentions, as a rare sign, chemosis of the bulbo-palpebral fold. He had 3 such in 25 cases.

Fuchs found small, whitish spots, due probably to old retinal hemorrhages.

Siccardi, from an observation of his cases, comes to the conclusion that the changes he saw speak loudly for a nephritis. He admits the possibility of a simple anemia being the cause of pallor of the retina, edema, and hemorrhages, and likewise acknowledges the reason for attributing functional disturbances of vision to the reflex action on the eye from the irritation caused by the attached worm in the intestinal canal, but there are, he thinks, other changes that cannot be explained by reflex stimulation or by simple anemia, and such are those demonstrated by a retinitis. Where retinitis is found with atrophy of the optic papilla a general affection is to be considered; in other words, a circulating poison. He avers that it is his belief that the changes of this nature are pro-

duced by a toxin, just as alcohol, lead, iodoform, etc., cause such lesions.

Night blindness is not a symptom to be ignored. Thornbill reports that he found it in 9.5 per cent of his cases, and Swan and Nell in 24 per cent of theirs (!) Only our special cases were questioned on this point, but three of our general series volunteered the information that they suffered from it.

Case 15 of the Ponce series of 1902 suffered from night blindness and partial amaurosis, and 6 and 8 from night blindness alone, a total of 3 in 80 cases, or a percentage of 3.7 in 80 cases.

Nystagmus is a rarer symptom which we have several times observed. Case 15, cited above, is a good example.

A most interesting observation is the great prevalence of cataract in Porto Rico, not only in the old, but sometimes in the young. Maj. Lippitt, whose experience is large, states that fully three-fourths of his cases in Porto Rico were anemic. A. W. Calhoun (*Ophthalmic Record,* Vol. XII, April, 1904) calls attention to the occurrence in several of his cases of a double, chalky-white cataract, beginning a short while (one year) after the establishment of uncinariasis. One was a boy 14 years of age, where the condition began eight months after the disease, and another a boy 16 years old.

Corneal ulcers are also reported. One such case was observed in the Ponce series of 1899.

We made a special effort to corroborate Stiles's observations on the pupil, and found, indeed, a decided tendency to its dilatation. But the patient is weak, dizzy and sick, and although we have not seen that writer demonstrate how he obtains the phenomenon described, we cannot believe it to be diagnostic. The fact is, in trying to demonstrate this symptom, we nearly hypnotized some of our patients. Stiles says: "If the patient is directed to stare intently into the observer's eyes, there will be noticed a symptom which it is difficult to describe, but which I have found more constant than almost any other noticed, namely: After a moment, the length of time apparently varying slightly, according to the degree of the disease, the pupils dilate and the patient's eyes assume a dull, blank, almost fish-like or cadaveric stare very similar to that noticed in cases of extreme alcoholic intoxication." He states that he does not go to the extent of considering the stare diagnostic of uncinariasis. We certainly do not consider this a prominent symptom per se, but the dilatability of the pupil is noticeable and goes to make up the tout ensemble of the facies which is very

suggestive of uncinariasis. The expression in moderate and marked cases, as will be noticed by the cuts in this report, is habitual and need not be elicited in this manner. Not only this, but we may consider ready dilatability of the pupil a symptom of infestation by many varieties of intestinal parasites.''

When the section on the subject of *Uncinariasis americana* is taken up, the exact relation of these ocular signs and symptoms to the so-called hookworm disease will be considered, and an effort will be made to differentiate those that are probably accidental from those that are undeniably a part of the disease. See **Ankylostomum duodenale.**

Ankylostomum duodenale. Sometimes written ANKYLOSTOMA DUODENALIS. LUSUSPARASIT. A nematoid worm, one-third to one-half an inch long, that infests the intestinal tract of man and some of the lower animals. In view of the recent interest in the ''hookworm'' (almost identical with this parasite) excited in the United States, it will be valuable to have before one the admirable account (translated by the Editor of this *Encyclopedia* for *The Ophthalmic Record,* VI, pp. 644-650) by Nieden of this parasite and the effect of its presence on the eye. (See, also, **Ankylostomiasis** and **Uncinariasis.**) He says that the actual presence of the ova of the parasite in the feces of living subjects was first demonstrated in the years 1877-78 by the Italians Grassi and Parona. Following these came the more extensive investigations of Perroncitto, explaining the actual cause of the so-called ''tunnel anemia'' that affected the workmen employed in the underground borings of the St. Gotthard railroad.

Although it is true that in 1838 Dubini of Milan frequently found a parasite in the intestines of patients who had died of anemia, and which Theodor von Siebold correctly diagnosed as belonging to the genus Strongylus, it was not until the investigations of Bilharz in 1853 and Griesinger in 1854 that the parasite was recognized as the cause of ''Egyptian chlorosis.'' After the diagnosis had thus been placed on a firm basis, the various modifications of this form of anemia, which up to that time had been attributed to manifold causes, were readily diagnosed, as reports from Brazil, Japan, the East Indies, Louisiana, etc., from the end of the '60s will show. It was noticed in this connection, firstly, that people addicted to the peculiar habit of dirt-eating were easily attacked by this disease of the blood and, secondly, that workmen in brickyards, mines, tunnels and charcoal furnaces also readily fell victims to the parasite. This gave rise to the various synonyms, *Anemia intertropicalis, oppilacas, latericia or montana, allotriophagia, maladie de terre* and *Tunnel-*

anämie. The discovery of the ankylostomun in the intestines of miners in Sardinia, France (St. Etienne) and Hungary (Kremnitz and Schemnitz) by Baccelli and Perroncitto furnished the clue to the etiology of all the cases of chlorosis among miners reported since the beginning of the century, the first of these occurring among workers in the mines of Valenciennes in France. This finding is further substantiated by the investigations of Masius, Francotte, van Beneden, etc., in Belgium. It is very probable that the parasite was brought by Belgian miners to the Rhenish and Westphalian coal mines, and the recent studies of Leichtenstern, Löbker and Tenholt show that, to a greater or less extent, the entire population of these collieries, the largest in Germany, is afflicted with the disease.

In consequence of numerous opportunities for studying the nature of this disease in its various phases, and as examinations of organs remote from the initial seat of the malady became more frequent, it was discovered that the eye often shows pathologic changes which must be regarded as entirely due to the parasitic disorder. Rampoldi (1887) and Fischer (Dortmund, 1892) first called attention to these complications, but on account of the small amount of material at their command they were unable to form any definite conclusions regarding their cause. Inasmuch as I have had occasion to examine several hundred cases, I take this opportunity of briefly recounting a few of the chief points of interest. I may say, to begin with, that the ankylostomum duodenale is a nematode, belonging to the family of the strongylidæ (Dochmius), and that it derives its name from the fact that the body has a peculiar angular bend and that the duodenum was formerly looked upon as its habitat. The latter view has not been borne out by autopsies, the upper portion of the small intestines (jejunum) having been found to be the favorite resort of the parasite. The male worm is lighter in color, shorter (6-8 mm.) and narrower than the female, which is of a yellowish-brown color and 10-12 mm. in length. The head exhibits a wide mouth that opens into a capacious oral cavity. The latter is supplied with six tooth-like projections. The oral cavity communicates with the gradually widening esophagus, which in turn terminates in the chylific intestine. The latter ends, in the female, in a cone-shaped tail, in the male in the cloaca, which contains the genital opening with its conical penis and two long spiculæ. The spiculæ hold the female during the act of coition. From the female genital opening a short vagina leads into an anterior and a posterior tubular cavity which contains the countless convolutions of the ovaries and tubes.

The ripe ova deposited in the human intestine are oval in form,

0.04—0.06 mm. long, 0.03 mm. wide and are, without exception, when discovered, found to be undergoing segmentation. The latter process does not continue, however, within the human intestine until the complete development of the embryo, on account of a lack of oxygen. For this latter purpose it is necessary that the ova find suitable surroundings (moisture and warmth) outside the body. In three days after leaving the intestine the embryo emerges from its capsule. The number of ova found in the human host is enormous. Leichtenstern found 19,000 in one gram of feces. If we divide the number of ova found in one gram of feces by 47, we obtain approximately the number of parasites that have found their way into the intestines. The proportion of males to females is as 1:3-6. The embryo becomes encapsulated at the end of four days in a transparent covering and remains thus encysted until it is introduced into the human body. The cyst wall is then dissolved by the gastric juices and the liberated embryo enters the small intestine where it soon develops into a full grown worm. As such it now fulfills to the fullest extent the two purposes of its existence, viz: nourishing itself by sucking inordinate quantities of blood from its host and propagating its kind in the most extensive fashion. The ova may be discovered in the feces four to five weeks after the ingestion of the parasite, the life of the latter being from six to eight years.

The ankylostomum derives its nourishment from the plasma of the blood and does not assimilate the corpuscular elements, which pass through almost unchanged. It takes in much more food than it actually needs and for this reason Leichtenstern has properly given it the name of "*Lususparasit.*" The loss of blood to the host is often augmented by secondary hemorrhage from the bites. The direct result of this constant loss of blood, which is at times very great (frequently 3,000 worms are found in one intestine), is excessive anemia of all the organs. The early symptoms are manifested in disturbances of the intestinal tract (especially loss of appetite and vomiting) and to these are soon added the sequelæ of the increasing anemia—weakness, dizziness, palpitation, dyspnea, etc. The face exhibits a yellowish tint, characteristic of the disease. The mucous membranes are waxy and the sclera has a peculiar glistening appearance. The blood is bright red while the corpuscles are pale and granular. Leucocytosis is found, especially in those cases where Charcot-Robin crystals are present in the feces. The hemoglobin is greatly diminished. The urine shows albumen in rare cases.

Unless proper and prompt treatment is carried out, or a sponta-

neous cure results, the ultimate outcome of the constant loss of blood is general marasmus and death.

As far as the special morbid changes in the eye are concerned, I have been able to demonstrate that from 7 to 8 per cent of all patients show affections of the fundus oculi. My observations extend over 180 patients, all of whom had the characteristic symptoms of ankylostomiasis.

No especial importance was attached to the appearance of the fundus due simply to the great anemia—such as more or less pale color of all the capillary vessels, diminished calibre of the arteries and their occasional pulsation under normal intraocular pressure, a tortuous course of the veins, and often a porcelain-colored appearance of the papilla, such as is seen in the eye after death.

The hemorrhages in the fundus, similar to those already described by von Biermer in pernicious anemia, are the most characteristic signs. According to my observations these occur more frequently and at an earlier stage of the disease in the peripheral parts of the retina than near the papilla or the macula. They are often in groups, dotted, and lie close together without being confluent. Occasionally, they precisely follow the course of the vessels and seem to be situated in the sheaths of the latter, thus forming striated hemorrhages which accompany the vessels almost to the papilla and frequently render their contour indistinct.

In addition to these signs we find in serious cases extensive hemorrhages into the retinal tissues. They are of the size of the papilla or even larger, and present irregular edges. I have seldom had occasion to notice the peculiar hemorrhages frequently found in leukemia and scurvy, in which a whitish spot is found in the center of the hemorrhage, indicating a beginning resorption. On the other hand, I could usually distinguish the regularly occurring fatty degeneration of the blood-spot, which showed the well known typical picture. I have never seen the stellate appearance of the macular region characteristic of retinitis albuminurica. As already mentioned above, the urine contained albumen only in very rare cases.

Postmortem examinations reveal the peculiar changes in the fundus with even greater distinctness than does the ophthalmoscope, the bright red blood-spots being very conspicuous in the pale yellow background of the retina. The microscope shows sclerotic and fatty degeneration of the intima of the blood-vessels. The same condition is found in the endocardium and larger vessels, and in the mucous membranes and other tissues of the various organs of the body similar hemorrhages are detected. These phenomena are analogous to

those described in 1894 by Natanson and in 1895 by Tschemolosow in four typical cases of pernicious anemia caused by bothriocephalus latus. In these cases the blood extravasations were grouped about the papilla and the macula and had also caused aneurysmal herniæ as a result of rupture of the adventitial sheath of the vessels.

The disturbances of vision are caused not so much by these retinal changes as by the constitutional condition. When, however, the extravasations occur in the region of the macula a scotoma is likely to result. In most cases in which I could detect extensive alterations in the fundus the patient had no intimation of the pathologic condition of the eye.

Accommodative weaknesses, inability to use the eyes any length of time and other forms of asthenopia are, on the other hand, readily noticed. Slight, intermittent paresis of the extrinsic and internal eye-muscles, with double vision and vertigo, is likewise a not infrequent occurrence, and where predisposing conditions, such as working in collieries, are present, nystagmus is a common complication.

Furthermore, we observe a retinal weakness in consequence of the anemia and malnutrition, evidenced by photophobia and hemeralopia, a condition often found in this part of the country during the Easter fast-days. In these cases we notice a slight concentric contraction of the field of vision, especially after a long-continued examination of the eyes. Emigration of the parasite into other organs has not been so far demonstrated, because favorable conditions for further development are present in the intestines only. The parasite cannot possibly occur, therefore, as an entozoon in the eye.

It is still a moot question what gives rise to the peculiar changes in the fundus, such as we notice in this disease and in pernicious anemia. It is doubtful whether the great loss of blood and the constant drain from the intestinal tract can alone account for them, especially when we remember that in similar acute and chronic hemorrhages from other causes no such retinal alterations occur. Even in excessive anemia and chlorosis we do not find analogous degenerations. It is very probable that one must look for the causative factor in the toxic products introduced into the body by the parasite. In like manner we must explain the fatty degeneration of the retinal fibres, with or without hemorrhages, that is observed in the cachexia of cancer. Whether these toxins, as Fischer believes, are contained in the Charcot-Robin crystals, future investigations must decide. It is a fact that these crystals are found most abundantly in those sections of intestine that contain the largest number of worms. If the above theory be correct we may also assume that

the toxins destroy the red corpuscles and are responsible for the formation of eosinophile cells (according to Leichtenstern, as high as 60 per cent) which in turn give rise to blood extravasations.

As for the therapy I may state that the disease is fortunately readily amenable to treatment in all cases in which the anemia or cachexia has not become too marked or has not lasted too long. A positive cure can be brought about by the administration of 10 grams of *extractum filicis maris recente paratum*, a nutritious diet and a course of tonics—especially of ferruginous preparations.

It is interesting to note that during the process of expulsion of the worms, the males are expelled sooner and in greater numbers than the females. This may possibly be explained by the fact that the males change their location more frequently (for purposes of copulation) while the female is more likely to remain fixed to the intestinal wall.

It is, finally, important from the standpoint of diagnosis to note that the ophthalmoscope demonstrates positively the differences between changes occurring in chlorosis and simple anemia and those brought about by the so-called pernicious anemia dependent upon the presence of infectious parasites.—(Ed.)

Anneslea grandiflora. (L.) A Mexican shrub whose flowers are used in eye diseases.

Annexes. (F.), n.n. Appendages.

Annidalin. See **Aristol.**

Annular conus. Schnabel (Norris and Oliver, *System of Diseases of the Eye*, III, p. 400) contrasts this anatomical condition with that of the crescentric conus (posterior staphyloma) commonly seen in myopia and remarks that the diameter of the sclero-chorioidal canal and of the part of the optic nerve surrounded by it is unusually large; the diameter of the papilla, however, is normal. When the intra-choroidal portion of the optic nerve has a diameter of, for example, three millimetres, and the intra-retinal portion (i. e., the papilla) a diameter of one and five-tenths millimetres, a white zone is seen between the edge of the papilla and the peripheral portion of the connective tissue (or of the choroidal ring, as the case may be); and it is this that forms the annular conus observed by the ophthalmoscope. The annular conus, then, is not situated in the region of the ocular membranes, but in that of the optic nerve—its white color coming not from the sclera that has become visible, but from the lamina cribrosa. The peripheral limits of the conus are formed by the choroidal ring. As the layer of pigment epithelium begins at this ring, there can be no pig-

ment epithelium within the area included by the annular conus. The pigment epithelium has not disappeared; on the contrary, it has never existed in the part of the fundus in which the conus is situated.

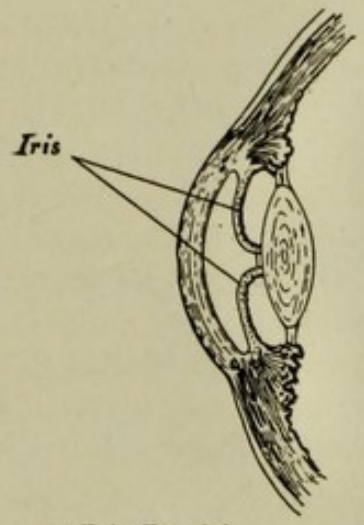
The annular conus forms a part of the transverse section of the optic nerve seen by the ophthalmoscope, and belongs, therefore, in its entire extent to the blind spot. The choroid over the staphylomatous area is thinner than normal, but the part of it immediately surrounding the optic nerve does not differ from the part situated behind the fovea centralis or the parts which cover the other portions of the scleral staphyloma. It is, therefore, out of the question that the stretching of the choroid due to stretching of the sclera could occasion choroidal atrophy of such a degree as to be scarcely distinguishable from the absence of that membrane, in the vicinity of its insertion.

Annular ligament. At its circumference the posterior corneal limiting membrane is thickened and forms a ring-like margin. This is called the annular ligament or *annulus tendinosus*. From it three distinct sets of bundles pass: (1) to the tendon of the ciliary muscle, (2) to the sclera and (3) to the iris. See **Histology of the Eye.**

Annular reflex. A reflection sometimes seen about the macular region during an ophthalmoscopic examination.

Annular synechia. Excluded Pupil. Exclusion of the pupil. It occasionally happens in an attack or attacks of iritis that the entire margin of the pupil is bound down to the lens behind it. When this occurs we have, as Jackson observes (*Manual of Diseases of the Eye*), the usual effects of broad adhesions. The escape of fluid from the posterior to the anterior chamber is interrupted, and other grave conditions arise. The fluid behind it pushes the iris forward, causing it to bulge, as in the figure. This is spoken of as ballooning of the iris, or iris bombé. The iris rises up on either side of the pupil, usually not equally all round, but in swellings separated by depressions where it is bound down by adhesions. In the midst of these elevations of the iris the pupil appears depressed and is spoken of as crater-like pupil. With the absence of its normal movements, and under the pressure to which it is subjected, the iris generally undergoes atrophy. Its forward displacement at the periphery is liable to bring it in contact with the cornea, closing the angle of the anterior chamber and causing a secondary glaucoma.

Such an eye, if left to itself, is almost certain to undergo degenerative changes that will render it hopelessly blind. Iridectomy should be done upon it as soon as possible, and repeated, if necessary to establish a free permanent communication between the



Iris Bombé.

anterior and posterior chamber; indeed, a portion of the iris should be excised even though the excluded pupil be perfectly clear, and the vision still good.

Annular ulcer. See **Cornea, Ring ulcer of the.**

Annulus. A ring-shaped or circular opening or margin.

Annulus arthriticus. (L.) A complete, closed circle formed by enlarged anterior ciliary veins around the cornea; seen in absolute glaucoma.

Annulus conjunctivæ. (L.) The limbus or sclero-corneal junction.

Annulus iridis major. Ciliary zone of the iris.

Annulus iridis minor. Pupillary zone of the iris.

Annulus of Zinn. The common tendon at the orbital apex, about the optic nerve, from which the straight muscles of the eye arise.

Annulus senilis. The ring of fatty degeneration of the tissues about the (upper) periphery of the cornea, generally seen in elderly subjects and commonly known as the arcus senilis.

Annulus tendineus communis. (L.) A synonym of the conjoined tendon, the origin of the four recti muscles, at the apex of the orbit.

Annulus tendinosus. (L.) A synonym of the annular ligament—the continuation of the posterior limiting membrane of the cornea.

Annulus Zinnii. (L.) Another name for the funnel-shaped "conjoined tendon" at the apex of the orbit from which arise the four recti muscles.

Anode. n. The positive pole of a galvanic battery.

Anodynes, Ophthalmic. Ocular analgesics. Agents that relieve pain in the eye or eyes. The most important of these are alypin, atropine and most of the cycloplegics, chloretone, cocaine, codeine, conium, dionin, eucaine, gelsemium, hypnol, lupulus, opium preparations, orthoform, phenacetine, phenazone and stovaine, Arlt's salve, cherry laurel water, brenzcain, chloral hydrocyanate, chloral hydrate, euphorin, veratrine, as well as most of the other local anesthetics.

Anomalie. (G.) Anomaly.

Anomalie congenite degli organi lagrimali. (It.) Congenital defects of the lachrymal apparatus.

Anomalie congenite dei muscoli oculari. (It.) Congenital defects of the ocular muscles.

Anomalie congenite del corpo vitero. (It.) Congenital anomalies of the vitreous.

Anomalie congenite della congiuntiva. (It.) Congenital defects of the conjunctiva.

Anomalie congenite della lente. (It.) Congenital defects of the crystalline lens.

Anomalie congenite dell' iride. (It.) Congenital defects of the iris.

Anomalie congenite delle palpebre. (It.) Congenital anomalie of the eyelids.

Anomalie congenite del nervo ottico. (It.) Congenital defects of the optic nerve.

Anomalien der Akkommodation. (G.) Anomalies of the accommodation.

Anomalien der Refraktion. (G.) Anomalies of the refraction.

Anomalies, Congenital. These prenatal defects have been observed in all parts of the eye and its related structures. They generally occur with malformation of other parts of the body. Some of them are caused by arrest of development, abnormal closure of some of the fetal fissures, or by intra-uterine inflammations. In other cases the causes are not known. A few of these congenital eye anomalies are anophthalmus, cryptophthalmus, microphthalmus, aniridia, megalophthalmus, cyclopia, ankyloblepharon, symblepharon, microblepharon, epicanthus, ptosis congenita, coloboma bulbi, coloboma of the eyelids, ablepharia, absence of iris, corectopia, persistent pupillary membrane, nevus, ectopia lentis, persistent hyaloid artery, dermoid tumors, orbital cysts, and congenital paralysis of eye-muscles. The various anomalies will be defined

under their separate headings; more fully under the section **Congenital anomalies of the eye.**

Anomalies of development. These include congenital defects and anomalies of every portion and organ of the ocular apparatus—from the eyelids to the cerebral centres. All of these will be found discussed under such individual and separate headings as *blepharia, congenital cataract, coloboma, acoria lenticonus, symblepharon adnatum, hyaloid artery,* etc., etc. A more complete major heading, **Congenital anomalies,** will treat the subject as a whole. To these captions the reader is further referred.

Anomalisch. (G.) Anomaly, abnormal.

Anomaloskop. (G.) This is an instrument devised by Nagel for the determination of the kind and amount of the various color-sense anomalies. Lenz (*Berlin Klin. Wochenschr.,* 1910) recommends it as a means of making an exact diagnosis quickly and surely.

Anomalous dispersion, Chromatic. See **Chromatic dispersion.**

Anommatous. adj. Destitute of eyes.

Anonymous, Mediaeval. The unknown author of a work entitled *Tractatus de Egritudinibus Oculorum ex Dictis Sapientium Veterum,* the MS. of which was discovered by Pansier in the Bibliothèque de l'Arsenal. His work is a mere compilation from Ar-Razi, Avicenna, and other Arabian ophthalmologic writers.—(T. H. S.)

Anonymus I of Casiri. This unknown, mediaeval Spanish-Arabian physician is the author of a book of little value, entitled, *Anonymi tractatus de oculorum morbis, in fine mutilus,* etc. Leclerc's conjecture that this work comprises, or contains, the missing ophthalmic treatise of Abenguefit, has been shown by Hirschberg to be entirely erroneous.—(T. H. S.)

Anonymus II of Casiri. This unknown, mediaeval Spanish-Arabian physician is the writer of several pages of manuscript which are still extant and which present an imperfect collection of Arabian ophthalmic prescriptions, of very little value historically or otherwise. —(T. H. S.)

Anoopsia. That form of strabismus in which the eye is turned upward.

Anoöpsia. (L.), n.f. (Obs.) A form of strabismus or squint in which the eye is turned upward.

Anophoria. This word is occasionally written anaphoria. The more usual form, however, is anophoria, this being used by Weeks, de Schweinitz, Duane, and most American writers. It means a tendency of both visual axes to rise above the horizontal plane. The term was first proposed by Stevens when he described the other phorias. As it is certain that one or both of the visual axes

often do tend to turn in, out, up or down, therefore it was natural to suppose that both axes might also together tend to turn upward or downward. The condition is seldom referred to by Continental or English writers, and it is doubtful if they acknowledge its existence.

From one or two authors it might be inferred that anophoria is quite common, and also of importance. The vast majority, however, treat it only incidentally or ignore it entirely. For example, in the last edition of Fuchs, edited by Duane, anophoria is referred to only in a few lines. It is disposed of in practically the same way by Weeks and de Schweinitz.

The most apparent symptom to a casual observer is the tendency of the individual to bend the head down while the eyes turn upward in order to bring the visual axes into the horizontal plane. Undoubtedly we do see persons occasionally who have this peculiarity. It is also true that those who possess this peculiar poise of the head in the most notable degree are not always those who suffer from asthenopic symptoms. If, therefore, this peculiarity is a symptom of anophoria we must infer that the condition itself is of no great importance.

While a general idea can be obtained by the position of the head, any exact diagnosis must of course be placed upon the arc of rotation as measured with a suitable tropometer (q. v.). When any such tendency does exist for the eyes to turn upward, the arc of rotation extends several degrees higher than usual. On the other hand, the excursions downward are proportionately limited.

The diagnosis is difficult. It is almost impossible to say in a given case whether the peculiar position of the head is due to the ocular muscles or to the muscles of the neck, or even to a malposition of the vertebræ which was developed in early childhood, and which has been allowed to continue uncorrected.

Concerning the treatment much has been written. Numerous operations have been described, in which by gradual division of the tendons of the superior rectus the visual plane has been lowered a certain number of degrees. Undoubtedly that has been done and could be done again. But any one who has had experience in making operations upon the vertical muscles has also found that the diplopia or deformity which resulted from these experiments is, on the average, quite as annoying as the original condition.

In a word, anophoria is a subject better known theoretically than practically.—(L. H.) See **Muscles, Ocular.**

Anophthalmia. (L.), n.f. Absence of the eyes.

Anophthalmia. This congenital condition denotes absence of an eye or eyes. In over 70 per cent of cases it is bilateral. Where it is unilateral the other eye may be normal or the subject of some defect, especially microphthalmia. Hasner observed in one case a coloboma of the lid and a nevus of the conjunctiva on the side of the absent eye.

Anophthalmos.

Anophthalmia is a condition clinically diagnosed as such, a true anophthalmia very rarely existing, as shown by painstaking anatomical and microscopical investigations. In a strict sense it really does not exist. Clinically, however, anophthalmia is said to be present where an eyeball is not macroscopically demonstrable or capable of being palpated. Tissues of mesoblastic origin can usually be found. The ocular muscles may be more or less developed and find insertion in the subconjunctival connective tissue or in the soft mass at the apex of the orbital cavity representing the rudimentary eyeball. Their differentiation however is poor.

The orbit is usually diminished in size, often quite small; the lids short, ill-formed, sometimes absent or with their margins turned in (entropion). The palpebral fissure is quite narrowed. The optic nerve may in places be fairly well developed, but is generally reduced to a fibrous cord. Epiblastic elements may be wholly missing, giving credence to the theory of non-budding or non-development of the primary optic vesicle.

Many cases of so-called anophthalmia are in reality high grade examples of microphthalmia. Especially is this true of orbitopalpebral cysts, in which a rudimentary eyeball is always found.

It is rather the rule to find associated with anophthalmia serious defects in the head, brain, and other portions of the body, such as asymmetry of face and head, defects and malformations of the ear, hare-lip, spina bifida, as well as malformations of the heart and other internal organs.

Frequent observations have been made of a purulent discharge from the conjunctiva at birth and its presence has been thought in some way to be associated with the destruction of the globe, but just how important a rôle inflammation plays one is unable to state.

The frequency of defects in the development of parts of the brain, especially of those structures vital to the integrity of a sound eye, the absence at times of the olfactory lobes, failure of evidence of epiblastic elements, and the very small size and even absence of an orbit point to developmental faults as the most logical explanation of the great majority of cases of anophthalmia.—(W. F. H.)

Anophthalmia cyclopica. A congenital malformation both of the orbit and of its contents.

Anophthalmie. (G.) A person without eyes.

Anophthalmohémie. (F.), n. Anemia of the eye.

Anophthalmos. (G.) One without eyes.

Anophthalmus. (L.), m.n. One affected with anophthalmia.

Anopia. (L.), n.f. Congenital absence or defective development of the eye.

Anöpsia. (G.) Upward strabismus, blindness.

Anopsia. (L.), n.f. 1. Congenital absence of both eyes or of the orbits and eyes. 2. Non-use of the eye, generally as the result of congenital conditions.

Anopsia, Ambliopia da. (It.) Visual deficiency from non-use of the eyes.

Anopticonervie. (F.), n. An obsolete term for amaurosis.

Anorthopia. When the eyes are turned away from parallelism; i.e., in strabismus.

Anorthoscope. An instrument for producing a peculiar kind of optical illusion by means of two disks rotating rapidly one behind the other. The posterior disk is transparent, and has certain distorted figures painted upon it; the anterior disk is opaque, but pierced with a number of narrow slits, through which the figures on the posterior disk are viewed. The effect depends on the persistence of impressions on the retina, the principle being the same as in the chromostroboscope, zoetrope and kinetoscope.—(C. F. P.)

Anotropia. Upward squint. Also written anatropia. See **Muscles, Ocular.**

Anottalmo. (It.) Anophthalmus.

Anpassung. (G.) Accommodation, adaptation.

Anpressen. (G.) To press against, to squeeze against.

Anquetschen. (G.) To squeeze against.

Anreiben. (G.) To begin to rub; as rubbing one's eyes.

Anreiz. (G.) Incitation; causing to incite, or to irritate.

Anreizung. (G.) Inciting, incitement, instigation; to cause.

Ansatz. (G.) An apophysis; an insertion.

Anschielen. (G.) To squint at.

Anschoppung. (G.) Passive hyperemia, engorgement.

Anschwellung. (G.) A swelling, tumefaction.

Ansieden. (G.) To begin to boil, to prepare by boiling.

Anspannen. (G.) Strain; tension.

Anspanner. (G.) A tensor.

Anstechen. (G.) To puncture; paracentesis.

Anstecken. (G.) To infect, to inoculate.

Ansteckend. (G.) Infectious or contagious.

Ansteckende Augenentzündung. (G.) An infectious ocular inflammation.

Ansteckendekrankheit. (G.) An infectious disease.

Ansteckende Liddrüsenentzündung. (G.) Purulent conjunctivitis.

Ansteckender. (G.) Contagious.

Ansteckendes. (G.) Contagion.

Ansteckung. (G.) Infection.

Ansteckungs. (G.) Contagion.

Ansteckungsfähig. (G.) Contagious, liable to contagion.

Ansteckungsfähigkeit. (G.) Power of being contagious.

Antagonism of ocular muscles. According to Savage (*Ophthalmic*

Myology, pp. 41, 42), "the helping of one muscle by other muscles is *synergism;* the opposing of one muscle by other muscles is *antagonism.* The following table furnishes a list of both assistants and antagonists of the chief extrinsic ocular muscles.

Internus	Synergists	Superior rectus. Inferior rectus.
	Antagonists	External rectus. Superior oblique. Inferior oblique.
Externus	Synergists	Superior oblique. Inferior oblique.
	Antagonists	Internus. Superior rectus. Inferior rectus.
Superior rectus in superversion	Synergists	Inferior oblique. A too high internus, or A too high externus.
	Antagonists	Inferior rectus. Superior oblique. A too low internus, or A too low externus.
Inferior rectus in subversion	Synergists	Superior oblique. A too low internus, or A too low externus.
	Antagonists	Superior rectus. Inferior oblique. A too high internus, or A too high externus.
Superior oblique	Synergists	Superior rectus. A too high internus, or A too low externus.
	Antagonists	Inferior oblique. Inferior rectus. A too low internus, or A too low externus.

Inferior oblique...	Synergists.....	Inferior rectus. A too low internus, or A too high externus.
	Antagonists.....	Superior oblique. Superior rectus. A too high internus, or A too low externus.

It will be noticed that every ocular muscle has one more antagonistic muscle than synergistic."

Antagonism of the visual fields. This condition results when the images of the two visual fields are of such a nature that they cannot be fused. Using a blackboard as a ground, let vertical lines be drawn in one field and horizontal in the other. One field will predominate to the exclusion of the other until some external influence (winking of the lids, changing position of the eyes) be brought to bear, when the second field will come into the foreground. There is no way of determining which field will predominate.

Antagonismus zwischen Trachom und Pneumokokken. (G.) Antagonism between trachoma and pneumococcus.

Antagonistische Farben. (G.) Antagonistic colors.

Anteorbital. In front or in advance of the orbit or eyes.

Ante-partum ophthalmia. An inflammation or infection of the eye occurring before the birth of the child. Thirty-five cases have been collected from the literature and arranged in table form by Stephenson. Seventeen additional cases have been similarly disposed in a second table (which have not before been reported) in which the ophthalmia developed within 24 hours after the birth of the child. This period of incubation being too short for infection at or after birth, points to ante-partum infection. Stephenson holds the belief that these instances of ante-partum ophthalmia are not so uncommon as hitherto believed, and that about one-half of the cases (44.5 per cent.) are satisfactorily accounted for by a premature rupture of the membranes, allowing access of micro-organisms to the baby's conjunctival sac. As regards the remaining cases (55.5 per cent.) a slight injury to the membranes may determine access of micro-organisms, or infection through the uninjured membranes must be assumed to have taken place. Further, increased temperature of the conjunctival sac in utero, enhanced virulence of the causative micro-organism, feebleness of the babies, slight lateral tears of the membranes, position of the fetus in the maternal passages, and the condition of the placenta cannot be shown to be

connected with the causation of ante-partum ophthalmia. Several of the so-called 'congenital' anomalies of the eyes, as corneal opacities, staphyloma, microphthalmos, cryptophthalmos and lachrymal abscess, are probably to be explained on the theory of an intro- an intra-uterine infection. Six of Wharton's cases showed conjunctivitis at birth; in the others the disease appeared up to the seventeenth day, the largest number of cases, 27, 29 and 13 respectively, on the second, third and fourth days. Additional cases of ante-partum ophthalmia are reported by Nance. (1.), Robinson. (3), and Ford (2). The latter is strengthened in the conclusion that infection may take place through the injured membranes. This view is also strongly supported by a remarkable case reported by Terson, in which the child was delivered by Cæsarean section. When the head appeared in the uterine incision the assistants noted that the eyes were red, swollen and discharging. The case ran the course of a severe purulent conjunctivitis, recovering under silver nitrate, with potassium permanganate irrigation. The bacteriologic examination revealed staphylococci and diplococci which took well the Gram stain, characterizing them as the micrococcus tetragenus. The treatment of these infections does not differ from that proper to post-partum ophthalmia.

Anterior chamber. The space between the cornea and iris. In fœtal life a delicate iridic membrane covers the pupil, subdividing the aqueous space into an anterior and posterior chamber; after birth the pupillary membrane disappears and the two spaces communicate through the pupil. The anterior chamber is really a lymph-space which varies in size with individuals. The contained fluid is also subject to considerable alteration, both in character and amount. According to Jackson, it is most shallow in early infancy from the undeveloped condition of the eye, and in old age from the increased size of the crystalline lens. It is deep in aphakia and still deeper in keratoglobus, both from prominence of the cornea and from flattening of the iris.

It is often rather deep in myopia. It may also be deep in plastic inflammation causing shrinking of the vitreous and retraction of the lens. It appears deeper when there is any opacity in the cornea. The anterior chamber is shallow in glaucoma, in cataract during the stage of swelling of the lens, during parenchymatous inflammation of the iris, or from bellying forward of the iris after exclusion of the pupil. After injury of the eye it may be shallow from traumatic cataract, and it is quite obliterated so long as a perforation wound permits the free escape of the aqueous humor. In degenerated

shrunken eyes it may be very shallow. The anterior chamber is of unequal depth in different symmetrical parts, from dislocation or partial absorption of the lens, unequal swelling of the iris, or from partial synechia. See **Anatomy of the eye**.

Anterior dichotomy. A name given to the condition existing in congenital malformations when supernumerary organs are found in the head or anterior end of the animal, e. g., four eyes in the human subject.

Anterior focal line, or first focal line, represents the line in the diffusion area (in considering astigmic lenses) along which a pencil of rays is collected.

Anterior homogeneous lamina. A name for Bowman's membrane. This corneal layer is also called anterior elastic lamina, membrane of Reichert and anterior or external basement membrane.

Anterior iridolysis. An operation intended to free the iris, which may have become adherent to the cornea after an ulcerative or a traumatic perforation. Such an adhesion may have the shape of a small thread only, or be broader, or it may even concern a large portion of the iris, as is usual in adherent leucoma and in corneal or corneoscleral staphyloma. The operation, if successful, removes the attachment of the iris and has a beneficial influence on the bad condition due to it, and may open up a useful pupil. Numerous operative measures have been devised by various operators and numerous different instruments have been recommended for their performance. Yet every case will have to be studied and handled on its own merits.

Bowman, having made a small corneal incision, entered a blunt-pointed Weber's lachrymal knife and cut the iris off the corneal scar by pressing the edge of the knife against the latter.

Meyer used a small sickle-shaped knife and cut the adhesion in the direction from the cornea toward the pupillary margin.

Kerschbaumer is reported by Schulek to have used a narrow von Graefe knife for the same purpose.

Walker also used a von Graefe cataract knife with which he entered the cornea peripherally at a point opposite to the synechia. By sweeping lateral movements he cut the adhesion without allowing the aqueous humor to escape, until the knife was withdrawn.

Lang used two Knapp's knife-needles, one with a sharp point, the other with the point rounded off. With the pointed knife-needle he pierced the cornea at a point lying sufficiently far to the side of the corneal scar, so that the blunt knife, being entered after the quick withdrawal of the first one, could be easily introduced

between the iris and cornea. With this second knife, the aqueous humor not having escaped, he could then easily cut the adhesion off. The chief difficulty seems to have been to find the small opening of the first knife-needle to enter the second one through it, though this defect in the technique is somewhat lessened by making it over or in front of a plainly visible scleral vessel.

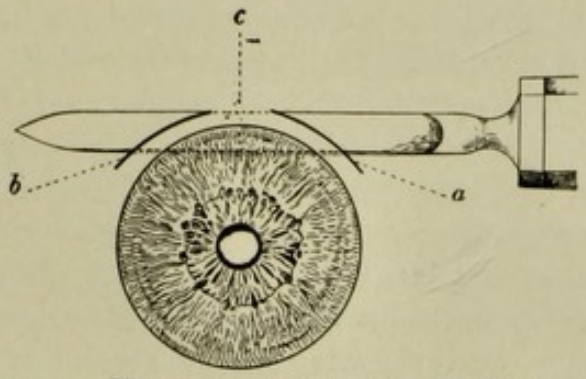
Others have used de Wecker's pince-ciseaux successfully to cut off such anterior synechiæ.—(A. A.)

Anterior lenticonus. A more or less conical projection of the anterior surface of the lens. In posterior lenticonus a similar cone is found at the posterior pole. See **Lenticonus.**

Anterior polar cataract. This opacity of the lens is, as the name implies, found at the anterior pole of the crystalline. It is generally produced (and it may be congenital) by the deposit of an inflammatory exudate on the anterior capsule while the lens presents at an opening in the cornea, the result of a perforating ulcer. See **Cataract.**

Anterior sclerotomy. This operation was first introduced by de Wecker in 1867. He aimed to establish by its means a cicatrix in the angle of the anterior chamber through which the intraocular fluids could filter out of the eye. In the following year Stellwag von Carion practised this operation on the living subject, and two years later, in 1871, Quaglino reported five cases of glaucoma which he had successfully treated by sclerotomy. During this year de Wecker modified his original operation somewhat to avoid the prolapse of the iris which had attended some of his earlier incisions. This modification of the operation, which has been widely practised by others, is performed as follows: After the pupil has been contracted ad maximum with a miotic, and the eye cocainized, the lids are separated with the speculum, and the globe steadied by grasping the bulbar conjunctiva a few mm. distant from and below the lower limbus of the cornea. A narrow von Graefe cataract knife is introduced 1 mm. from the outer corneal limbus, as represented at *a* (see the figure) and made to emerge at *b*, at the other side of the anterior chamber. The incision is then continued upwards with slow sawing movements, the cutting edge of the knife being directed somewhat anteriorly, until only a bridge of tissue, about 2 mm. broad remains at *c*, this being left undivided to prevent iris prolapse. After the aqueous has been permitted to escape from the eye by cautiously tilting the edge of the knife slightly forward, the knife is slowly withdrawn. If the pupil is round, eserine is instilled and a bandage applied, but if it be oval or irregular, indicating a ten-

dency of the iris to prolapse, the membrane should be gently stroked by a spatula and attempt made to restore the pupil to its normal form. In the rare cases that actual prolapse of the iris occurs, the prolapsed portion should be excised at once, and the sclerotomy converted into an iridectomy. Wiegman recommends making the incision with a double keratome which he designed for the purpose.



Anterior Sclerotomy. Showing the position of the knife in the eye during the incision of the sclera. It lies at least 1 mm. away from the limbus in the sclera.

In addition to prolapse of the iris which has just been referred to, when the chamber is very shallow, the operator may fail to enter the anterior chamber, the knife being inserted instead into the deeper layers of the cornea. To avoid this accident and also its converse of making the incision too far posteriorly and thereby wounding the lens, the best of illumination is necessary and the operator will do well to resort to the condensation of artificial light. In case the operator gives a wrong direction to his knife and splits the cornea or makes what is known as the *interlamellar incision,* the knife may be withdrawn and re-entered at a better angle. Should, however, the chamber have been opened and aqueous permitted to escape, the knife should be withdrawn and the operation postponed until the chamber has reformed. The same delay is advised if the operator realizes in time to desist, that the counter-puncture has been made too posteriorly.

After the toilet of the eye and the instillation of a miotic, a bandage is applied, the dressing being removed at the end of 24 hours. The lips of the wound may be found coaptated, and healing may be perfected so that the thin cicatrix is barely visible. Oftener perhaps there is a gaping of the wound and the condition described by de Wecker as a *filtration-cicatrix* forms. This is less pronounced than the cystoid cicatrix which is observed after the prolonged and imperfect healing of incisions and wounds of the eyeball, and consists

of a broadening and elevation of the scar with a slight bulging of the conjunctiva. de Wecker claims that such a cicatrix affords the maximum amount of drainage for the intraocular fluids, though he also asserts that a considerable degree of leakage may be attained through even a closely united scar.

According to de Wecker, anterior sclerotomy is particularly indicated prior to iridectomy when the tension is very high and the anterior chamber shallow. In chronic glaucoma in combination with miotics, he considered it to be the operation of choice. He also recommends it in hydrophthalmus, in hemorrhagic glaucoma, and in cases of absolute glaucoma to lessen pain. Finally, he commends its performance in the prodromal period of inflammatory glaucoma when miotics are without effect.

After operating on a large number of cases, Panas concluded that anterior sclerotomy occupies the middle place between a large peripheral iridectomy and repeated paracentesis of the cornea. In chronic glaucoma, he found that it was a useful supplement to miotics. In hydrophthalmus, however, it was as valueless as all forms of operation, and in his opinion did not remove the necessity of enucleation in absolute glaucoma. Although at one time extensively practised especially by French surgeons, sclerotomy has now but few advocates, as iridectomy with a scleral section has been shown to possess all the advantages of sclerotomy, while affording at the same time a possibility of re-establishing a communication between the anterior chamber and the canal of Schlemm.

Some operators have modified the operation as follows: Quaglino's incison was much the same as is usually employed for iridectomy and was made with a large triangular keratome, the knife being entered 2 mm. behind the limbus. During the withdrawal of the keratome, the handle was tilted back to raise the blade and prolapse of the iris guarded against by permitting the aqueous to flow slowly off. Despite this precaution, however, and the use of eserine, prolapses were frequent, necessitating excision of the prolapsed portion of the iris.

Snellen adopted Quaglino's method, as he found it less liable to induce prolapse of the iris. He treated a series of cases of bilateral glaucoma by iridectomy on one eye and sclerotomy on the other and found that the better vision was obtained by the latter. He, therefore, recommended sclerotomy, repeated if necessary as the initial operation, resorting to iridectomy only when the sclerotomy failed to prevent a rise of tension.

Bader followed de Wecker's method in its essential details, but

aimed at making the corneal puncture and counter-puncture as near as possible to and in front of the insertion of the iris. He endeavored to leave a large bridge of conjunctiva, stretching across the sclerotic incision, and, with this in view, divided an extent of sclerotic equal to nearly a third the circumference of the cornea.

Martin precedes sclerotomy by paracentesis with a Desmarres needle introduced into the cornea at the vertical meridian 1 mm. from the limbus. If aqueous still remains after withdrawal of the needle, he permits it to drain off by the aid of a lance. The wound is then enlarged with one or two cuts of the iris scissors.

Both Panas and de Wecker advocated the operation of cicatrisotomie or outètomie when rise of tension persists after iridectomy. This consists in incising the cicatrix with a narrow Graefe knife, in order to divide the attachments of the iris in the angle of the cicatrix, the conjunctival bridge being left undisturbed. The writer has found this procedure of value in the several cases in which he has resorted to it.

In cases of glaucoma simplex of a suspected malignant type, Pflüger incises the cornea as if for a broad iridectomy, but withdraws the linear knife with which the incision is made before the section is completed. If no decrease in tension occurs after the escape of aqueous, he considers the operation completed. Should, however, the tension fall, the incision is finished and the iris excised. —(W. C. P.)

Anterior staphyloma. After extensive ulcer of the cornea the resulting cicatricial area, being thin or less resistent than normally of the intraocular pressure, may bulge so that an anterior staphyloma is the result. When perforation has also occurred with extensive prolapse, in—healing of the iris associated with wide-spread organization of inflammatory exudates there is a total anterior staphyloma.

In 9 cases of complete, or almost complete, anterior staphyloma, transplantation of animal corneæ produced a permanent flattening of the cornea in five recorded cases. Of the two eyes in which the result was bad, one was eviscerated and the other enucleated. Both these were cases of total anterior staphyloma which would probably have required this treatment if transplantation had not been attempted. Transplantation is scarcely to be thought of as a method of improving vision, but it may in some cases improve the condition of the sightless globe, and do away with the necessity for enucleation or one of its substitutes.

The Editor operated ten years ago, with success, so far as relieving

the staphylomatous condition of the cornea is concerned, on a young girl for bulging of the anterior segment of the globe. The transplanted rabbit's cornea became fully incorporated in the corneal surface and helped to flatten the front of the eye and preserve the organ intact—at least until recently.

Anterior symblepharon. Union between the eyelids involving the conjunctivæ, but not so far back as the fornix.

Anterior synechia. Adhesion of the iris to the cornea, generally due to operative, traumatic or ulcerative perforation of the latter and hernia of the former. In those instances where the early use of atropia, eserin, etc., is insufficient to reduce the hernia, the attachment may be cut loose with Lang's twin knives or by other operative methods. See **Cornea, Ulcer of; Iris, Diseases of.**

Anthracosis oculi. (L). Malignant ulcer of the eye.

Anthrax. ANTHRAX PUSTULE MALIGNANT PUSTULE. This disease arises in man by inoculation of the *bacillus anthracis* from the lower animals. The eyelids are the ocular structures most commonly affected, and the infection is found among persons who are employed in the care of animals and among those who handle hides and wool. The infection is carried by the hands, by dirty instruments, or by the bites of insects which have fed on infected cadavers. The disease, which fortunately is rare in this country, begins as a small vesicle surrounded by an areola. Soon a livid-red papule develops, followed by a bulla or pustule, and this, in turn, by a black eschar. There is a broad area of edematous infiltration of a violet color. The gangrene may spread rapidly and terminate fatally, or a localized slough may be thrown off, leaving an ulcer, which heals by granulation. When the eyelids are involved there may be extensive destruction, only the ciliary margins remaining. The constitutional symptoms are those of sepsis. The diagnosis will rest on the history of the case, the appearance of the lesions, and the finding of the anthrax bacillus. The prognosis is serious, from 30 to 50 per cent. of the cases ending fatally. The treatment will embrace general supportive measures, incisions, the use of the galvanic cautery to destroy the infected area, and the application of bichlorid solutions. After recovery a plastic operation may be required. Where there is extensive loss of tissue, it will be advisable to suture the marginal portion of the lid to its fellow to prevent lagophthalmos and ectropion.—(J. M. B.)

Antibodies. Substances, such as antitoxins, formed in the blood and fluids of the body antagonistic to bacteria and their poisonous products. We recognize the presence of antibodies in the sera of animals

by certain characteristic reactions which they produce under carefully controlled conditions. In chemistry, chemical substances and elements are recognized by their physical character, form, color, weight. Knowing one chemical substance or element, we recognize a second unknown by the changes which occur when it is mixed with the known. These changes we call reactions. Antibodies, however, are easily destroyed by the ordinary physical processes and methods of chemical examination. We are accordingly limited in our study of antibodies to the observation of the reactions which they produce when combined with other substances and cells. Thus antitoxins in a serum are demonstrated by the neutralization of toxin by the serum as shown by the failure of the toxin-antitoxin mixture to produce death in the test animal. Bactericidins are recognized by their lethal action on bacteria. Hemolysins produce hemolysis of red blood cells.

The number of possible antibodies is limited only by the number of substances which can act as antigens. In general, antibodies fall into several classes distinguished by the character of their reactions. Chief among these classes are the bactericidins, antitoxins, precipitins, agglutinins, hemolysins and opsonins. Usually the antibodies with which we have to deal in the study of immunity are those which appear in response to the artificial introduction of antigens. These antibodies are known as immune antibodies. In certain instances, however, antibodies which produce the same reaction as immune antibodies may be demonstrated in normal serum, that is, the serum from uninoculated animals. Thus we recognize that in normal serum there is a certain amount of opsonin which, when mixed with a bacterial suspension, so modifies the bacteria that they may be taken up by leucocytes. The inoculation of suitable quantities of bacterial substance may greatly increase the opsonin contained in this serum, thus adding the action of the immune opsonin to that of the normal opsonin already present in the serum.

Ehrlich has classified antibodies into groups distinguished by the reactions which they show in various combinations. This complete system of classification is known as the side-chain theory, and supposes that immune bodies consist of a central fragment to which are attached special groups having special functions and special structure, so that they combine with other substances. The combining groups fit each other as a key in a lock. Briefly, on this theory, Ehrlich classifies antibodies according to their supposed molecular structure. Antitoxin is supposed to possess a single combining group or receptor, which fits the corresponding toxin. Agglutinins

and precipitins have one combining group and a second group which facilitates agglutination or precipitation. Other more complex antibodies such as the hemolysins are supposed to have a combining group for the red cells and a second group for the complement or alexin. Those of this latter class are called amboceptors, that is, they form a means of union for the red cell and the complement. Substances of this class are also known as sensitizers in that they sensitize the cell to the action of complement. As pointed out by Bordet, the phenomena observed in these reactions are attributed by Ehrlich to the properties in the antibody rather than to those in the antigen and the complement. The side-chain theory of Ehrlich has had enormous influence on the development of our knowledge of immunity, but it is possible that many of the reactions which require a complicated series of explanations on this theory may be in the future much more easily and satisfactorily explained on the basis of colloidal reactions by physiochemical methods.

It must be remembered too that we are able to recognize a rather limited number of classes of antibodies only, because a limited number of methods have been devised by which their presence can be demonstrated. These methods consist chiefly in changes produced in suitable reagents, such for instance as the laking of red blood cells by hemolysins, the agglutination of bacteria or other cells, the formation of a precipitate in a mixture of sera, the taking up of bacteria by leucocytes, etc. As other methods by which characteristic reactions can be produced and adequately controlled are developed, other types of antibodies may be demonstrated. The reaction known as the fixation of complement enables us to demonstrate the presence of antibodies in the serum of animals inoculated with various bacteria.

In addition to the antibodies already mentioned we know of others such as the leucotoxins, neurotoxins, and nephrotoxins. Some of these are specific for their corresponding antigens. In others, the specificity of the antibodies has been called in question. Antiferments have also been demonstrated.—(E. E. I.) See, also, **Seropathy.**

Antidiphtheric globulins. See **Antidiphtheric serum**; also, **Seropathy.**

Antidiphtheric serum. SERUM ANTIDIPHTHERICUM, ANTIDIPHTHERIC GLOBULINS, DIPHTHERIA ANTITOXIN. The serum of horses immunized to the toxin of the diphtheria bacillus, to which is added after filtration some antiseptic such as tricresol or chloroform. The concentrated diphtheria antitoxin is obtained by the precipitation of the globulin fraction which contains most of the antitoxin by the addition of neutral salts. The serum is marketed in syringe packages

ready for use. It is also supplied by some firms in dry form. The diphtheria antitoxin sold in interstate commerce in the United States is required to conform to the standard established by the United States Health and Marine Service, and must contain the number of antitoxin units claimed on the label.

The dose required for a case of diphtheria will vary with the age of the patient and the extent and duration of the disease previous to the treatment. If administered on the first or second day of the disease in a mild case from 2,000 to 5,000 units is often sufficient. The longer the disease has proceeded the more heroic should be the dosage. The general tendency in recent years is to use larger and frequently repeated doses of antitoxin.

The immunizing dose is from 500 to 1500 units. It should be remembered that passive immunity in this disease after a dose of serum is of relatively short duration, perhaps two to three weeks. —(E. E. I.)

This preparation is unquestionably the most successful and widely known of the specific sera, the general employment of which has reduced so remarkably the mortality in diphtheria. Its use in diphtheric infections of the eye has been attended with the same favorable results as in cases of the ordinary pharyngeal and nasal infections. Antidiphtheric serum has been used also, empirically, in the treatment of various suppurative lesions not due to the diphtheria bacillus, such as corneal ulcer of pneumococcal origin, purulent conjunctivitis, hypopyon, etc., with reported benefit. See **Seropathy in ophthalmology**.

Antifebrin amblyopia. Antifebrin (PHENYLACETAMID; ACETANILID) poisoning has been followed by dilation of the pupil, with decreased or lost light-reaction, together with other more or less severe general disorders. Hilbert observed, after a three gram dose, visual weakness, with narrowing of the visual field, constriction of the retinal vessels, and pallor of the papilla. A case accompanied by strong cyanosis showed blueness of the conjunctiva. See **Toxic amblyopia**; also **Acetanilid**.

Antifebrinvergiftung. (G.) Antifebrin poisoning.

Antigen. This is a substance which when introduced into the living body gives rise to antibodies, the presence of which is recognized by various characteristic reactions. The toxin of the bacillus of diphtheria when injected into the horse in successively increasing doses produces changes in the animal such that at length it can withstand a dose of toxin many times as great as would have caused death before the treatment. The serum of this horse, when injected in

proper amount into another animal, will protect the second animal from an otherwise fatal dose of the toxin. The protective substance in the serum of the treated horse we call antitoxin, an antibody to a toxin. The toxin which stimulates the production of the antitoxin we call antigen.

Another familiar example of the production of antibodies by an antigen is found in typhoid fever. The serum of an individual who has passed through the disease will cause the agglutination of typhoid bacilli (Gruber-Widal reaction). Here the typhoid bacillus and its products act as antigen giving rise to the formation of antibodies (in this case agglutinins), the presence of which is recognized by the phenomenon of agglutination.

The principal antigens with which we have to do in the treatment of disease are of bacterial origin. In some cases bacteria produce soluble products such as the toxins of diphtheria and tetanus, which when introduced into suitable animals produce antibodies (antitoxins). Certain other bacteria produce little or no soluble toxin. Suspensions of these bacteria, however, when introduced into animals give rise to various antibodies which are recognized by their characteristic reactions with their respective antigens (see **Antibodies**). The action of each antigen as demonstrated by the action of its antibody is specific for that antigen. That is, the typhoid bacillus produces antibodies which react with the typhoid bacillus (agglutinin etc.) and not with other organisms such as the staphylococcus and streptococcus. Two closely related antigens may give rise, however, to antibodies some of which are common to both immune sera. This fact is made use of frequently in determining the relationship of bacterial species.

Other substances such as the tissues or serum of animals will act as antigen when introduced into the body of animals of another species. Thus precipitins, agglutinins (such as the hemagglutinins), hemolysins, etc., can be demonstrated in the serum of animals after the injection of these antigens.

Certain substances of vegetable origin also have antigenic properties. Some of the vegetable poisons such as abrin and ricin are well known examples of vegetable antigens.

The chemical structure of antigens as well as of the antibodies to which they give rise is as yet unknown. With very few exceptions, substances the chemical structure of which we know do not give rise to antibodies. One exception to this statement, however, may be noted, that of cobra venom which has been obtained in pure crystalline state as lecithid (cobra lecithid) and which produces demon-

strable antibodies when injected into animals. In general, substances having antigenic properties are proteids.

The term antigen is also used in a somewhat modified sense in discussions of the complement fixation test as applied to the diagnosis of syphilis (Wassermann test). Here the term antigen is applied to the extract of syphilitic liver, presumably containing the products of the spirochæta pallida, the cause of syphilis. In the various modifications of the Wassermann test, it has been found that extract of guinea-pig heart and other substances may be used to replace the extract of syphilitic liver. These substances are referred to as antigen, although it is obvious that they have no specific relation to the anti-substances in the serum which it is designed to detect.—(E. E. I.) See, also, **Seropathy.**

Antigonococcic serum. The serum prepared from the blood of rams or horses immunized against the gonococcus. In certain cases the serum has been thought to give favorable results in the treatment of gonococcal arthritis. It has also been used in the treatment of certain cases of gonococcal iritis. It is of comparatively little value in the treatment of infections of the mucous membranes.—(E. E. I.)

Antikörper. (G.) Antibodies.

Antimeningococcus serum. The serum prepared from the blood of horses immunized with cultures of the diplococcus intracellularis. It has been used quite extensively and with favorable results in the treatment of epidemic meningitis, due to the diplococcus intracellularis. It is best given intraspinally by lumbar puncture. Given subcutaneously, it has little if any demonstrable curative effect. The dose in the adult is from 15 to 30 ccm., repeated at intervals of a few hours. Great care must be exercised in the injection of the serum to avoid too rapid increase in the intraspinal pressure. Careful observation of the pulse and blood pressure during the injection will assist in the avoidance of unfavorable symptoms.—(E. E. I.) See, also, **Seropathy.**

Antimeristem-Schmidt. A proprietary vaccine for the cure of cancer and sarcoma.

Antimeter. An antiquated optical instrument for measuring small angles.

Antimetropia. (L.), n.f. That refractive condition in which there is myopia in one eye and hyperopia in the other. See **Refraction and accommodation.**

Antimony. The salt of this metal in which the ophthalmologist is mostly interested is "tartar emetic," whose application to the eye, either as a powder or in solution, produces a pustular conjuncti-

vitis and pericorneal injection. Still stronger compounds, like "butter of antimony" (antimony chloride), act as caustics (by forming albuminates with the tissues) and have, when applied to the lid, accidentally brought about destruction of the cornea. Probably, also, the free hydrochloric acid in the "butter" adds to its destructive action. Except for their rare employment as cauterants for ulcers antimonial compounds have no place in ocular treatment.

A boy who was given a teaspoonful of antimony chloride solution (Liquor stibii chlorati, G. P.) by mistake, suffered from symptoms of gastritis, associated with widely dilated pupils that did not respond to either light or accommodation.

Antimydriatic. A drug or other agent that arrests or reduces dilation of the pupil.

Antinode. In *optics,* a point in a vibrating string where the amplitude of vibration is greatest. It is the middle of the loop, the summit of oscillation, and half way between two adjacent nodes. See **Nodes.**

Antinosin. NOSOPHEN-SODIUM. SODIUM TETRAIODOPHENOLPHTHALEIN. This compound appears as a blue powder, and is recommended as an antiseptic to replace iodoform. It is soluble in water and used in from one-half to one per cent. solutions. It is also employed as a gargle in pharyngeal diphtheria.

In cases of simple cartarrhal conjunctivitis and hyperemia of the conjunctiva W. O. Moore uses a few drops of a one per cent. solution instilled into the eye three times a day. Solutions of antinosin should be kept in a dark bottle and in a cool place.

Antipathy to binocular single vision. It is well known to observers that, in squint especially, it is not always possible, even by the use of the stereoscope, amblyoscope (q. v.) and other devices to induce both eyes to see together; in other words, to secure any form of binocular vision. In this case some central or other defect in innervation or in the fusion faculty is assumed. Savage (*Ophthalmic Myology,* pp. 426-430) defines this condition as one in which it is impossible to fuse the two images of an object. Such cases were observed by Graefe, who defined the condition as "antipathy to binocular single vision." The cause of this antipathy, in all probability, is that the macula of one eye is connected with one side of the brain, while the macula of the fellow eye is connected with the other side of the brain. To fuse images on the two maculas their impressions must be carried to the same side of the brain, which cannot be accomplished unless the nerve fibres passing from the two maculas find their way into the same optic tract and thence go

to the same cuneus. If the maculas fail to have a common connection with the brain, other retinal points that ought to correspond cannot do so, and there must be diplopia in all parts of the field. The condition, if it exists, is congenital, and the only reason why there is not annoying diplopia must be due to the habit of mental suppression acquired in infancy. Esotropia due to such a cause must occur earlier in life than is usual, possibly within the first few weeks after birth.

Pathology points to the possibility of such a cause for esotropia. A disease involving the center of sight in one cuneus, or a disease involving all the nerve fibers as they pass from one cuneus in their course to the optic chiasm, whether in the tract or farther back, must cause hemianopsia, involving corresponding halves of the two retinas, the temporal half of one retina and the nasal half of the other. Many such cases have been observed. In some cases the line dividing the blind part from the seeing part of each retina has been vertical, passing down through the macula; in other cases, while these lines were vertical, they missed the maculas, passing a few degrees either to the right or to the left of both, the two maculas falling either in the blind or in the seeing parts, in either case showing that both were connected with the same side of the brain; in other cases the dividing lines have not been vertical, the obliquity being sometimes as much as ten degrees, but the same in the two eyes. The oblique lines have passed, in the reported cases, either through the maculas or have fallen on corresponding sides. No case, so far as the author knows, has ever been reported showing that the blindness in the temporal half of one retina included the macula, while the blindness in the nasal half of the other retina did not include the macula, else no further argument would be necessary. That pathology has shown no cases of faulty connection of the maculas with the brain is probably due to the rarity of the condition—certainly as rare as is "antipathy to binocular single vision," for the one must be a synonym of the other. If the lines dividing the retinas into two halves pass, in some cases, down through the maculas, while in other cases both these lines pass either to the right or to the left of the maculas, it must be conceded as a possibility that the dividing line in one retina may pass to the right of the macula, while the dividing line in the other retina may pass to the left of the macula. In this case disease of one cuneus or of one tract would destroy the perceptive power of one macula, while the other macula would be uninvolved. There being no disease in such a case, the impress of an image on one macula would be conveyed to one side of the brain,

while the impress of the image on the other macula would be sent to the other side of the brain, and there would be no fusion of the two. So far as the author can see, nothing else can account for "antipathy to binocular single vision."

Every surgeon of much experience with esotropia has had cases that he could not cure, however skilled as an operator. Each attempt to correct the error in such a case makes the patient worse, for the reason that, under the old condition, the power of suppression of images in one eye had been acquired, while under the new condition, the images fall on new parts of the retina of the eye operated upon, and diplopia is at once made manifest. The more nearly the readjustment of the muscles brings the eyes straight—to exactly straighten them is impossible—the more annoying becomes the diplopia. If the patient is mature at the time the operation is done, his diplopia will always be annoying, for he can never reacquire the power of mental suppression. To have let such a patient alone would have been a mercy.

Fortunately, esotropia due to the cause under discussion is rare. That the mistake of operating on such cases may not be made, the operator should give most careful study to every case. When there is great amblyopia of the esotropic eye, one may feel fairly sure that the case is not of this character; for usually a case of this kind has fairly good vision in either eye when the other is excluded, for the esotropia is alternating. But all cases of alternating esotropia, with fairly good vision in each eye, do not belong to this hopeless class. In any case of esotropia the fusion test should be applied; but in alternating estropia this test becomes absolutely essential. When the images can be fused, the case can be cured; if the images cannot be fused, a cure is impossible, and should never be attempted.

Antiphoria. A form of heterophoria in which the directions of the main tendencies of the two eyeballs are opposed to one another.

Antipneumococcic serum. Antipneumococcic serum, as at present prepared, has received an extensive trial in pneumococcal infections. In lobar pneumonia and other general infections the results have not been encouraging. Isolated cases and in some instances small series of cases have been reported in which recovery followed the use of the serum, but the consensus of opinion is that in this class of cases its value has not been demonstrated.

Römer has made an extensive study of antipneumococcic serum in serpiginous ulcer of the cornea. In his first series of cases in which he used a polyvalent serum, he obtained somewhat better results than in a control series in which the serum was not used.

Later he supplemented the injections of serum by active immunization, using for this purpose vaccines prepared from pneumococcus cultures. The suspension of killed pneumococci was given preferably first, followed in a few hours by the serum. Using this technique Römer was able to check the advance of the ulcer and obtain healing in 20 out of 24 cases. In 2 cases he had to resort to the galvanocautery, and in the remaining 2 cases panophthalmitis developed. Some observers have been inclined to regard Römer's last series as made up of unusually favorable cases, and claim that if the infections had been of average virulence, his results would have been no better than those following ordinary symptomatic treatment.—(E. E. I.) See, also, **Seropathy.**

Antipneumokokkenserum. (G.) Anti-pneumococcic serum.

Antipyonin. This is a proprietary mixture mostly composed of sodic tetraborate, used as a dry powder for dusting over corneal ulcers and wounds and into the sac for the relief of conjunctival affections. It is a substitute for iodoform, calomel, xeroform, etc., in lesions where these remedies are indicated. See, also, **Boro-borax** and **Boricin.**

Antipyrin. (G.) Antipyrine.

Antipyrine. PHENAZONE. ANALGESINE. PARODYNE. $C_{11}H_{12}N_2O$. A mildly bitter, whitish, odorless powder, soluble in one part of water, alcohol or chloroform. Internally it is a poisonous antipyretic drug; locally it contracts the blood vessels with which it comes in contact.

It is incompatible with spirit of nitrous ether, iodine, and preparations containing iodine, mercuric chloride, tannic acid, phenol, thymol, phenyl salicylate, calomel, and the alkaline salicylates.

Although the use of this remedy in therapeutics is mostly internal it is on occasions employed topically. For example, Wicherkiewiez recommends it in from 5 to 10 per cent. aqueous solutions as a collyrium in a number of conjunctival diseases.

For the relief of the smarting and occasional pain following the use of collyria made with zinc sulphate, zinc chloride and other soluble zinc salts H. V. Würdemann advises the addition of ½ per cent. antipyrine to these mixtures.

W. K. Butler believes that antipyrine has an anesthetic effect in certain mixtures and uses it in conjunctival catarrh with irritative symptoms. He thinks that it may be substituted for the objectionable cocaine so commonly prescribed. Either of the following may be used, as indicated: antipyrin, 6 centigrms.; boric acid, 6 decigrms.; distilled water, 32 grms.; or, zinc sulphate, 3 centigrms.;

antipyrin, 6 centigrms.; boric acid, 6 decigrams; distilled water, 32 grms.

As a cooling and detergent wash in ordinary cases of conjunctival catarrh or hyperemia Nelson Black prescribes one of the following formulæ, directing that a few drops be put into the eye three or four times daily:

℞

Cocain. hydrochlor.	0.030
Antipyrin.	0.10
Acidi borici	0.40
Aquæ camph.	
Aquæ borici dest.	āā 15.00

℞

Zinci sulph.	0.030
Antipyrin.	0.10
Aquæ camph.	
Aquæ dest.	āā 15.00

℞

Antipyrin.	0.10
Acidi borici	0.40
Aquæ camph.	
Aquæ dest.	āā 15.00

Antipyrin has also been recommended by Kozlowski and Wicherkiewicz in a 10 per cent. to 25 per cent. solution for washing out the lachrymal sac after probing in suppuration of the lachrymal sac. It is further recommended by the latter in a 3 to 5 per cent. solution in all forms of conjunctivitis (except acute trachoma) especially after influenza, and in a 25 per cent. solution in chronic trachoma. The instillation causes violent burning and stinging at first, but the sensation disappears quickly. In chronic inflammatory glaucoma the pains were lessened by instillation of a few drops of a 25 per cent. solution into the respective nasal canal. Vigues reported good results after spraying in some forms of pannus, and keratitis and in peripheral phlyctenulæ. For clearing of corneal scars spraying antypirin (after cocainization) has been employed successfully. In neuritic atrophy of the optic nerve it was employed by Valude on account of its action upon the vaso-motor system. He recommends subcutaneous or gluteal injections of a 50 per cent. solution, every second day 1.0 and later 2.0 ccm. with a little cocain.

Internally it is of benefit in doses of 0.5 to 1.0, 3 times a day, in the treatment of subacute or chronic inflammatory glaucoma, if the

pains reappear after operative treatment. It is also recommended in absolute glaucoma. Iritic pains are also relieved by antipyrin but aspirin is a better remedy for this purpose.

Antipyrin amblyopia. The eye is rarely affected, in the toxic sense, by this agent. When it is, the symptoms form part of a general dermal inflammation, i. e., eruptions and infective processes in the buccal and nasal mucous membranes. In a few cases conjunctivitis (with considerable edema of the conjunctiva), eruptions on the lids and conjunctiva as well as lachrymation occur. The lids, taking part in the lid-skin infection, may become so swollen as to shut one or both eyes; or the lids alone may show an eruption, such as urticaria or eczema.

Dilatation of the pupil does not take place in these cases unless the antipyrin poisoning is so severe as to end in collapse or epileptiform convulsions.

Definite visual disturbances also occur. A woman who took one gram of antipyrin became sick after five minutes with fever, followed by an urticaria of short duration. The heart action was strong and there was great irritation. Amaurosis of one minute duration followed, with edema of the face. Recovery occurred after three days. While the amaurosis in this case was transient, in another patient it lasted half an hour. A woman, after taking 1 gram after a meal, had pressure-pains in the back of the head, buzzing in the ears, dizziness, feeling of anxiety, palpitation of the heart (200 per minute), cold sweat on the face and dyspnea. After twenty minutes everything became black before her eyes and in a few minutes she became blind for thirty minutes. The conjunctiva bulbi was hyperemic, there was an increased flow of tears, all associated with a slight exophthalmos.

Even after small doses (one gramme) the patient may have blepharo-conjunctivitis with swelling of the face, lachrymation, and catarrh of the respiratory passages. Less frequently one encounters dilated pupil, decrease of central vision, and still more rare is an attack of complete but temporary blindness. These symptoms are in general seen in cases of idiosyncrasy against antipyrin. de Schweinitz, who tried the effect of the drug on himself, noticed scintillations followed by bright spots before his eyes. See **Toxic amblyopia.**

Antipyrinvergiftung. (G.) Antipyrin poisoning.

Antirrheoscope. J. J. Oppel's apparatus for observing and testing vertigo of ocular origin.

Antisepsis and antiseptics. Agents that act as germicides are called

antiseptics, while the germ-free condition with the methods employed to realize it is designated antisepsis. To this end both in general surgery and in ophthalmic therapeutics, we employ those agents that are found by experience to act best as bactericides. The delicate structures of the ocular apparatus require, however, the kind of care that is not called for elsewhere, so that it is not always compatible with safety to employ the same anti-bacterial remedies (or at least not in the same dosage) that are indicated in wounds or other lesions of more resisting tissues. For example, mercuric bichloride and carbolic acid are well tried and useful antiseptics, but they cannot be properly used in the conjunctival sac in anything like the strong solutions which one would apply to the tissues of the arm or leg. The desire to kill all the pathogenic bacteria that infest the eye—as in a laboratory experiment—induced early clinicians to use the most powerful and effective germicides, but it was soon demonstrated that it is not only impossible to sterilize completely the conjunctival sac and the surrounding tissues, but that the attempt to do so is likely to bring about vascular disturbances and other changes that are more productive of harm than the disinfection of the ocular tissues does good. This is especially true of operative procedures; strong antiseptics destroy the vitality of the wound edges, delay healing and actually invite infection.

One is prone to forget, also, in drawing conclusions from laboratory experiments made on the conjunctiva and other ocular organs of the lower animals that these may be more sensitive to or less affected by the drug in question, than are human eyes. Thus, it by no means follows that because a certain agent brings about this or that alteration, or produces certain symptoms in the eyes of the rabbit, guinea pig or dog that the same results will necessarily follow the identical experiments on the eye of man.

The most that can, after all, be said in favor of laboratory experiments of this kind is that the simian ocular apparatus is much better adapted for the purpose than are the ocular organs of the small mammals. At the same time the man-like apes and higher monkeys are difficult to obtain for experimental purposes and their cost alone is almost prohibitive. Still it is better to make the best use of clinical observation on human beings and rely on them alone than to be led astray by misleading comparisons and unjustifiable deductions. In the opinion of the writer the great majority of therapeutic experiments on the eyes of the lower animals, especially of the guinea pig, are valueless, if not positively deceptive—so far as they claim to possess virtue in ophthalmic therapy.

The importance as well as the difficulties of rendering the conjunctival sac aseptic is illustrated by the calculation of Novy that thirty billions of bacteria contain about $\frac{1}{400}$ grain of organic matter, an amount too small to be appreciated by our unaided senses.

As the various antiseptics used in ophthalmic surgery are separately dealt with and their comparative value as microbicides elsewhere discussed, we give here only a small list of the preparations usually included in the category. Among them are boric acid, picric acid, airol, airoform, alphozone, amyloform, lotio nigra, aqua sublimatis, most of the silver salts, aristol, aseptol, berberine and hydrastine with their salts, betanaphthol, blenol, boro-borax, borol, boroglycerite, oil of cade, calomel, calomelol, cerevisine, chloral hydrate, chlorine water, copper sulphocarbonate, creolin, europhen, formalin, gold chloride, gujasanol, Guthrie's salve, hydrastine, hydroquinone, ichthyol, iodine and its preparations, most of the soluble salts of mercury, the bichloride, benzoate, cyanide, oleate, oxycyanide, iodides and oxides, monochlorophenol, phenoalyl, several potassium salts, including the chlorate and chloride, protargol, pyoktanin, blue and yellow, quinine and its salts, quinosol, radium, resorcin, salol, sodium benzoate, benzosulphinide, borate, chloride, saccharate, salicylate, sozoiodolate, sulphate and chlorinated soda, sophol, sozoiodole-zinc and mercury, sublamine, thigenol and trikresol.

It may be well to say a few words about some of the most important of the foregoing list.

First are several salts of mercury. In this connection it has been noticed the more mercury a preparation contains the more powerful its disinfectant action. The best known of these salts are the bichloride and oxycyanide (q. v.). Schlösser advises its use in 1 to 2 per cent. watery solution and says that it may be used in any capacity to which sublimate is adapted and that it is not so irritating to the ocular tissues. The subconjunctival employment of the cyanide has already been alluded to in conjunction with acoin (q. v.) and it must be repeated that in solutions of 1 to 2,000 to 4,000 it is about the most reliable agent we possess in deep (purulent) infections of the eyeball.

Formalin, $\frac{1}{1000}$ to $\frac{1}{5000}$ salicylic acid (3 per cent.), pyoktanin, boracic acid (3.5 per cent.), chlorine water (2 to 5 per cent.), potassium permanganate ($\frac{1}{1000}$ to $\frac{1}{4000}$), sodic benzoate (five per cent.) and a saturated solution of hydrogen peroxide in water, to which may be added various antiseptic preparations of salts of metals, (iodine, silver, copper, zinc) and many organic compounds also belong to the class of astringents or caustics. A third class of anti-

septics are such neutral bodies as vaselin, paraffin, castor oil, glycerine, etc., that act indirectly as antiseptics by furnishing a soil but poorly adapted to the growth of some pathogenic bacteria.

Preparations of certain aniline dyes were, as germicides, introduced into the local treatment of eye diseases by Stilling. They were very popular for a time, especially the yellow and blue pyoktanin, both of which in the solid form and in all their watery solutions were widely used. Interest in them has been more recently revived by Rudini and others but it has again waned. Methylene blue and toluidine blue are also employed by some ophthalmic surgeons in corneal ulcer and in infective conjunctivitis.

Zinc permanganate, as dark violet-brown, hygroscopic, crystalline granules, similar in appearance to permanganate of potassium is, like it, used as an antiseptic and astringent wash. It is employed as a bactericidal collyrium in $\frac{1}{1000}$ to $\frac{1}{500}$ solutions and should from its chemical composition be very useful clinically. I have prescribed it with much benefit as a $\frac{1}{3000}$ solution for the home irrigation of the nasal duct following operation for the relief of lachrymal stricture.

The problem of obtaining the complete antiseptic action of sublimate upon the ocular tissues without disturbing unduly the vascular supply of the parts and without inducing discomfort, is solved by the use of a formula proposed by J. A. White. He found that while it is impossible to use, especially in operative work, such decided germicide solutions as $\frac{1}{3000}$ in water that strength might be employed as an ointment with vaselin. His formula is:

℞

Hydrarg. bichlor.	gr. $\frac{1}{6}$
Sodii chlor.	gr. $\frac{5}{6}$
Alcohol dil.	q. s.
Petrolati	℥j

Dissolve the sublimate and the common salt in a few drops of dilute alcohol and mix with the vaselin, which has been previously kept at a temperature of 212° F. for half an hour. Stir until cool. This may be put into soft capsules for individual use, or kept as an antiseptic base for atropine and other ointments. I have prescribed this salve and used it extensively in private, dispensary and hospital work and can recommend it as a most useful application to the sac when a reliable antiseptic is desired. It is my practice to fill the sac with the ointment twice in 24 hours as one of the preliminaries to major operations on the globe. I also prescribe it extensively alone and in conjunction with other remedies for the home treatment of several forms of blepharitis.

J. A. Lippincott, advises a modification of the ointment, especially in infected ulcers of the cornea, by the addition of lanoline, which takes up the watery solution of the bichloride better than vaselin alone. His formula is as follows:

℞

Hydrarg. bichlor.	gr. i
Sodi chlor.	gr. vi
Petrolati	ʒii
Lanolin.	ʒiii

As the result of several years' trial of both the original and the modified formula of White's ointment there seems reason to believe that the former is the preferable.

Clarence P. Franklin reports of toluidine blue (q. v.) that "after ten years' use of this drug the statement seems warranted that it is a most efficient remedy in muco-purulent conjunctivitis and is practically a specific for the Koch-Weeks and Neisser forms of the disease. The usual ten days to two weeks' discharge of "pink eye" is reduced to four to six days and with this treatment there seems to be less chance of a fresh infection; at least the writer has never seen a return in any instance among many cases.

In ophthalmia neonatorum and gonorrheal ophthalmia of the adult the purulent process is markedly and rapidly lessened.

It is to be used three times a day (in $\frac{1}{1000}$ solution, dropped into the conjunctival sac) and alternated with solutions of adrenalin and boric acid. This treatment has given uniform results with no untoward symptom except that, rarely, a patient of pronounced susceptibility complains of slight stinging on its first instillation." —(Ed.).

Antiseptic-Credé. A trade name for silver citrate (q. v.).

Antiseptisch. (G.) Antiseptic.

Antiseptus. (G.) Antiseptic.

Antistreptococcic serum. A preparation of streptococci and their toxins. In the case of the streptococcus and some other bacteria the toxins are to a large extent intracellular, and difficulty is experienced in obtaining their corresponding immune sera. Moreover, different strains of streptococci vary greatly in virulence among themselves for the same animal, and different species of animals may exhibit wide variations in susceptibility to infection by any one strain. Several strains of virulent streptococci are usually employed in the immunization of animals, and the antistreptococcic serum produced is thus polyvalent. Antistreptococcus serum has been used in a large number of cases of cellulitis and

other streptococcus infections, and many favorable clinical results following its use are on record, including severe infections about the face and eyes. There is a constant tendency, however, to report favorable cases, while the large number of cases not responding to treatment pass unnoticed. Moreover, the clinical course of streptococcus infections is proverbially uncertain, and, as in pneumonia, this fact has led clinicians to attribute cures to the most diverse empirical remedies. For this reason it is advisable to exercise caution in accepting the favorable reports on the use of antistreptococcic serum, although it must be admitted that the serum has a certain claim for recognition as a scientific attempt at specific therapy.—(E. E. I.)

Antistreptokokkenserum. (G.) Anti-streptococcic serum.

Antitetanic serum. This preparation, similarly to antidiphtheric serum, is obtained from horses immunized to increasing doses of the tetanus toxin. The greatest value of antitetanic serum lies in its prophylatic use in lacerated and deep puncture wounds in which experience shows that tetanus infection is likely to occur. Cases in which tetanus develops following lacerated or other wounds when the early prophylactic injection of a suitable dose of tetanus antitoxin has been made, are extremely rare. In cases which come under treatment after the symptoms of tetanus have appeared, the injection of the serum locally, intraneurally or by lumbar puncture is indicated. Many cases have undoubtedly been saved by its use, the beneficial results depending on the early neutralization of the toxin, before it has become widely diffused throughout the nervous system.—(E. E. I.)

Antithyroidine-Moebius. SERUM ANTITHYROIDEUM, (Merck). An amber colored liquid, with a faint odor and taste of carbolic acid, composed mostly of the blood-serum of sheep from which the thyroid gland has been removed at least six weeks before. The fluid is preserved by the addition of 0.50 per cent. of phenol. It is administered in initial doses of half to one cc. (8 to 15m.) three times daily, to be increased as required.

Commenting on this and other antithyroid preparations, the Editor of *New and Non-Official Remedies* (3rd edition) says:

"The use of these preparations is based on the theory that the thyroid gland secretes products which are toxic but which neutralize and are neutralized by other toxic substances produced elsewhere in the body. Removal of the thyroid glands, therefore, leads to the accumulation of these second toxic substances, as evidenced by the phenomena cachexia strumipriva and myxedema. On the

other hand the blood or milk of such animals is claimed to be capable of preventing the effects of a hypersecretion of thyroid substance, such as is supposed to occur in Basedow's disease (exophthalmic goiter).

These views are still largely hypothetical; but many clinical observers report distinctly beneficial results in the milder forms of the disease and in obscure nervous disorders which are supposedly connected with thyroid hypersecretion. The effects are less pronounced in the more severe forms. The action is merely palliative and other measures of treatment should not be neglected.

Improvement occurs in two or three weeks and is indicated by an amelioration of the nervous symptoms, tremors, palpitation, insomnia and excitability.

The administration must be long continued. Oral and hypodermic administration are equally effective, but the former is usually preferred. These preparations are not toxic, even when very large doses are used."

Antitubercle serum. A serum prepared by immunizing horses with toxic substances derived from the tubercle bacillus. The dose is 1 to 4 ccm. given daily. The value of the serum is problematic and is not yet clinically or conclusively demonstrated.—(E. E. I.) See, also, **Seropathy.**

Antityphoid serum. Derived from horses immunized with cultures of the typhoid bacillus. Favorable results in the treatment of typhoid are reported after the use of this serum, particularly in the reports of Chantemesse. The serum has not come into general use and clinicians are not yet agreed as to its curative value.—(E. E. I.) See, also, **Seropathy.**

Antityphoid vaccination. The immunization of persons against typhoid fever by the injection of suspensions of dead typhoid bacilli. The immunizing injections are made subcutaneously at intervals of about ten days, and are usually three in number. The dose for an adult is 500 millions for the first injection and 1000 millions for the second and third. The method when employed with due regard to surgical cleanliness, using a properly prepared vaccine, is devoid of danger. Usually there is but little reaction beyond a slight feeling of malaise and headache, and rise of temperature appearing from six to eighteen hours after the injection. Occasionally more severe reactions are met with, in which the temperature rises somewhat higher and the constitutional symptoms are more severe. The reaction passes away, however, in a few hours and no permanent harm results. Occasionally after the second injection a more marked reac-

tion is observed than after the first. This may in part be ascribed to the increase in dosage but is also probably due to changes caused by the first injection whereby the individual is sensitized to the action of typhoid protein.

The efficacy of this method of immunization against typhoid is proved by the statistics of armies in which the method has been extensively practised. By this method of immunization typhoid has been practically eradicated from the United States Army even in the case of those bodies of troups encamped in regions where typhoid is widespread among the civilian population. Statistics of other armies such as those of the German Army in South Africa, the French Army in Algiers, the Japanese Army, and the British Army in India indicate the value of this form of immunization. In civilian life, statistics are less readily available but there seems to be no doubt of the prophylactic value of the method.—(E. E. I.)

Antlitz. (G.), n. The face or countenance.

Antlitzarterie. (G.) The facial artery.

Antlitznerv. (G.) The facial nerve.

Antlitzpulsader. (G.) The facial artery.

Antlitzschlagader. (G.) The facial artery.

Antocular. Having a location in front of the eye.

Antonelli's peripheral iritomy. Antonelli's (*Révue générale d'Ophtalm.*, 1896, p. 385) peripheral iritomy (iritomie periphérique) should perhaps only be attempted on blind eyes, because of the liability of producing a traumatic cataract. Antonelli employed a double-edged lance, which he introduced in the sclero-corneal region nearly perpendicular to the surface of the globe, but slightly obliquely. The point of the knife is thrust into the chamber, into the tissue of the iris, and its base incised by sweeping the knife around the periphery of the chamber to the extent of 5 to 6 mm.—(W. C. P.)

Antonius Feuer. (G.) Erysipelas.

Antophthalmic. Efficacious in the treatment of ophthalmia.

Antorbital. In front of the orbit.

Antrace. (It.) Anthrax.

Antröpfeln. (G.) To trickle, drip, or drip on.

Antrophose. A phosphene (or subjective light or color sensation) having its origin in the optic centers.

Antrum, maxillary, Diseases of, producing eye symptoms. See **Cavities, Neighboring.**

Ants, Poison of. There can be no doubt but that a bite from most varieties of Formica, through the introduction of formic acid beneath the palpebral skin or the mucous coverings of the eye, may set up

considerable edema and other signs of inflammation of the affected eye, but it does this probably in common with the insults of certain spiders and some flies. In several cases of ant-bite the local irritation did not subside for several weeks.

Antyllus. A distinguished physician of the 3d century A. D., concerning whose life next to nothing is known. It was even supposed for a time that he lived in the early half of the 2d century, but this is now conceded to have been erroneous.

Of the writings of this excellent surgeon, nothing but fragments have descended to our time. These, however, proclaim a man of very great ability—at least in general surgery and medicine. Not only, in fact, was he the first to describe aneurysm in detail, but he invented the excellent operation for this condition which is still in use and which is still customarily called "the Antyllic operation." This procedure, as is well known, consists in tying the vessel above and below the sac, and then opening the sac in order to remove its contents.

Antyllus seems to have been an economical person, for he recommends that leeches, when sucking, should be cut in two, in order that they may continue at their work without undergoing repletion.

Ophthalmologically, Antyllus is of some importance, because it has been claimed repeatedly that he is the inventor of cataract extraction. This, however, as Hirschberg has shown, is indubitably a mistake. The former opinion rested not on any extant passage from Antyllus, but on an obscure quotation made by Salah ad-Din from Rhazes. It is possible that certain physicians of antiquity really attempted the extraction of what we call a cataract—as to this we cannot be absolutely certain. However, it is more than probable that all that was ever extracted by way of the anterior chamber of an eye in all ancient times was simply what we call hypopyon. The suction method of removing cataracts from young eyes was invented in the Arabic Middle Ages by Ammar, or Omar (born in Missoula, and practised in Egypt) while the extraction of senile cataract was introduced by Daviel in 1748. For the sake of completeness we may add that the universal supposition in early times was that a cataract is a film, or inspissated "humor," lying in a supposedly existent chamber, or space, between the pupil and the lens, and that this error was not removed till 1705, when Brisseau and Maitre-Jean showed beyond all question that a cataract is not a pathologic product situated in front of the lens, but the lens itself which has become opaque.—(T. H. S.)

Antyllus-Kuhnt operation. A procedure for the relief of paralytic

ectropion. A wedge-shaped section of the conjunctiva and tarsus, with its base at the free border of the lid, is excised from the lid for the purpose of shortening the latter. A keratome is inserted between the skin and tarsus and the triangular piece of tarsus and conjunctiva thus liberated removed without cutting the skin. The edges of the cartilage and conjunctiva are then brought together and sutured, a proceeding that produces a fold in the skin at that point; and therein lies the weakness of the operation. See **Ectropion, Operations for.**—(C. H. B.)

Anwachs. (G.) A swelling, an accretion.

Anwallung. (G.) A paroxysm.

Anwaschen. (G.) To begin to wash.

Anwässern. (G.) To irrigate, to wet with water.

Anwendung. (G.) An application, a use.

Anwinken. (G.) To wink; to wink at.

Anwuchs. (G.) An accretion; grown to.

Anwull. A tree whose parts are used in India as a remedy for ophthalmia.

Anzeichen. (G.), n. A symptom or sign.

Anziehender Augenmuskel. (G.) The internal rectus muscle.

Anzieher. (G.) An abductor.

Aorasia. (L.), n.f. Blindness.

Aorta, Aneurysm of. See **Aneurysm of aorta.**

Aortic insufficiency, Eye symptoms of. Pulsation of the papillary and retinal arteries, due to a marked hypertrophy of the left ventricle, has been observed in this cardiac lesion, although rhythmic movements are, as a rule, not so strongly marked as in some forms of glaucoma.

The capillary pulsation at the optic disk changes the color of the papilla from red to white alternately. While this form of arterial pulsation seldom extends over the boundaries of the papillary region, the venous pulsation, usually present to a greater or less degree, may extend far into the periphery of the retina. This venous phenomenon is said to be characteristic of insufficiency of the aorta.

Edema of the eyelids also appears with insufficiencies of the cardiac valves; it is part of a general venous congestion, the result of defective compensation.

The interference with the circulation from cardiac insufficiencies easily causes nutritive disorders of the vessel walls, which in its turn often leads to thrombus-formation in the peripheral veins—especially thrombosis of the vena centralis retinæ—and in the heart itself.

Embolic processes being a direct consequence of thrombosis, may affect the visual organ. It is especially the embolism of the arteria centralis retinæ which is of first importance; other changes in the visual apparatus may result from thrombosis or embolism in the central nervous system. These changes are analogous to those following hemorrhages (apoplectic attacks) which, due to greatly increased blood pressure, occur more frequently in insufficiency of the aorta than in other cardiac lesions. "Scintillating scotoma" or phosphenes is not infrequently a prodromal symptom of a cerebral apoplexy. The prognosis of the ocular disturbances that result from aortic insufficiency is unfavorable. Their successful treatment (see **Embolism of the central artery of the retina**) depends upon possible improvement in the local conditions and, secondarily, upon cure or amendment of the cardio-vascular alterations that originally produced the eye changes.

Apanastema. (L.), n.n. (Obs.) A wart-like outgrowth on the conjunctiva.

Apertometer. According to Gould, an "optical device for determining the angle of aperture of microscopic objectives. The apertometer of Abbé, which is mostly used, consists of a semicircular piece of thick glass with the straight edge beveled at 45 degrees. Light entering the curved edge is reflected upward by the beveled edge. This is received by the objective of the microscope. By means of two metal slides moving on the curved edge the exact angle of the light required to fill the back lens of the objective is indicated on the curved edge and can be read off directly."

Apertor oculi. (L.) The levator palpebræ muscle.

Aperture. In *optics,* the diameter of the exposed part of a lens or object glass in an optical instrument. *Aperture Angle,* of a microscope objective, is often expressed in degrees; and in this case the so-called *angular aperture,* that is, the angular breadth of the pencil of light which the objective transmits from the object or point viewed: as an objective of 100° aperture. *Aperture-stop,* the diaphragm or stop placed with its center on the optical axis at some point between two consecutive lenses of an optical system, which is thereby divided into two parts, a *front component* L_1, consisting of the part of the lens-system in front of the interior stop, and a *hinder* component (L_2) consisting of the remainder of the lens-system lying on the other or far side of the stop. It is called a *front stop* when it is placed in front of the entire system, and a *rear stop* when it is placed behind, or towards the image-side of the optical system. *Numerical aperture,* according to Abbé, the product of

the refractive index (n) and the size of the aperture angle (Ø), or n.sinø.—(C. F. P.)

Apex-angle. See **Angle.**

Apex of prism. This is formed by the convergence of the plane surfaces at one extremity; the thin edge of the prism.

Apfelauge. (G.), n. Staphyloma of the iris.

Apfelbein. (G.) The cheek-bone.

Aphakia. Absence of the crystalline lens, whether as the result of operation, absorption, or dislocation. The refractive power of the crystalline being equal to about ten diopters, the eye is made hyperopic to that extent, and after cataract operations, as is well known, this has to be taken into consideration and suitable glasses ordered.

Images of Purkinje.

b. and c. Absent in aphakia. a. Reflection from the cornea. b. From the anterior surface of the lens. c. Inverted image from the posterior surface of the lens.

Moreover, as aphakia necessarily involves a loss of accommodation power a second glass, for reading and other near work, is required in addition to the distance lens.

Aphakisch. (G.) Being without the crystalline lens.

Aphakous. Affected with aphakia.

Aphasia. (L.), f.n. Interference with the expression of ideas, although the apparatus of expression and perception, as well as the intellect seem unimpaired.

Aphasia Optical. See **Optical aphasia.**

Aphemesthesia. A form of aphasia, known as word-blindness or word-deafness.

Aphorama. With projecting eyes, so that one may see in the distance on either side without turning the head. Also written Aphorema.

Aphorema. Having projecting eyes, so that one may see in the distance on either side without turning the head. Also written Aphorama.

Aphose. A subjective sensation of shadow or darkness.

Aphrasia. (L.), f.n. An aphasic disease of the central nervous system in which there is inability to form phrases, and the command of words is small.

Apical. Pertaining to the apex.

Apical angle. See **Angle.**

Apiol, Oculo-toxic symptoms from. This derivative from the fruit of the parsley plant was formerly used as a substitute for quinine. In doses from one-half to one gram, it produces a stimulating effect like that of coffee, but in larger quantities—2 to 4 grams—induces an intoxication accompanied by ocular symptoms, such as, phosphenes; deafness; tinnitus; frontal headache; etc., like large doses of quinine.

Aplanasia. Aplanatism, or the absence of spherical aberration.

Aplanatic. Formerly applied to an optical system that was merely free from spherical aberration; but, according to Abbé, in order that an optical system may be aplanatic, it must fulfil each of two requirements, namely: It must be free from spherical aberration for a definite pair of conjugate axial points, and these must also satisfy the stipulation that the ratio of the slope-angles of each pair of corresponding incident and emergent rays must be a constant—(the Sine-condition, q. v.)—when they are called *aplantic points.* (See Southall, *Principles of Geometric Optics.*) It is impossible to design even a multiple lens of wide aperture, which shall bring all the rays falling upon it from *any* point on the axis to a point-focus on the axis; but an aplanatic system may be constructed which will cause all incident rays from a particular point on the axis to focus at a point upon the axis.—(C. F. P.)

Aplanaticism. The same as aplanatism.

Aplanatisches System. (G.) Aplantic system.

Aplanatism. n. Absence of spherical aberration.

Apoatropine. Atropamine. $C_{17}H_2NO_{21}HCl$. A cycloplegic alkaloid made from atropine by loss of water. Both this alkaloid and its salts—the sulphate and hydrochloride—are white crystals that are soluble in water and alcohol. They act like atropia but are not much used in ophthalmology.

Apochromatic, adj. In *optics,* applied to an improved form of lens devised by Abbé of Jena, constructed of a new kind of glass which allows of a more perfect correction of chromatic and spherical aberration than was formerly possible. The condition by which these properties are obtained in the new objectives depends upon the elimination of those errors which originate mainly in the unequal behavior of different colored rays; in fact, the elimination of such errors secures an achromatism of higher order than has hitherto

been attained. Therefore, objectives of this construction may be distinguished from *achromatic* lenses, in the old sense of this specific quality, by the term *apochromatism,* and may by called *apochromatic* objectives. The greatest freedom from spherical aberration in such systems is secured through *aplanatism* (q. v.).—(C. F. P.)

Apochromatism. The condition of being apochromatic (q. v.).

Apochysis. (L.), f.n. (Obs.) Cataract.

Apocodein, Oculo-toxic symptoms from. This substance, derived from codein by dehydration, produces a mydriasis in poisonous doses.

Apomecometer. An instrument used in measuring heights, constructed on the same principle as the sextant.

Apomecometry. The art of measuring elevations and distances.

Apomorphia, Oculo-toxic symptoms from. Apomorphin in 2 per cent. solution produces complete anesthesia of the cornea and conjunctiva of animals in about ten minutes. It lasts for about five to ten minutes. The conjunctiva becomes pale and presents a tough, almost leathery appearance, and its anterior epithelium becomes clouded. The pupils are dilated, as they also are after internal or subcutaneous administration. In man one to two per cent. solution of this drug induces dilation of the pupil and xerosis of the conjunctiva with such general symptoms as nausea, a feeling of heaviness in the limbs and exhaustion.

Aponeurosis orbito-ocularis. One of the numerous synonyms for Tenon's capsule (q. v.). Orbital aponeurosis, fascia bulbi, vaginal tunic, Bonnet's capsule, fascia Tenoni, tunica vaginalis oculi vel bulbi are others.

Apophyllite, n. A crystallized mineral allied to the zeolites, occurring in laminated masses or in tetragonal (four-angled) crystals, and having a pronounced pearly luster on the surface of perfect cleavage, parallel to which it separates readily into thin rhombic laminæ. Named because of its tendency to exfoliate—strip off its leaves. It exfoliates also under the blowpipe. From its peculiar luster it is sometimes called *ichthyophthalmite,* that is, fish-eye stone. It is a hydrated silicate of calcium and potassium, containing also some fluorin.

Apophyllite rings, n. The rings produced by *apophyllite* (q. v.) when examined between two crossed Nicol prisms with divergent white light; the rings are approximately white and black, a slight trace of green being observed inside of each black ring.

Apoplectiform bulbar paralysis. This condition of hemorrhage, embolism or thrombosis of the arteries of the bulb and pons, presents occasional eye symptoms. It is acute in onset, and immediately

fatal, or, as the underlying vascular pathology would suggest, capable of improvement with more or less permanent defect.

The prophylaxis and treatment of the acute stage cited under arteriosclerosis and apoplexy is here indicated. In young individuals syphilis is to be thought of as a possible cause, and energetic specific treatment instituted. As in chronic progressive palsy, the difficulties in swallowing and respiratory embarrassment must be guarded against by proper diet. Nothing is to be gained by use of strong drugs.

Apoplektisch. (G.) Apoplectic.

Apoplexy, Cerebral. Hemorrhage into the brain tissues, generally due to cerebral endarteritis or softening. See **General diseases.**

Apotheke. (G.) An apothecary's shop.

Apotheker. (G.) An apothecary.

Apothekerbuch. (G.) A dispensatory, pharmacy, pharmacopoecia.

Apothekergewicht. (G.) Apothecaries' weight, troy weight.

Apothekerkenntniss. (G.) Pharmacology.

Apothekerkunst. (G.) Pharmacy, pharmeceutical.

Apothekerordnung. (G.) A dispensatory.

Apothekerwaaren. (G.) Drugs, articles kept in a drug store.

Apothekerwissenschaft. (G.) Pharmacology.

Apparecchio della vista. (It.) The eye and its appendages.

Appareil de la vision. (F.) The visual apparatus.

Apparent accommodation. See **Accommodation, Apparent.**

Apparent cataract. The appearance of opacity of the crystalline lens, when that organ is viewed by the oblique illumination or by inspection only, which on the use of the ophthalmoscope proves to be a simple translucency.

To show the student a gray, senile lens, and after his diagnosis of cataract, to demonstrate its transparency with the ophthalmoscope, is a common method of enforcing the importance of the ophthalmoscopic examination. The sector shadows of irregular lens astigmatism sometimes encountered in skiascopy may bear a startling resemblance to the opacities of commencing cortical cataract. Other lens changes without opacity simulate early nuclear cataract.

Halben has reported an instance of the kind with a careful study of the causes of this phenomenon. To explain these cases, he very carefully considers the reflections which occur from the surfaces of the lens, and of its different layers; both of the light entering the eye, and of the light emerging from it during the ophthalmoscopic examination. Light entering at certain angles may be turned back by even total reflection, giving the gray appearance seen by ordinary daylight.

On the other hand the light from the fundus may encounter the surfaces of the different layers of the lens at such angles that it will be largely turned back within the eye, giving the shadow shown in the particular ring of pupil.

Apparent distance. Same as **angular distance** (q. v.).

Apparent magnitude of an object. In *physiologic optics,* that magnitude which is measured by the optic or visual angle subtended between lines drawn from the extreme points of the object to the center of the pupil of the eye. This angle may be considered to be inversely as the distance of the object.—(C. F. P.)

Apparent motion in skiascopy. This expression relates to the play of light and shadow within the pupil area during the skiascopic examination. For example, when a plane mirror is used the real movement of the light upon the retina is always in the same direction as the movement on the face, but if the retina be seen in the erect image, the apparent movement of the light in the pupil will be with the light on the face.

Apparent rest. This phrase is generally used in connection with the extrinsic ocular muscles to describe their complete relaxation. When it occurs there is often a tendency to deviate from the primary position. The condition is also known as actual rest.

Apparent size of objects. For many years, students of the science of optics have endeavored to explain the apparent size of objects when viewed at a distance that must be considered as infinite. The apparent size of the sun or moon at the horizon as compared with its apparent size at the zenith has long been a problem concerning which merely theoretical explanations have been invoked.

Of all of the theories advanced to explain this phenomenon only the most prominent need be mentioned. The first and best known accounts for the apparent difference in size at the two points by endeavoring to show that the light rays coming from the moon at the horizon have to penetrate a greater amount of air and hence undergo a greater refraction than when coming from the zenith. Moreover, distant objects, whose size is known, come within the peripheral portions of the visual field and there is consequently a ground for comparison. The greater refraction by a thicker stratum of air must be considered theoretically possible, but comparison plays but a small rôle.

The second theory is based upon the same two hypothetical factors, varying from the firsf only in that it claims that the refraction of the rays at the horizon is due, not to the thicker stratum of air, but to very fine particles of moisture suspended in the air. As is known, this moisture is denser near the surface of the earth than

in the heights of the surrounding atmosphere. Hence rays passing tangentially to the earth's surface would pass through far more moisture-laden air than rays coming radially to the surface. But here too, the question of greater refraction is merely theoretical and no actual proof can be shown.

The apparent flattening of the sky as noticed by Young has also been invoked as an aid toward clearing the mystery of this phenomenon. If one endeavors to divide the space between the zenith and the horizon into two equal parts, the result is that the lower portion is always too small. This is due to aërial perspective, that master of vague terms. The apparent difference of the size of the moon at the horizon and at the zenith is attributed also to this feature.

The most satisfactory explanation of this phenomenon is dependant upon a very simple experiment that can be performed without the aid of laboratory apparatus. It is easier to utilize the rays from the full moon than from the sun as they are not so blinding and the uniformity of illumination eliminates any error that might arise from different pupillary diameters. Apart from retinal disturbances that might follow observance of the sun at the zenith with the naked eye, the contraction of the pupil would be marked compared with the size of the pupil under the milder influence of the sun's rays at the horizon. The moon at the horizon seems to have a diameter about double that of the same body seen at the zenith. Let the observer, however, face away from the moon at the horizon and then bend backwards, at the same time bringing the full force of the superior recti into play, i. e., elevating the eyes as far as possible, until the moon comes into view; the diameter of the moon, though just above the horizon, will seem no greater than when it is at the zenith. The same experiment can be reversed. After noting the size of the moon at the zenith, let the observer lie flat on the ground and the diameter of the moon will appear to be greater, though not doubled.

The explanation to be deduced from this experiment is dependant upon the laws of convergence and accommodation. Theoretically an emmetropic eye does not accommodate when the rays entering that eye are parallel. This does not take into account the position of the ocular axes nor the influence of the extrinsic and intrinsic ocular musculature. In the erect position, when the visual lines are parallel to each other and tangential to or slightly inclined toward the surface of the earth, the internal recti muscles are in action. Although this effect may be very slight, there is still

some nervous stimulus at work. This innervation is necessarily coincident with an equally slight innervation of the muscles of accommodation by reason of the coincident action of their cerebral centers. The result of this is that the visual image is somewhat magnified and the greater the distance of the object from the eye and hence the greater the lack of means of size comparison, the greater is the relative enlargement of the image. Moreover, images transferred from the retina to the cerebrum while the center of accommodation is in a condition of stimulation, undergo a cerebral enlargement from force of habit. Because, any object for which we must accommodate is sufficiently close as to require convergence and our cerebral image of that object is large. Hence any effort at convergence is coincident with an effort at accommodation, it matters not that the object be at an infinite distance, and the resultant cerebral image will undergo a cerebral enlargement, due to the stimulation of these two centers. Hence the rôle played by the cerebral centers of vision, by accommodation, and by convergence must not be overlooked, though its importance cannot be estimated. But certain it is that the apparent size of the moon at the horizon is as well a cerebral as an ocular distortion.

When the eyes are raised as in observing the moon at the zenith, the visual lines are slightly divergent, due to the imperceptible action of the oblique muscles. This physiological divergence is accompanied by an absolute relaxation of accommodation, exactly as physiological convergence is associated with an increased tonus of the muscles of accommodation. Moreover, there is no stimulation of the cerebral center of accommodation and hence the cerebral image appears to be of the normal size. The retinal image is also of normal size.

Thus it is that habit is of importance in accounting for the apparent size of the moon on the horizon and at the zenith. As we are accustomed to observe images enlarged while the center of accommodation is in action, just so are the images of actual size when this center is at rest. This theory, however, does not take into account any refraction of the rays by an increased thickness of the air layer traversed, nor does direct comparison with objects of known size play an important rôle. Whether or not this theory will stand the test of time and further observation remains to be seen.*—H. S. G. See **Apparent magnitude** and **Magnifying power**.

*As far as I know, there is no account in the literature of this theory. It was communicated to me personally by Professor Elschnig.

Apparent strabismus, or apparent squint, occurs in persons with normal muscle balance but also with a certain type of skull in which the visual axes seem to diverge or converge more than usual, giving the expression, facial and other, of a heterotropia. In some cases this seeming muscular anomaly may be so marked as to deceive even the trained observer, who learns the true state of affairs only by applying well-known tests for squint.

Appendages of the eye. These are sometimes called the *tutamina oculi,* and include the following structures: the eyebrows (*supercilia*); the eyelids *(palpebræ)*; conjunctiva, and lachrymal apparatus.

Apperception. n. Conscious sensory impressions.

Appianamento della cornea. (It.) Flattening of the cornea.

Applanatio. (L.) Flattening.

Applanatio corneæ. (L.) Morbid flattening of the cornea. This condition may result from an interstitial keratitis. It also occurs occasionally after cataract operations and after healing of corneal traumatisms. As a consequence, the anterior chamber is shallow and the visual acuity is markedly diminished, not only because of opacities in it but from irregular astigmatism and decrease in the refractive power of the cornea.

Applanation. Flattening, as of the cornea.

Apraxia. (L.), f.n. Complete loss of the power of communication. Mind- and object-blindness; loss of memory for the uses of objects.

Lewandowsky (*The Ophthalmic Year Book,* 1909, p. 282) observed an instance of ocular apraxia in the inability to close the eyes, although the facial nerve acted normally and all the reflexes of the orbicularis were preserved. The patient slept with his eyes closed. In a second case of typical hemiplegia, with slight paresis of the inferior facial upon one side, the same author observed impossibility of closing the eyes under the influence of the will, with conservation of all the reflexes. The patient was unable to keep his eyes open when the hand was quickly moved toward them.

Apron, Congenital, of the palpebral conjunctiva. An enlargement of the semilunar fold, or rather an extensive development of the membrana nictitans has been observed and reported a number of times. This condition is easily observed on everting the upper lid when, at the fornix, there appears a reduplication of the conjunctiva, somewhat resembling a symblepharon fold, which extends the whole length of the lid. An example of this congenital anomaly has been recently reported by Tyson, in a woman 40 years of age.

Aprosopia. (L.), f.n. Congenital absence of the eyelids, in association with other facial defects.

Apus. (L.), adj. The swift (Cypselus apus) bird formerly used in preparing a remedy for weak eyes.

Apyonin. YELLOW PYOKTANIN. BENZOPHENONEID. See **Pyoktanin.**

Aqua amygdalæ amaræ. BITTER-ALMOND WATER. Made by dissolving one part of oil of bitter almonds in 1,000 parts of water. This mixture is by no means a constant medical agent, as its efficacy depends upon the proportion of hydrocyanic acid it contains, a variable quantity in bitter-almond oil. Bitter-almond water is used as an excipient in soothing collyria in much the same manner that cherry-laurel water is employed.

Brenzcain (q. v.), made by the action of anhydrous hydrocyanic acid on choral, has been used as a substitute for bitter-almond water owing to its exact dosage. One part dissolved in 160 parts of distilled water makes bitter almond water of the same strength as the P. G. The only question that arises is whether in collyria it is as free from irritating effects upon the eye as the best examples of this important vehicle.

Aqua aromatica. This mixture forms one of several excipients for collyria official in the German pharmacopeia. It is used as a mild astringent and eye-wash in simple conjunctivitis and conjunctival hyperemia.

℞

Misturæ oleoso-balsamicæ	
Aquæ aromaticæ	aa 60.0 (℥ii)
Aquæ fœniculi	100.0 (f℥iij.f℥iss)

Aqua calcaria, P. G. See **Lime water.**

Aqua calcis. See **Lime water.**

Aqua camphoræ. CAMPHOR WATER. Approximately 8 parts of refined camphor can be dissolved, by the aid of talc and other agents, in 1,000 parts of water. This solution forms one of the oldest eye-waters in the pharmacopeia and acts as a soothing and mildly stimulating astringent application, according to the amount of dilution and the other remedies prescribed with it.

J. A. Spalding complains that druggists follow no particular rule in preparing this important vehicle for collyria. He points out that formerly it was compounded by dissolving an ounce of camphor in an ounce of alcohol and then mixing the resultant powder with magnesia carbonate. The latest pharmacopeia substitutes talcum (which is inferior to magnesia carbonate) in place of the magnesia, and there is no explicit direction that the alcohol should be allowed to completely evaporate before the resulting powder is dissolved in the water and ample time (a month) allowed

to get a perfect solution. For use as a diluent of other agents or as one ingredient of eye-waters there is, after all, no more satisfactory method of preparation than that of placing a few pieces of gum camphor in a bag which is immersed in a gallon bottleful of sterile, distilled water. Shake the bottle half a dozen times a day for a week, after which the supernatant liquor will be found sufficiently impregnated with camphor to be efficient for the purposes mentioned.

Aquacapsulite. (It.) Punctate keratitis.

Aqua chlorata. AQUA CHLORI. See **Chlorine water.**

Aqua chlori. See **Chlorine water.**

Aqua destillata. See **Water.**

Aqua fontana. See **Water.**

Aqua hamamelidis. EXTRACT OF WITCH HAZEL. This official preparation contains 15 per cent. of alcohol and although more popular with the laity than with the medical profession, makes a fairly useful constituent of evaporating lotions and stimulating collyria.

Aquala. (L.), f.n. The crystalline lens; also a term applied by Celsus to prolapse of the membrane of Descemet through an ulceration of the cornea which has not led to perforation.

Aqua laurocerasi. CHERRY-LAUREL WATER. This is a well-known excipient for ocular remedies, its curative virtues being chiefly due to the very small and variable amount of hydrocyanic acid in its composition.

J. A. Spalding found that no rule prevailed among the druggists in his neighborhood (and presumably in other localities) as regards the mode of preparing cherry-laurel water. Some followed the U. S. dispensatory and used the essential oil; others followed the French Codex. The cherry-laurel water made according to the dispensatory from essential oil of bitter almonds, cherry-laurel or peach-pits, is inferior in purity to the imported French water, and is very irritating to the eye. He states that if we are to expect good results from the use of these valuable excipients, we must either direct our patients to a druggist who prepares them properly, or prepare our own lotions, or complain to the editors of the standard works in question, urging them to print proper directions in the making of these valuable waters for eye lotions. It would seem a matter of regret that medicines of so much comfort to irritated eyes should have to be laid aside owing to differences in preparation and without some proper substitute at hand.

Aqua ophthalmica. (L.) A variety of liquid applications for the eyes, i. e., "eyewaters," is included in this category.

Aqua ophthalmica adstringens. (L.) See **Aqua ophthalmica aluminosa** and **Collyrium adstringens zinci.**

Aqua ophthalmica alba. (L.) A mixture of 5 parts, each, of zinc sulphate and zinc oxide, 20 of tincture of opium, 40 of alcohol, and 1,000 of rose-water.

Aqua ophthalmica aluminosa. (L.) A preparation official in several old pharmacopeias, consisting of alum and water in varying proportions.

Aqua ophthalmica cærulea. (L.) Solutio cupri ammoniacalis.

Aqua ophthalmica Conradi. (L.) See **Collyrium ex hydrargyro muriatico corrosivo.**

Aqua ophthalmica fœniculata. An eyewash very popular throughout Germany for the various forms of chronic conjunctivitis, which consists of the tinctura and aqua fœniculi.

Aqua ophthalmica Lanfranci. (L.) See **Mixture cathérétique.**

Aqua ophthalmica mercurialis. (L.) Collyrium ex muriate hydrargyri oxygenato.

Aqua ophthalmica nigra. Lotio nigra. See **Black wash.**

Aqua ophthalmica nigra Graefi. (L.) A mixture of 3 parts of calomel, 5 of extract of hyoscyamus, 150 of rose-water, and 500 of lime-water.

Aqua ophthalmica Odhelii. (L.) See **Decoctum rutæ zincatum.**

Aqua ophthalmica pragensis. (L.) A mixture of 1 part zinc sulphate, 1 part of mucilage of gum arabic, and 50 parts each of rose-water and elder-flower-water.

Aqua ophthalmica resolvens. (L.) A preparation, official in the Hamburg Codex of 1835, containing 1 part of antimony and potassium tartrate, 60 parts of laudanum, and 240 of water.

Aqua ophthalmica Romerhauseni. (L.) Aqua ophthalmica fœniculata (q. v.).

Aqua ophthalmica Saturnii (seu saturnina). (L.) A mixture of 1 part of acetate of lead, 15 parts of mucilage of quince-seeds, and 240 of rose-water.

Aqua ophthalmica vitriolica. (L.) Collyrium astringens zinci.

Aqua plumbi P. G. See **Lead water.**

Aqua pura. See **Water.**

Aqua rosæ. Rose Water.

Aqua sambuci. See **Sambucus.**

Aqua saturnina. See **Lead water.**

Aqua sublimatis, P. G. Liquor hydrargyri perchlor. Sublimatlösung.

One of the most valuable solutions we possess in the treatment of external eye diseases.

In the P. Br. the solution of corrosive sublimate is a colorless liquid, with a strong metallic taste, containing half a grain of bichloride to the imperial fluid ounce. In Germany it is frequently employed as an antiseptic with other agents, as in the following:

℞

Scopolamini hydrobrom.	0.005-0.01 gm.
Cocainæ hydrochloratis	0.1 gm.
Atropinæ sulphatis	0.05 gm.
Aquæ sublimatis ($\frac{1}{5000}$)	5.0 c. c.

℞

Scopolamini hydrobrom.	0.005-0.01 gm.
Aquæ destillatæ (Or aquæ sublimatis, $\frac{1}{5000}$).	5.0

℞

Cocainæ hydrochloratis	0.1 gm. (gr. iss)
Aquæ destillatæ (Or aquæ sublimatis, $\frac{1}{5000}$).	5.0 c. c. (f℥i$\frac{1}{4}$).

℞

Atropinæ sulphatis	0.1 gm. (gr. iss)
Aquæ sublimatis ($\frac{1}{5000}$).	10.0 c. c. (f℥iiss).

Aqua zeozoni. This is a solution of a monoxyderivative of esculin (from the horse chestnut) and is the same agent as employed by Unna for the protection of the skin. It is also sold under the trade name of zeozon or ultrazeozon. It has recently been recommended in solution as a substitute for tinted glasses to relieve both normal and diseased eyes from the dazzling effects of ultra-violet rays. It accomplishes this end by staining the cornea. Ruhemann reports that instillations into the conjunctival sac three or four times daily cause no irritation or damage to the cornea even when used for months or a year; that such employment prevents continuously the dazzling effects of bright light, doing away with the necessity for wearing protective glasses, veils, etc., and preventing the disagreeable symptoms due to dazzling, such as head pressure, dizziness, headache, etc., when the pupils are widely dilated by atropine. He reports good results in 40 cases and concludes by saying that a 0.3 per cent. solution of aqua zeozoni is able to dissipate the dazzling caused by light which contains too many ultra-violet rays, especially sunlight, and in consequence is of great value in high altitudes, at sea, in blinding snowlight, and may therefore be used prophylactically in the different industries which use very bright light and cause electric ophthalmia, glass blowers' cataract, etc. It may be

necessary when working in very bright light to use a 0.5 per cent. solution.

The remedy is also valuable when diseased and inflamed eyes are to be saved from the dazzling and other noxious influences of ultra-violet light, as in various affections of the conjunctiva, iris, retina and in aphakia and opacities of the lens.

Alt has also experimented (*American Journal of Ophthalmology*, Sept., 1911) with this solution and although the time is too short to warrant a detailed report he is convinced of its value which by the absorption of the ultra-violet rays adds to the comfort of eyes in many instances.

Aqueous chamber. See **Chamber, Aqueous; Anterior chamber.**

Aqueous humor. The anterior or aqueous chamber is a lymph-space filled with a clear liquid, like distilled water. This fluid is secreted by the vessels of the uvea, especially of the ciliary body, and is quickly renewed when evacuated from the aqueous space that contains it. The humor is in constant movement within the anterior chamber, and this continual motion probably prevents deposits from forming on the walls of the anterior chamber. The drainage of the interior of the eye is involved in the lymph stream of which the aqueous forms a large part. Secreted mostly by the uveal body it collects in the anterior chamber and after a time leaves it by way of the sponge-like tissues of the spaces of Fontana and through the lymph-crypts of the iris. Its index of refraction—an important matter—is stated by Helmholtz to be 1.3365, that of distilled water being 1.33354. According to von Michel the aqueous of the pig contains 0.89 of inorganic matter; 0.107 of albumen; 0.293 of other organic substances, and of water 98.71.

The aqueous is a good solvent, as witness the test for belladonna poisoning. A drop of aqueous humor from the eye of a person poisoned by this drug, or by atropine, will dilate the normal pupil of a second subject.

According to Dwight, the tension of the eyeball is kept up mainly by the active secretion of the aqueous humor, and, as this tension amounts to the force exerted by a column of mercury twenty-six millimetres in height, it is not surprising that when the cornea is punctured the fluid should rush with some force towards the avenue of escape. This rush is, in fact, so great that it sweeps the iris with it: hence great care must be taken, in operations on the cornea, to prevent the iris from being carried into the lips of the wound and becoming incarcerated there. The decrease in the intra-ocular tension which necessarily occurs when the humor is evacuated causes

the blood to pour in increased quantity into the iris and the ciliary body, which greatly aids the transudation of fluid. See, also, **Anatomy of the eye.**

Aquo-capsulitis. See **Keratitis, Punctate.**

Arabic ophthalmology. See **History of ophthalmology.** Also, **Ali b. Isa; Ammar; As-Sadili.**

Arabs, Ophthalmology among the. See **Arabic ophthalmology.**

Arachis, Oil of. See **Oil of arachis.**

Arachnoidal sheath of the optic nerve. See **Anatomy.**

Arachnoidealschneide. (G.) The arachnoid sheath.

Arachnoid of the eye. An obsolete term for a serous membrane supposed to cover the cornea, iris, ciliary body, and choroid. It was applied to the supposed lining membrane of the lymph space between the choroid and sclera. Both the Arabian and the mediaeval Christian ophthalmologists applied this term also to the anterior capsule or surface of the crystalline lens. See **Lamina fusca.**

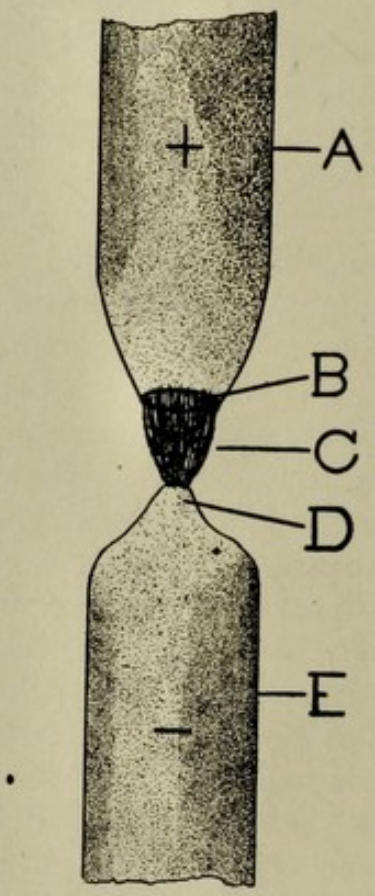
Aranzio, Giulielmo Caesare. (1530-1589). He was a pupil of Maggi, and Professor of Anatomy and Medicine at Bologna. He discovered, or at all events first accurately described, the pes hippocampus. He undoubtedly discovered the coracobrachialis muscle, the foramen ovale, the ductus arteriosus, and the corpora Arantii. In our special field, he discovered the levator palpebræ superioris muscle, and, it is sometimes said, the retinal image. As to this latter averment, however, there is much doubt. Aranzio's experiment was this: In the posterior wall of an ox's eye, he cut a hole of the width of the optic nerve. Then, in a dark room, he turned this hole (which extended as far as the vitreous humor) toward a student, then struck a light, and, holding the flame exactly before the pupil of the eye, he directed the student to look with one eye into the artificial opening. The student, so doing, did not even profess to behold the retinal image, but (it would seem) only the upright flame itself, through the pupil and the cornea.—(T. H. S.)

Arbeitersschutzbrillen. (G.). Protective spectacles for workmen.

Arc. Any part of a curved line.

Arc lights and their effect on the eye. Arc lighting is the term used to describe artificial lighting by means of lamps in which the light is obtained from the electric arc. Imitations of the electric arc lamp, also called arc lamps by their manufacturers and promoters, are in common use, as for example the "gas arc," consisting of a cluster of gas burners which somewhat resemble the electric arc lamp in exterior appearance and quantity of light.

When an electric circuit carrying sufficient electric current (amperes) and pressure (volts) is opened or interrupted, and if the opening is short, the current continues to flow across this opening, forming what is known as the electric arc and producing an intense light. The points between which the electric arc flows are called



Open Carbon Arc Lamp

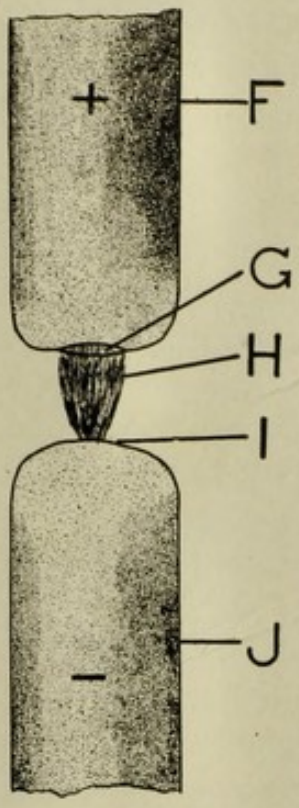
A—Positive carbon.
B—Positive crater of boiling carbon from which most of the light is emitted.
C—The arc, which is a distinct flame and is surrounded by a burning carbon flame.
D—White-hot tip of negative carbon, also source of considerable light.
E—Negative carbon.

electrodes. In the early experiments with the electric arc these electrodes were mounted horizontally with the result that the heat of the arc caused rising air currents which carried the flame of the arc upward and made it assume the shape of the arc of a circle. Hence the name of electric arc was applied to it and has been used ever since to describe all phenomena where electric current flows across a gaseous space between two electrodes in sufficient quantity so that it is something more than merely a series of spark discharges.

The electric arc produces such intense heat that electrodes of metal are both melted and vaporized. For this reason electrodes of carbon in the form of pencils were employed in earlier commercial arc

lamps and are still in extensive use. Carbon electrodes are used because they do not melt, and burn without objectionable fumes.

The electric arc lamp in its various forms is a very useful illuminant if properly equipped, properly placed and properly main-



Enclosed Carbon Arc in Which the Arc is Enclosed by a Small Glass Globe Preventing Rapid Combustion of the Carbon Tips

F—Positive carbon.
G—Crater from which most of the light is emitted. This shifts from time to time around the tip of the carbon, causing light fluctuations.
H—Arc flame.
I—Hot tip of negative carbon.

Note that the ends of both carbons are blunt because of the restriction of combustion due to the enclosing globe. This bluntness also interferes with the emission of light and renders the enclosed arc less efficient as a light producer than the open arc.

tained. It has, however, some characteristics which may render it a very unsatisfactory source of illumination if proper precautions are not taken. In order that the difficulties may be understood, it is necessary to describe briefly the characteristics of the different forms of arc lamp now in common use.

Open carbon arcs. Open carbon arc lamps (See figure) maintain the arc between pure carbon electrodes with a free, unobstructed circulation of air around the arc, except that there is usually a single globe to protect the arc from the wind and to diffuse or

soften the light when used indoors. As the tips of the carbon electrodes burn away the carbons are fed together by a machine that operates automatically by means of electro-magnets. These release a clutch or clockwork mechanism allowing the carbons to feed together. Such open arc lamps usually give a very unsteady light. The arc wanders somewhat around the ends of the carbon tips. The feeding mechanism never gives a perfect feed and currents of air have some effect on the arc, all tending to create unsteadiness.

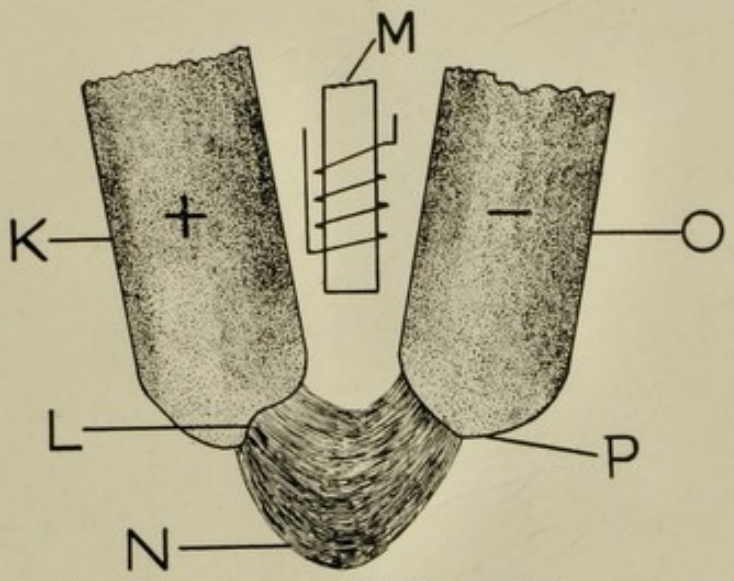
Enclosed carbon arc lamps. In this improvement over the open carbon arc lamp, (See figure) there is a glass globe around the arc which is tightly enough closed to keep the free oxygen of the air away from the arc. This prolongs the life of the carbons and reduces the expense of trimming or putting in new ones. It also tends to make a steadier light without the frequent fluctuations of the open arc; nevertheless it is subject to considerable variation from one hour to another, as the arc wanders around the ends of the carbons.

The *intensified arc,* is a modification of the enclosed arc lamp, has recently been used to a limited extent for interior lighting where it is desirable to have light of a color resembling daylight. The principal difference between the intensified arc lamp and the older types of enclosed carbon arc lamps is in the use of much smaller carbons for a given current. This results in a steadier and more efficient light, because the light-giving carbon tips or craters (from which most of the light comes in a common arc lamp) are not shielded and do not have their heat conducted away by the mass of surrounding carbon, as they do when larger carbon pencils are used.

Arc lamps using pure carbons are at present writing being rapidly driven out of use because the tungsten incandescent electric lamp offers a steadier and more economic source of light. Previous to the introduction of the tungsten lamp, carbon arcs were used in constantly increasing numbers where large lamps were wanted because they were more economical than incandescent electric lamps.

Flame-arc lamp using impregnated carbons. In this lamp carbons are used containing certain salts which give a large increase in the amount of light given by the arc. In the open and enclosed carbon arcs before described, most of the light comes from the intensely

heated carbon tips and a relatively small percentage from the flame of the arc. In the flame-arc lamp with impregnated carbons, the flame of the arc is the chief source of the light. These flame arc lamps are made in various forms, some with vertical electrodes and others with electrodes inclined at an angle and pointing downward, as in the figure. In the latter case the flame which would naturally rise in the form of an arc by the force of the heated air



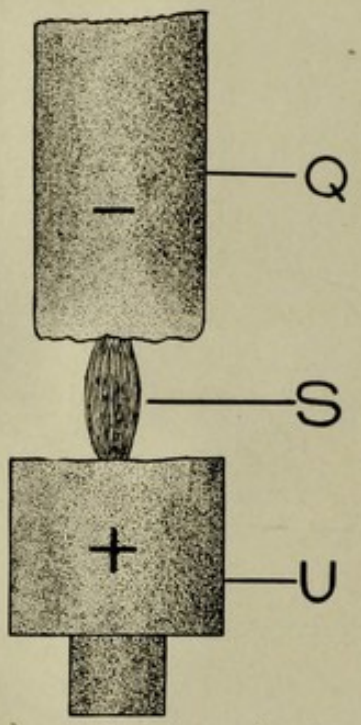
Flame-Arc with Impregnated Carbons. Inclined Carbon Type

K—Positive carbon.
L—Positive crater.
M—Electro-magnet to deflect the arc downward and keep the arc-flame in good position to emit light.
N—Flame of arc, which in this type of lamp is the principal source of light, due to salts impregnated in carbons.
O—Negative carbon.
P—Negative tip.

currents, is blown or deflected downward by a magnet placed just above the arc. The color of the light from these flame-arc lamps depends on the kind of material used in impregnating the carbons. That most commonly used gives it a yellow tinge. Such arcs are likely to be rather unsteady on account of their flaming character. In some cases the arc is so enclosed that it prolongs the life of the electrodes. These flame-arc lamps as ordinarily used are of much higher candlepower than the ordinary carbon arcs. On account of their fumes they are not suited to some kinds of interior lighting.

Luminous-arc lamps with electrodes of metallic salts. In the luminous-arc lamp the electrodes usually consist of one relatively heavy metallic electrode, which is consumed very slowly, and one made from metallic salts or oxides. In the luminous arcs now in most

common use (see the figure) the positive electrode is a piece of copper while the negative is a steel tube filled with black magnetic oxide of iron, called magnetite. Such arcs are commonly known as magnetite arcs. Much of the light in these is obtained from the luminous-arc flame caused by the magnetite electrode. The light from such lamps shows sudden fluctuations due to the shifting of the flame of the arc from one side to another. They also give off fumes and are therefore used mainly for outdoor lighting and the



Luminous Arc

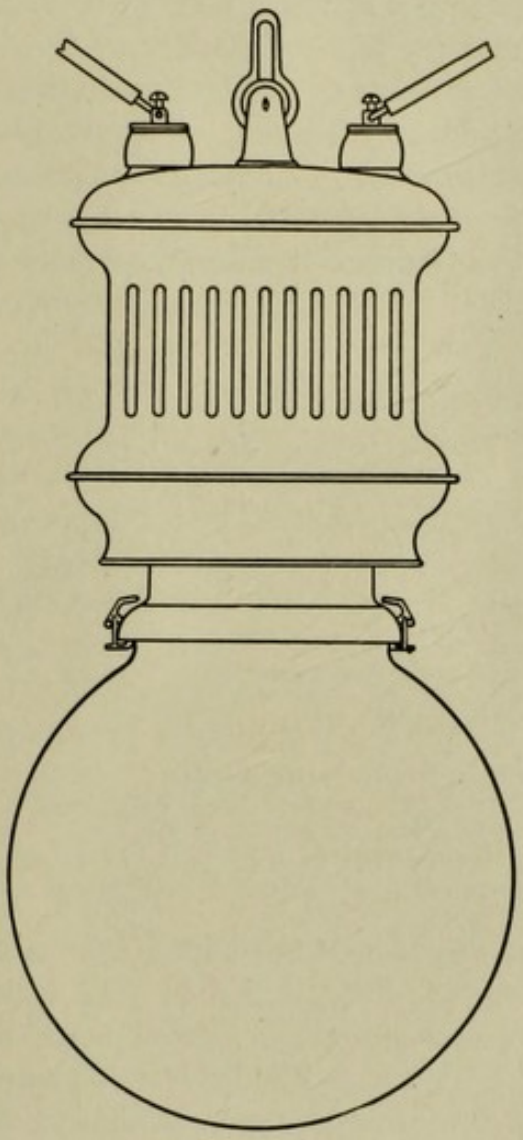
Q—Negative electrode consisting of sheet steel tube filled with magnitite (black magnetic oxide of iron) and other metallic oxides.
U—Heavy copper electrode kept cool by its size and radiating surfaces.
S—Arc flame which is principal source of light due to the peculiar characteristics of the metallic oxides used in negative electrode "Q."

illumination of such large interiors as foundries and machine shops.

The general external appearance of electric arc lamps, already described, varies considerably with the different types and makes, but generally consist of a lower globe (see the figure) surrounding the arc and supported from a case which contains the mechanism for automatically feeding both electrodes at the proper rate. In flame-arc lamps provision must be made for either carrying away the fumes or, if the arc is of the enclosed type to condense the fumes in some unobjectionable place where they will interfere least with the cleanliness of the globes.

Mercury-vapor arc lamps. With these lamps an arc is maintained

through the vapor of mercury confined in a long tube. A mercury-vapor tube lamp, as shown in the illustration, consists of a glass tube, from which the air has been exhausted to a high vacuum, and electrodes at each end of the tube between which the current passes

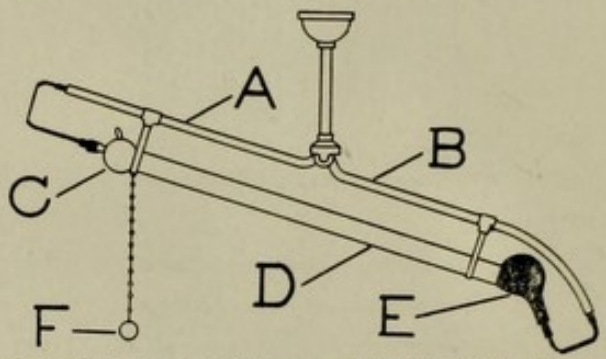


Typical Electric Arc Lamp; Electro-Magnetic Feeding Mechanism in Upper Case, Underneath Which is a Globe Surrounding the Arc.

when the mercury-vapor arc is formed. The lower electrode consists of mercury in a small bulb. To start the arc a high voltage discharge is passed between the electrodes, or the lamp is tipped to allow the mercury to make a momentary contact between the electrodes. In either event sufficient mercury is vaporized to allow the electric current to pass through the mercury vapor and form a mercury vapor arc through the tube. This mercury vapor arc fills the tube and gives a greenish light in which there is an entire

absence of red rays so that red objects under this light appear black or violet. Mercury vapor arcs in quartz tubes may be operated at higher temperature than glass will permit. They furnish a light more nearly white, although of a decidedly greenish tinge. The light from mercury-vapor lamps, when the mercury bulb is concealed as in commercial lamps, is very steady.

As to the effect on the eyes of these various lamps, it will be seen from the foregoing description that all of the lamps except the mercury vapor arc are inherently unsteady. This makes them undesirable for use where close work, such as writing or reading, is to be performed. The less detailed the work the more opportunity for em-



Mercury-Vapor Arc Lamp with Straight Glass Tube

AB—Form for supporting tube.
C—Upper electrode.
D—Glass tube in which mercury vapor arc is formed.
E—Lower electrode with bulb partly filled with metallic mercury from which the mercury vapor is obtained to form the arc.
F—Chain to pull for tilting tube to start lamp by allowing mercury to flow and establish a circuit from one electrode to the other.

ploying an unsteady light without particular damage to the eyesight. The enclosed-carbon arc lamp, when in good condition and supplied with a steady source of current, is the least objectionable of the first three types mentioned for interior illumination. Flickering and unsteadiness, of course, brings constant work on the muscles of the eye, which if too long continued, at frequent intervals causes eye strain and nerve tire.

Another characteristic of the three types of arc lamps which should have serious consideration as to its effect on the eye is the glare which is received from the arc if it is not properly enclosed with a diffusing globe of opal glass. Such diffusing globes have the effect of spreading out a source of light so that the discomfort of looking at it is reduced.

Arc lamps being the most powerful illuminants used and the arc being the most concentrated form of artificial light the danger to the eyes directly exposed to them is greater than with most other

illuminants. When used for interior lighting they should be placed high, out of the ordinary range of vision, and equipped with opal diffusing globes, unless an indirect system of lighting is employed, in which latter case the light is reflected to the ceiling and thence down into the room, so that no direct light from the lamp reaches the eyes.

Temporary damage to the eyes is almost sure to result from continuous looking at, or even facing at close range, common commercial arc lamps; while permanent damage to the ocular apparatus has frequently been caused by powerful (accidental) arcs or flashes forming about power house switchboards and other places where heavy electric currents are handléd. (See **Injuries to the eye.**)

The mercury-arc lamp is, however, a very different illuminant from other arc lamps. The light being distributed evenly through the tube, it is comparatively easy on the eyes. The chief objection is its color, which makes all reds appear as violet or black, and gives a ghastly appearance to persons. There are places, however, where the color is not an objection and the economy of this lamp has frequently made it possible to secure better illumination for working purposes than would have been furnished with other illuminants at a cost which the user would pay. There has been much speculation as to whether the unusual color of this light would not have some bad effect on the eyes of those working under it, but as yet none has been detected and reliably reported after nine years of use.

Dr. Louis Bell of Boston, as a result of extensive experiments, has reached the conclusion that with the mercury-vapor light visual acuity is better and the perception of detail easier on black and white surfaces than with other common artificial illuminants. This is ascribed to the mercury-vapor light being more nearly monochromatic than others, so that there is less chromatic abberation in the optical system of the eye. M. Luckiesh of Cleveland, on following up this investigation with others along the same line, confirms Bell's conclusions.

As there are some ultra-violet rays in the spectrum of the mercury vapor arc, it is always wise to have glass between such arcs and the eye. This is accomplished by the tube in itself in the case of the low-temperature arcs now most commonly used in the United States. Where high-temperature arcs in quartz tubes are used, a glass outer globe should be employed. The danger of such ultra-violet rays even without the glass globe has however, been much over estimated, as has been shown both by Bell and Luckiesh.

Powerful electric arcs are now in common use for various industrial processes requiring intense heat; these processes include electric welding, electric furnace work and the burning or melting of steel work with the electric arc. In all of these processes it is very important to protect the eyes of the workman from the direct rays of such powerful arcs. This is usually best done by a helmet or box placed over the head, with plenty of ventilating space at top and bottom. The workman looks out through a window of dark glass in the front of the helmet and in order to be of much practical use the glass must be so dark that little can be seen through it under ordinary daylight conditions. Ordinary dark glasses are insufficient unless they are of several thicknesses, and even then there is risk that the workman will look over or under them at the arc. Strange as it may seem, it is possible for a man working with arcs of considerable magnitude to become accustomed in a few minutes to the powerful light, so that looking directly at the arc is possible without serious discomfort at the time. Herein lies the chief danger of such operations, because there is occasionally a strong temptation to look at the arc without the intervention of dark glasses because the dark glass is a hindrance to seeing some parts of the work. Care should also be taken in all such work that the arc is shielded from the eyes of nearby workmen or curious visitors who may be damaged by looking at such arcs without realizing the risk. Such temporary exposures to the direct light of these powerful industrial arcs, unless very brief, is almost certain to be followed after several hours by intense pricking and stinging pains in the eyes.—(J. R. C.)

The action of the direct rays of the sun and of a powerful electric light is at first a thermic change of the outer portions of the retina later followed by chemical and atrophic changes which destroy the finer structures of the rods and cones, with resultant atrophy, even to the percipient cells of the brain. The thermic and light rays also cause disturbances of function, from opacities of the cornea or media to destruction of the retinal cells, the fibres of the optic nerves and tracts, and atrophy of the visual centers. (Parsons.)

Schanz and Stockhausen show that ultra-violet rays in artificial lights produce erythropsy and electric ophthalmia. There is a tendency to constantly increase the intensity of the light by the amount of ultra-violet rays, and the injurious effect of artificial light is also increased. Common glass, out of which eye-glasses and lamp globes are made, absorb only the very short rays (0-300 u.u.); these rays, however, do not penetrate the eye; they produce only irritation of the external parts of the eye. Rays of 300-350 u.u. in length are

absorbed by the lens; rays 350-400 u.u. long cause fluorescence of the lens and reach the retina.

The above mentioned authors were able to make a glass (euphos-glass) which absorbed all ultra-violet rays up to 400 u.u. and the visible spectrum became dimmer only 5 per cent. Their investigations show that the greatest amount of light that the human eye can stand is a surface brightness of 0.75 of a Hefner candle to the square centimeter.

Experimenting with the ultra-violet or chemic rays, Stroebel found that the media of the eye allow them free passage. It is possible with them to induce a circumscribed inflammation of the retina. Under their influence the iris became hyperemic, inflamed and pigmented, but it is stated that the iris is able to exclude their influence from the deeper tissues.

C. Hess tried the effect of the uviol lamp upon the lens and found degenerative changes in the epithelium of the lens capsule, with proliferation of the cells near the equator. These changes were observed in frogs, rabbits, guinea-pigs, and monkeys. While the degenerative changes did not set in more rapidly in the warm-blooded animals than in the cold-blooded ones, in the former they seemed to be followed by more active proliferation of the cells. The author discusses the bearings which these observations have upon the etiology of glass-blowers' cataract. He thinks it possible that the long exposure of the eyes of these men to rays of short-wave length leads to degeneration and proliferation of the cells of the lens capsule; that ultimately the regenerative changes are not able to keep pace with the degenerative processes, and so cataract formation begins. He observed that the changes described above did not appear when an ordinary sheet of glass was placed between the animal and the lamp, and so he suggested that glass-blowers' cataract might be prevented by suitable spectacles.

Birch-Hirschfeld opposes the statement of Best, that the ultra-violet rays of our artificial sources of light are perfectly irrevelant for the eye, and maintains that, besides the luminous, the ultra-violet rays may injure the retina, not only in intensities which can only be employed in experiments, but also under ordinary conditions. The smoke-colored coquilles are sufficient for most practical purposes, but not the little blue ones, which Best ranks in the same order, not only because their absorption of short-waved rays is less than that of the smoke-colored, but also because they transmit the very active luminous blue rays. He says the authors who attribute senile cataract to the detrimental influence of ultra-violet light go

much too far, lacking any proof. The etiological part of ultra-violet rays in inflammations of the anterior segment of the eye (ophthalmia electrica) is undoubted. For the disturbances of the retina (central and peri-central scotomas, impairment of color sense), through glaring by lightning, short circuit, arc light, light of mercurial vapors, etc., besides the ultra-violet rays between 400, 350, and 330 mm., the violet and blue rays play a part, as well as in erythropsia. Against this former opinion Birch-Hirschfeld opposes quite another view, that only the ultra-violet rays be detrimental to the eye.

Randolph (*Ophthalmic Record*, VI, pp. 322, 323) reminds us that in 1888 Terrien reported a number of cases of intense inflammation of the conjunctiva, together with great swelling of the lids and profuse lachrymation in those who worked at electric experimentation. Then Terrien spoke of the affection as electric ophthalmia (*l'ophtalmie electrique*) and he made his report to the Surgical Society of Paris in December, 1887. His observations have been confirmed by Rockliff and Emrys-Jones, both of whom report cases of the so-called electric ophthalmia. Maklakoff, of Moscow, in 1889 reported a number of cases where electric light of great intensity had produced not only severe eye symptoms but also an eruption upon the exposed portions of the body, as the hands and face, in workmen in a large factory near Moscow. All these observers were able to demonstrate the fact that the injurious effects were produced by the luminous and the chemical rays and that the heat rays played no part. This latter is an important point, as showing that it is the peculiar illuminating quality of the electric light to which injurious effects are to be attributed. So much for the effect of the electric light at short range. Some few cases are recorded where the retina has been seriously and permanently injured by exposure to the arc light located farther off than in the class of cases just mentioned, but there is nothing in the literature of the subject which bears exactly upon the point under discussion, namely, as to whether the arc light at a railway crossing is a source of danger to those at the crossing.

That the effect of such a light is trying to the eyes, there is no difference of opinion among ophthalmologists. The arc light is not only too intense a light, but too white a light, and is more like lightning. The effect of such a light upon the retina is to exhaust it and to blunt its sensibility, and after the exposure of the eye to such a light and until the retina has recovered from the effects of the powerful stimulus, the person will not get correct impressions (i.e., as to distance and character) of other objects and particularly of

less luminous objects, as for instance of the headlight on an approaching locomotive. According to the observations of Fullerton and Cattell, when two lights of equal intensity are viewed in succession the second light appears the fainter. How much more intensified this effect would be when the first light excelled the second in luminosity, or, in other words, when the transition is from the arc light to the headlight! One can understand for oneself what this means by looking at an arc light for a few moments and then turning away and trying to take in surrounding objects. The latter will appear very indistinct. The period during which the retina is recovering from the effect of the light is known as the period of adaptation, and it is evident that during this period (of variable length) a person would be poorly equipped to avoid an approaching danger which under other circumstances is promptly appreciated. This is what happens to some degree when the arc light shines directly into the eyes of the street traveler, as it would undoubtedly do if placed at a crossing. Bicyclists are constantly complaining of the uncertainty of traveling along roads lit by arc lights, and complaints are not wanting to show that the light on the Statue of Liberty, instead of rendering objects clearer in New York harbor, has rather the opposite effect and so dazzles the eyes of the pilots (in other words, exhausts the sensibility of the retina) that lesser lights, as signals, are seen imperfectly. Some years ago a cluster of powerful arc lamps was suspended at Hell Gate, at the instance of the Sound steamer lines. This light was intended to aid in navigating the crooked and dangerous channel in that vicinity, and it was hoped that it would approximate to daylight conditions by lighting up the whole area of the water. The navigators, however, found that the light was a distinct disadvantage and they pronounced it a failure, and it was abandoned.

Widmark has shown by numerous experiments that disturbances in the eye due to intense light are caused by the ultra-violet rays acting upon the fixed elements of the anterior part of the eye. This does not include the influence of direct sunlight upon the retina and choroid. These rays are largely intercepted by the sclera and entirely absorbed by the iris. Of the transparent media the lens absorbs a large proportion. The dark heat-rays are especially absorbed by the fluids of the eye; perhaps, partly, by the cornea. They have but little influence on the ocular tissues.

It would seem from all this that the electric light under certain conditions produces structural changes in the eyes, these changes showing themselves in inflammation. Under other conditions the

effect of the light is manifested chiefly in subjective symptoms known as dazzling and retinal exhaustion, causing the person to see indistinctly less luminous objects, and it is quite reasonable to conclude that these last conditions exist in some degree in the case of the street traveler at the railway crossing lit by the arc light, so that such a light in such a location might prove a source of danger to those at the crossing.

Of course prevention is better than cure in this important matter. Workmen and others exposed to the intense glare of electric furnaces and other sources of high-power, violet-rayed light should wear deep-tinted amber (q.v.) or euphos (q.v.) lenses, while the lights themselves, or the "peep-holes" that reach them, should be guarded by similarly colored glass.

Inasmuch as yellow or amber tints interfere with the definition in the "open hearth" and other processes a deep-blue glass is preferred; the amber tint is satisfactory for Bessemer and some other processes, that depend largely on flame changes.

There is no specific treatment for the ocular lesions produced by high-power lights; rest, atropia, dark tinted lenses, and soothing (local) applications, are commonly prescribed.

Archigenes. A distinguished Roman eclectic physician, who was born at Apamea, A. D. 48, and died in the Eternal City in 117. He seems to have passed most of his life at Rome, for he is often mentioned by the satirist Juvenal. His writings undoubtedly exercised a great and lasting influence over Galen (A. D. 131-210) the greatest physician of antiquity after Hippocrates. As an ophthalmologist he is not of much importance, for his only writing on the eye is a brief section on ophthalmic remedies in a work on materia medica.—(T. H. S.)

Architecture of school-buildings. See **Hygiene of the eye,** and **School hygiene, Ocular relations of.**

Arch, Orbital. The superior margin of the orbit.

Arco senile della cornea. (It.) The arcus senilis.

Arcus juvenilis. A congenial opacity of the cornea, also called *sclerophthalmos,* and *macula arcuata.* It is generally within the clear cornea and is usually associated with other ocular defects.

Arcus senilis. The degenerative band that forms, generally in elderly people, around the upper half of the sclero-corneal ring. It is occasionally seen in young adults and may (but rarely) affect the whole circumference of the cornea.

Arcus senilis der Cornea. (G.) Arcus senilis of the eye.

Arcus tarseus inferior. (L.) A blood-vessel lying between the tarsal cartilage and the orbicularis muscle on the free border of the lower

eyelid. It is formed by a branch of the inferior palpebral artery and the palpebral branch of the nasal artery. See **Anatomy of the eye.**

Arcus tarseus superior. (L.) Anastomosing branch of the superior palpebral artery with the palpebral branch of the lachrymal artery. See **Anatomy of the eye.**

Ardi-Nana. Physician to Esarhaddon, king of Assyria, who reigned B. C. 681-668. Two of the letters of this very ancient ophthalmologist (both directed to the king) are still extant. The more interesting runs as follows:

"To the king, my lord, thy servant, Ardi-Nana. May it be peace in the highest degree to the king, my lord; may Ninip and Gula give cheer of heart and health of body to the king, my lord. It is extremely well with that poor man whose eyes are diseased. I had applied a dressing to him; it covered his face. Yesterday, at evening, I undid the bandage which held it, I removed the dressing which was upon him. There was pus upon the dressing as much as the tip of the little finger. Thy gods, if any of them has put his hand to the matter, he has indeed given his order. It is extremely well. Let the heart of the king, my lord, be cheered. In seven or eight days he will be well."

Ninip and Gula were the Assyrian gods of healing.—(T. H. S.)

Area centralis. (L.). According to Mueller, the area centralis is that part of the retina where, during the period of development, the formation and differentiation of rods and cones first takes place and where the further differentiation of the retinal layers occurs. The area centralis of man forms in the 17th week; and its center, the fovea centralis,—without any relation to the choroid fissure—appears during the 8th month. This area has been found in almost all vertebrates; its absence determines the absence of the fovea centralis. The area centralis of birds often appears double, or even triple in some species.

Area, Macular. That part of the retina most sensitive to light and form impressions. See **Histology of the eye.**

Area Martegiana. The region of dilation of the posterior segment of the hyaloid canal in the vitreous humor of human fetal existence, and in many mammals during adult life.

Area of critical definition. That portion of an optical image within which details are clearly defined.

Area, Visual, of the cerebral cortex. See **Intracranial portion of the visual apparatus.**

Arecaidinethyl ester. See **Homoarecoline.**

Arecaine. One of the inactive alkaloids from *Arecha catechu*—the betel-

nut. The miotic, *arecoline* (q. v.), is derived from this same tall, East Indian palm.

Arecoline. This is a poisonous, miotic alkaloid derived from the areca nut—Arecha catechu (betel-nut), a tall, East Indian palm. In its general action arecoline somewhat resembles pilocarpine. It was prepared as a hydrobromide ($C_8H_{13}NO_2HBr$) by Merck in 1894. It occurs in the form of colorless, acicular prisms readily soluble in water and alcohol; slightly in ether and chloroform. The areca nut also contains three other alkaloids—pelletierine, arecaine and guvacine—but only arecoline seems active. It is used as an eyewater in 1 per cent. solution.

According to Lavagua, a drop of 1 per cent. solution of the hydrobromate produces a maximal miosis in 10 minutes, which decreases after 15 minutes, and disappears in 45 minutes. Arecolin is easily sterilized, does not produce headache or pains in the eye, and in cases where eserin is not tolerated, it may replace the latter.

The observations of Lewin and Guillery show that one drop of a watery one per cent. solution of the hydrobromate causes a feeling of warmth in the eye, lachrymation, and blepharospasm, but this discomfort lasts only for a minute. A hyperemia of the bulbar conjunctiva and a slight pericorneal injection then follow—signs that disappear in a few minutes. About two minutes later there occurs (as the result of clonic contractions of the iris muscle) contraction of the pupil. This is noticeable after 5 minutes, reaches its maximum after 10 minutes, and lasts 25 to 30 minutes. These changes are accompanied by more or less macropsia (q.v.).

A one-half per cent. arecoline hydrobromate solution affects the pupil and the accommodation almost as much as a one per cent. solution. Without preliminary ciliary or conjunctival injection and after a transient pricking and itching there occurs (in 2 to 3 minutes) a contraction of the pupil, which reaches its maximum in 10 to 12 minutes, lasts about 30 minutes, and then disappears.

Although the pupil dilated by atropine is said not to be contracted by arecoline, yet the reverse does not hold.

Arecoline acts on the ciliary muscle in much the same way in individuals with various refractive errors. The ciliary contraction always precedes that of the iris, just as with physostigmine; but arecoline acts more rapidly than eserine, and its action lasts a shorter time. The near-point draws nearer to the extent of from 3 to 5 D. This limitation of accommodation disappears in about an hour.

The intraocular pressure tension is lowered by arecoline so that in the treatment of glaucoma it may on occasions replace physostigmine;

indeed, in some patients it produced miosis where physostigmine had failed.

Arecoline-eserine. This is a mixture (Merck) of equal parts of arecoline hydrobromide and physostigmine (eserine) sulphate. The combined action of these two miotics is greater than either of them exhibited separately.

Areolar choroiditis. This disease is sometimes called "Foerster's choroiditis," from the name of the ophthalmologist who first described it. It occurs in the form of bilateral changes in the macular region and the disk which consists of well defined, mostly discrete, punched-out, round patches of choroidal atrophy, rather larger than the papilla. They are closely disposed, and sometimes coalesce. The atrophy of the choroid within the affected patches is usually complete, showing the whitish filamentous sclera, occasionally bordered with a narrow margin of coal-black pigment.

Argamblyopia. Weakness of vision from disuse of the eye.

Arganon. A white powder said to contain 4 per cent. of silver casein, soluble in hot water. It is used locally as an antiseptic and astringent. The ordinary strength of the aqueous solution, employed especially in mucopurulent discharge from the eye, is 2 per cent. gradually increased to 10 per cent.

Arganon, New. This is a light-yellowish powder slightly soluble but quite stable in water. It contains about the same percentage of silver as arganon (q. v.) and is employed in strengths of from $\frac{1}{500}$ to $\frac{1}{200}$ in purulent and mucopurulent conjunctivitis.

Argema. (L.), n. Obsolete name for a white spot appearing at the margin of the cornea, as the result of a phlyctenular ulcer.

Argenol. An argentic albuminoid containing about 10 per cent. of metallic silver. It is found as brown crystals, easily soluble in water and glycerine. As a substitute for the nitrate it is by some observers preferred when silver compounds are ordered. The usual aqueous solution employed is from 1 to 10 per cent.

Argentamine. LIQUOR ARGENTAMINI. This is a colorless 8 per cent. solution of silver nitrate or phosphate in a 15 per cent. solution of ethylenediamine, and corresponds to a 10 per cent. solution of the silver salt. It is astringent and antiseptic, like other silver salts, but is said to be less irritating and more penetrating than the nitrate and is used wherever it is indicated.

Daxenberger was one of the earliest ophthalmologists to advise its use. He commends it in all cases of conjunctivitis, brushing a 5 to 10 per cent. solution over the everted lids. In addition to this a 3 per cent. solution is to be instilled. The writer prefers it in ophthalmia neonatorum; also in 3 per cent. solution as a prophylactic.

He considers its value to be due to the fact that its bactericidal action is upon the sub-conjunctival tissues; that it is not superficial in action like most other silver salts.

Argentation. Argyria or argyrosis (q. v.).

Argentea. In comparative anatomy (q. v.) the silvery or more generally, the green and gold iridescent membrane that, in the eyes of fishes (see **Fishes, Eyes of**) lies external to the choroid and internal to the supra-choroid lymph space. It sometimes covers the whole interior of the globe.

Argentic acetate. See **Silver acetate.**

Argento (nitrato di). (It.) Silver nitrate.

Argentol. Silver quinaseptalate. Silver oxiquinoline-sulphonate. This agent is a yellow powder, sparingly soluble in water and alcohol, and readily affected by light. It is recommended, in $\frac{1}{1000}$ to $\frac{1}{300}$ solutions, in purulent diseases and catarrh of the conjunctiva.

Argentose. A soluble compound of silver and a nucleoproteid, containing 30 per cent. of the former. It is an effective germicide and is used like silver nitrate in acute conjunctivitis and as a prophylactic in ophthalmia neonatorum.

Argentum colloidale. Collargol. Argentum credé. Argentum solubile. An allotropic form of silver, said to consist of 86 parts of metallic silver, some silver oxide, and albumen. It is made by the action of sodium citrate and ferrous sulphate on nitrate of silver. Collargol occurs as black, scale-like pieces, soluble in twenty parts of water. It has been used in blennorrhœa neonatorum and other infective processes, but its chief use is in the preparation of Credé's ointment which is composed of collargol 15 parts, water 5 parts, white wax 10 parts and benzoated lard 70 parts. In ophthalmic surgery it is a valuable antiseptic counterirritant, to be applied as a poultice to the lids in most serious cases of intraocular inflammation. The ointment is smeared on the closed lids and eyebrows at night, a bandage is applied and the greasy mixture washed off with warm water in the morning. This application may be repeated many times without producing any serious abrasion or other lesion of the skin and without impairing its analgesic counterirritant and resolvent action.

Argentum Credé. See **Argentum colloidale.**

Argentum solubile. See **Argentum colloidale.**

Argilla. White clay. Kaolin. Bolus alba. China clay. Terra sigillata, turica sive lemnia. White clay consists essentially of aluminum silicate, being mostly a decomposition product of felspar. It sometimes contains silicate of iron, which, when present in considerable quantities, makes with the former *bolus rubra, bolus*

armena, or red clay. Argilla forms earthy clumps which with water are transformed into a paste. It is prepared for pharmaceutical purposes by treatment with hydric chloride and washing out sand. Until a few years ago, it was employed as an excipient in pills, in toothpowder, powder for moist eczemas, and for baths. In popular medicine it is often employed in the treatment of swellings, eczema and wounds. In 1898, Julius Stumpf directed the attention of the profession to its strongly drying properties, as well as to its antiseptic and deodorizing qualities. Megele confirmed Stumpf's reports. Wolffberg subsequently recommended a formalin-argilla-paste for advanced cases of serpent ulcer of the cornea and in the gonorrheal conjunctivitis of adults. If used alone, the bolus alba should be heated to 150° C. to sterilize it and at the same time to increase its desiccating properties. An admixture of 5 drops of 1 per cent. formalin with five to ten grams of argilla gives one a highly antiseptic paste which impregnates ulcerated corneal tissues and intimately covers and disinfects a conjunctiva poisoned by gonorrhea. According to Wolffberg this paste is not only of therapeutic but also of diagnostic value. Although it spreads out like thick cream and is soon washed out by the tears when applied to the healthy conjunctiva, it adheres like a membrane to the gonorrheal eye, as long as the infection remains. It gives notice, after a fashion, of a probable implication of the cornea when it adheres to the tissues at the limbus. If the case is a light one, or when recovery begins, the membrane is removed in toto and without difficulty, although not as easily as in the normal eye to which it does not adhere at all. It is better to prepare the paste fresh for each case and vary its consistency by diluting it more or less according to the character and progress of the case.

White clay is also used in v. Bruns' and Herrnheiser's *Airol* (q. v.) paste.—(*Encyklopädie der Augenheilkunde.*)

Argin. This is one of the less known substitutes for silver nitrate and contains about ten per cent. of metallic silver combined with protalbin. It is generally used in ten per cent. watery solution for the same ophthalmic purposes as other soluble argentic salts. If applied to the eye for protracted periods it may set up an argyrosis of the conjunctiva.

Argirosi. (It.) Argyrosis.

Argonin. SILVER SODIO-CASEINATE. Prepared by adding silver nitrate to the sodium compound of casein. It is a fine white powder, containing about 4 per cent. of silver and is but slightly soluble in water.

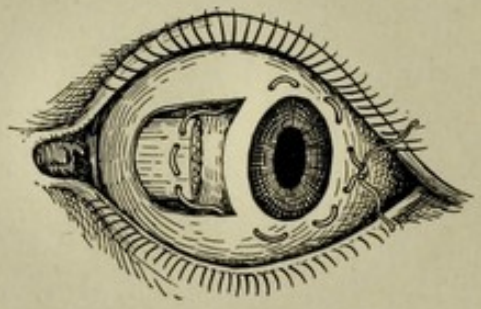
Like argentamine (q. v.) it penetrates more deeply than silver

nitrate and does not coagulate the albumen. In ophthalmia neonatorum and allied diseases it is used in 3 per cent. solutions; smaller quantities in milder infections of the conjunctiva where silver nitrate is indicated.

According to Snellen argonin l. (lösliches argonin), a newer preparation freely soluble in water, is found as a light-yellow powder and contains 10 per cent. of metallic silver. According to Sellink it is markedly bactericidal.

E. C. Ellett, Trester Smith, Horace Bigelow and others have reported the satisfactory employment of this agent, in 5 and 10 per cent. solutions, instead of silver nitrate in the treatment of purulent ophthalmia—especially in gonococcal infections. The last-named observer believes that its easy solubility, deep penetration of the tissues, germicidal qualities and the fact that strong solutions do not require neutralization make it an ideal remedy in the treatment of both infantile and adult gonorrheal ophthalmia.

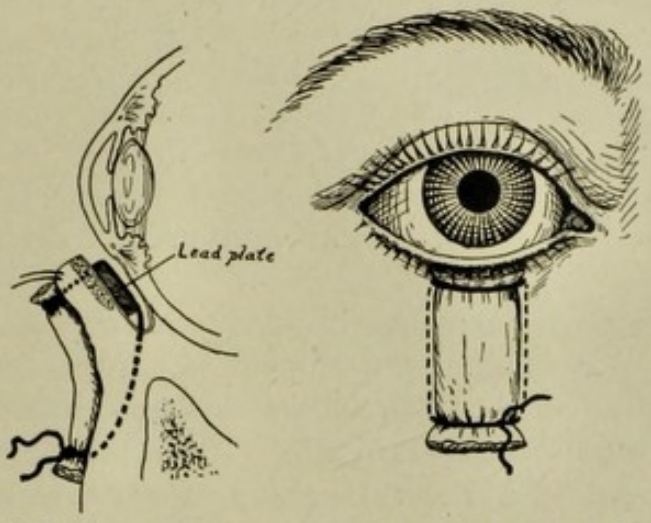
Argyll-Robertson's advancement operation. Argyll-Robertson (On a Modification of the Ordinary Method of Operating for Advancement



Advancement with Suture Carried Around the Cornea. (Argyll-Robertson.)

of the Tendon of a Rectus Muscle. *Brit. Med. Jour.*, 1891, Vol. II, p. 471), after dividing and isolating the tendon, in much the same manner as Williams and Beard, used a double-armed waxed silk suture, one end of which was passed in and out through the tendon or muscle parallel to the corneal margin, and a sufficient distance back from the insertion to give the desired advancement. The needle was then passed beneath the conjunctiva, around the cornea, well beyond its opposite margin. The second needle was then similarly passed in and out through the conjunctiva around the other half of the cornea to emerge near the first needle. See the figure. After excision of so much of the tendon as it was desirable to remove, the parts were brought into apposition and the suture tied. This suture was allowed to remain 4 or 5 days.—(E. J.)

Argyll-Robertson's operation for ectropion. It is perhaps an unusual thing for an out-curving of the tarsal cartilage to be the cause of ectropion or even to be a contributing agent of sufficient importance to demand attention. For the correction of those few cases where such a deformity does seem to be a pronounced feature Argyll-Robertson has performed the following operation, which is a modification of the Snellen sutures. A double-armed ligature of No. 2 braided silk, previously prepared by boiling in paraffin, is passed from the front



Argyll-Robertson's Operation for Mechanical Ectropion.

straight through the entire thickness of the lid, 2 mm. below the ciliary margin and about 6 mm. from the middle. It is carried free over the conjunctiva and reinserted at the bottom of the cul-de-sac, passing diagonally down and out so as to emerge 32 mm. below the lid margin. The other end of the suture is similarly placed 6 mm. to the other side of the midline. This arrangement leaves two vertical loops of thread crossing the palpebral conjunctiva about a centimeter apart. Beneath these loops is now inserted a lead plate (25x6x1 mm.) whose edges have been carefully smoothed and rounded off and which is bent to fit the curve of the globe. A roll of gauze is placed beneath the horizontal loop on the outside of the lid and the sutures are secured over its lower end. The sutures are allowed to remain in position seven days. If the lead plate is covered with paraffin it is less apt to cause irritation.—(C. H. B.)

Argyll-Robertson pupil, or reflex iridoplegia, is a condition in which both the direct and indirect reactions of the pupil to light are lost, but reflex contraction remains intact which is brought about by the associated actions of accommodation for near vision and the convergence of the visual axes.

It is not always easy, especially when the pupils are much con-

tracted, to elicit this phenomenon. Probably the best plan is to seat the patient before a well-lighted window and direct him to gaze at an object in the distance. Then cover the eye with a black, opaque object (a book forms a good obturator) and again warn the patient to still look as if he were gazing in the distance. Wait two minutes with the patient's eyes still covered; then suddenly remove the opaque cover. If the light reflex is present it will almost certainly be shown by narrowing of the pupil; if not, no change in the diameter of the pupil will occur. Then, shade the eyes by partially covering them with the book but not so fully but that the pupils can be observed. Again tell the patient to gaze for fully half a minute in the distance. Then, without removing the shade, suddenly tell him to fix the end of a finger thrust in front of his eyes about six inches away. The pupils will contract, it matters not how small they were previously, if the accommodation-convergence reflex arc is intact.

Miosis is frequently associated with the phenomenon, and in some cases the pupils are found oval or pointed. While both eyes are in nearly all cases affected, still we occasionally see individuals in which the condition is more marked in one eye than in its fellow, or where it may be completely unilateral. Many cases begin unilaterally (13 per cent., Rochon-Divignaud and J. Hettz), remaining so for some time, but finally becoming bilateral.

Reflex iridoplegia is never seen in perfectly healthy persons. It is observed in several diseases, but by far most frequently in those conditions caused by syphilis, particularly tabes. Some authors (Dejerine, Dufour and Uhthoff) have stated that they believe all cases to be due to syphilis.

As an aid in diagnosing these diseases it is of inestimable value, for it often precedes all other characteristic symptoms. The oculist is often the first to discover that the unfortunate patient is in the incipient stage of locomotor ataxia.

In 166 cases of Argyll-Robertson pupil reported by Uhthoff, 67.6 per cent. were associated with tabes; 8.8 per cent. with dementia paralytica; 8.17 per cent. with syphilis without tabes; 5.87 per cent. with other cerebral diseases; 1.4 per cent. with multiple sclerosis; 2.0 per cent. with railway spine and injury of the head; 0.7 per cent. with congenital feeble-mindedness; 0.7 per cent. with hystero-epilepsy; 0.7 per cent. with abuse of tobacco; 0.7 per cent. with hemianesthesia dextra and 3.6 per cent. with no assignable cause.

The statistics of Maeli, Siemerling, and Thomsen, embracing 4,000 cases of disease of the nervous system have been collected by Uhthoff

and show that in 492 the pupillary light reflex was lost. The diagnosis of those cases in which the loss was noted was as follows: Progressive paralysis, 85.5 per cent.; tabes, 4.25 per cent.; syphilis, 1.83 per cent.; multiple sclerosis, 1.2 per cent.; injury to head, 0.6 per cent.; paranoia and epilepsy, 2 per cent.

As to whether genuine examples of Argyll-Robertson pupil may be only temporary in some instances is a question which is in dispute. The fact that it nearly always accompanies diseases of the nervous system, which are in their nature progressive, leads us to believe that it is, as a rule, permanent. Sulzer states that in observing the pupillary light reflex in 53 cases in the early stages of syphilis, 11 were found to be affected. Some of these were carefully followed and, later, the eyes returned to the normal condition.

The seat of the lesion causing Argyll-Robertson pupil has been placed in different locations by different investigators. Pathological changes in the floor of the aqueduct of Sylvius were found by Peneles, Zeri and others on microscopical examinations of the brains of tabetics. Kostenitsch also found round-cell infiltration in this locality. Schutz reported finding pathological changes in the nerve fibres of the gray substance on the floor of the aqueduct in twenty cases of progressive paralysis, which during life had exhibited the Argyll-Robertson phenomenon. Some writers have assigned the cervical portion of the spinal cord as the region affected. Wolf states that in loss of light reflex in certain cases of tabes and general paralysis, which retained the knee-jerk intact, lesions had been found in the posterior columns of the cervical cord. Cases with retained pupillary light reflex and lost knee-jerk showed lesions of the cord below the third or fourth dorsal vertebra. Cases with the pupillary light reflex and knee-jerk both gone showed the entire cord affected.

Marina is of the opinion that the seat of the lesion is in the ciliary ganglion and ciliary nerves, and states that he has found changes in their structure in every case examined.

Neither pathological nor clinical investigations up to the present time have absolutely established the location of the lesion causing Argyll-Robertson pupil.—(A. S. R.)

Argyll-Robertson'sches Phänomen. (G.) Argyll-Robertson phenomenon.

Argyria conjunctivæ. ARGYROSIS OF THE CONJUNCTIVA. Staining of the conjunctival tissues by one of the silver salts. See **Argyrosis oculi.**

Argyrol. SILVER VITELLINE. This is a proteid salt of silver containing from 20 to 25 per cent. of the metal. The watery solution is yellowish or black according to its strength. It stains the skin and, like other silver salts, may produce a permanent or at least lingering argyrosis (q. v.). The same statement may with truth be made of most silver salts. This staining quality is, so far as it goes, an evidence of the effect produced on the albuminous constituents of the ocular tissues and, by inference, on invading bacteria. A number of instances of argyrosis from argyrol and other recent silver preparations could be quoted. It is claimed that the staining in the case of argyrol is largely due to the use of old or decomposed solutions. It is well known that argyrol solutions are prone to deteriorate on standing.

These experiences emphasize the need of using always perfectly fresh solutions kept from the light and air in, if possible, a cool or quite cold place. It should also be remembered that applications to abraded surfaces of even unaltered solutions are not without danger of argyrosis. Argyrol is nontoxic and possesses distinctly antiseptic qualities.

It was first described (and recommended) by Barnes and Hille as occurring in dark-brown or black-glistening flakes readily soluble in water and glycerin. Twenty per cent. solution is entirely non-irritating to the normal conjunctival sac. In from 5 to 25 per cent. watery solution it has been widely recommended as a substitute for silver nitrate. Both argyrol and its companion salt, protargol, have a therapeutic value all their own and, when properly employed, are superior to other organic salts in any dose.

From an extended study and experience Bruns believes that the best results in severe cases of blennorrhœa are to be obtained by erecting a dam of wax or paraffin about the margin of the orbit and immersing the eye in a strong solution for periods of an hour or two, day and night. As the agent is non-irritating its full effects can thus be secured without pain or damage to the eye. McGillivray gives a full account of the therapy of argyrol as follows:—

Judged from the bacteriological standpoint, argyrol would seem to rank inferior to nitrate of silver as a germicide, and to be of little real value as a substitute for this time-honored preparation. Be that as it may, those who have given argyrol an extensive clinical trial, and who are thereby able to judge of its therapeutic value, are enthusiastic in its praise.

It is very soluble in water, but incompatible with cocaine hydro-

chloride and other alkaloids. We have used it chiefly in 10 and 25 per cent. aqueous solution, and have found that its instillation into the eye is not only painless, but it is followed by a feeling of comfort and relief. When the solution is kept for some time, and especially in the light, it decomposes, and is then liable to cause irritation. It should therefore always be freshly prepared, and kept in the dark or in non-actinic bottles.

The chief objection to the use of this drug from the patient's standpoint is that it stains the skin and handkerchiefs a deep chocolate-brown color. This objection, however, is trifling, for the skin stains can be readily washed away with water, while linen stains are instantly removed by dipping the fabric in 1 in 1000 bichloride of mercury solution. We have not had a single case of argyrosis—permanent staining of the conjunctiva—with argyrol. One complaint one frequently hears is that the drops pass down the tear duct into the nose and pharynx, and may alarm the patient, unless previously cautioned, owing to their brown color and metallic taste. This objection is really a merit, as will be seen when we come to discuss the treatment of lachrymal affections.

The great advantage argyrol possesses over nitrate of silver lies in the fact that its application is painless, even in strong solution, and that it can be used freely and frequently by the patient without any risk. Nitrate of silver is, as you are aware, a dangerous remedy, except in the hands of the surgeon, and its application, even in 2 per cent. solution, is attended with such excruciating pain as to make the strongest shudder.

In ophthalmia neonatorum, after the discharge has been removed by the free use of the douche and saline solution, some half-dozen drops of a 25 per cent. argyrol solution are instilled into the eye, the chin meanwhile being held higher than the forehead. This is again repeated every half hour during the day, and the margins of the lids are kept smeared with vaseline during the night. If the discharge be copious, the saline douching is repeated every half hour or so. This method of treatment has given us admirable results, for all our cases have done well, and corneal ulceration has not been seen since we systematically adopted it three years ago. If the treatment just described be properly carried out, the discharge will be found to become speedily diminished, and recovery will be more rapid than if the lids be everted, their conjunctival surface brushed daily with a 2 per cent. solution of nitrate of silver, and mild antiseptic douchings employed at frequent intervals. In applying the argyrol solution it is not necessary to evert the lids, as in the case

of nitrate of silver. This proceeding in the hands of the unskilled is a source of grave danger to the cornea. With argyrol all that has to be done is to remove the discharge thoroughly with the saline douche, then instil some half dozen drops of the solution in the eye.

During the acute stage of simple catarrhal conjunctivitis and in milder types there is no remedy that we have tried to compare with frequent instillation of a 10 per cent. argyrol solution. In the severer types, 25 per cent. solution should be employed, especially in those cases that are on the borderland of purulent conjunctivitis. The discomfort experienced in these cases is relieved instantly after the instillation, the discharge becomes rapidly checked and recovery is obtained, as a rule, without the least discomfort to the patient. The treatment should be applied every two or three hours, or oftener if the discharge is plentiful. If the affection does not go on to complete recovery, as sometimes happens, but passes into the subacute or chronic stage, where there is little or no discharge, argyrol is useless, and its place should at once be taken with any of the older collyria. It is during the catarrhal or purulent stage of conjunctival affections that argyrol is not precipitated by the sodium chloride of the tears, so that simple instillation is all that is necessary, provided the patient holds the chin higher than the forehead, to enable the fluid to find its way into the upper cul-de-sac by gravitation. The head should be held in this position for a full minute or so after the instillation, during which time the patient should wink freely, to allow the solution to become diffused over the whole conjunctival surface. When the patient sits up it is a good plan to get him to blow the nose freely, so as to flush out the tear ducts.

When a chronic, slow-going form of conjunctivitis is attended with discharge, argyrol solution is useful only in checking the discharge and preparing the eye, so to speak, for more suitable treatment. If there be little or no accompanying discharge, argyrol is practically useless. When the condition is associated with hypertrophy of the palpebral conjunctiva and eversion of the eyelids, 2 per cent. nitrate of silver solution, applied daily by the surgeon with a camel's hair brush to the everted eyelid, is by far the best non-operative treatment.

In the simple variety of corneal ulcers argyrol and atropine drops are very useful, in 10 and ½ per cent. solutions respectively, instilled three times a day, the atropine drops being applied half an hour or so after the argyrol. In catarrhal ulcers this treat-

ment is also very satisfactory, but in sloughing ulcers of the cornea, with hypopyon, it is disappointing, even although freely and frequently applied in 25 per cent. solution. When the condition is due to pneumo-coccal infection it is also a failure, and no time should be lost in applying the cautery. In phlyctenular keratitis, with or without voscularisation, argyrol solution is of no use; yellow oxide of mercury ointment, with cocaine and atropine, is certainly the best treatment we know of.

We have found argyrol of very little use also in follicular, granular, and diplo-bacillary conjunctivitis, except as an adjuvant in checking the discharge.

In the more common forms of epiphora, due to inflammatory swelling of the lachrymal passages, argyrol is most beneficial. We treat these cases with instillations of a 10 per cent. solution, teaching the patient to press over the lachrymal sac with the finger while the head is held well back and turned slightly to the opposite side, the idea being to get the fluid into the sac and down the nose on the principle of the filling and emptying of a ball syringe. Should this fail after a fortnight or three weeks' trial, we pass a No. 2 Bowman's probe down the duct into the nose without dividing the canaliculus. The probe must be passed with the greatest care, so as to avoid injuring the lining membrane of the duct. The instillations of argyrol, etc., are continued three times a day for a few weeks. Improvements will be found on the second or third day if the treatment is to be successful. We have tried this method of treatment in this troublesome affection for nearly three years with very gratifying results. In chronic dacryocystitis, or mucocele, after dividing the lower canaliculus and passing the largest Bowman's probe, the patient is instructed to empty the sac by pressing over it with the finger, and to instil a 25 per cent. solution of argyrol solution over the inner canthus, the same manipulations for getting the solution down into the nose, as described in the management of simple epiphora, being adopted. Under this treatment the discharge from the sac soon becomes arrested, and fewer probings are necessary. The same treatment is adopted in dealing with tear duct obstruction where a style is employed. The use of an Anel's syringe, with argyrol solution, in the treatment of lachrymal affections may be attended with unpleasant consequences. It sometimes happens, especially with a restless patient that the mucous membrane of the duct becomes abraded, when the fluid may pass into the subcutaneous tissue, and leave a slight permanent staining of the eyelids.

In preparing the eye for operation, such as for cataract extrac-

tion, when there is evidence of discharge, as shown by staining of the dressing, or by obscuration of the ophthalmometer mirror by mucus, we have used argyrol solution in the strength of 25 per cent. solution, to diminish the activity of the conjunctival flora. The results obtained are thoroughly satisfactory, for we have not seen a case of suppuration following operations since this method of treatment has been adopted some three years ago.

The treatment of the simple or squamous form of blepharitis by argyrol is, in our experience, inferior to that with yellow oxide of mercury ointment. In ulcerative blepharitis the best results we have had have been with nitrate of silver in 2 per cent. solution, applied to the margin of the eyelid after the crusts have been carefully removed with a weak, tepid solution of baking soda. The nitrate should be applied daily till the ulcerative condition has healed up, when the treatment with simple yellow oxide of mercury ointment, applied three times a day, should be adopted. The ointment should be continued for a few weeks after the lids appear well, to prevent a relapse, and any refractive error should at the outset be corrected and suitable glasses be worn constantly.

During the past few months we had three most typical cases of dendritic corneal ulcers under treatment about the same time in the hospital. Each case, to begin with, was treated with 25 per cent. solution of argyrol every hour or two, but without the least beneficial result. On applying the galvano-cautery, however, recovery soon took place.

In addition to these observations and experiences of McGillivray it is to be noted that—

A. Duane uses argyrol in all forms of acute conjunctivitis. He employs it especially when there is much secretion both for office and home treatment. The patient is instructed to apply it as follows: First wash out the eye freely with an indifferent solution (saline or boric acid); then drop in the argyrol; then after 5 minutes wash out this with the coagula that it has produced; then instill argyrol again, and this time let it remain. This prevents the disagreeable sensation of a foreign body that is produced if the argyrol and coagula are left in. He also uses argyrol (preceded by adrenalin) in lachrymal disease; but now only by instillation—never by injection into the sac.

Many physicians prefer to use this remedy as an ointment rather than in solution, and it may be employed in this way in all strengths. Lanoline, petrolatum and cold cream form good excipients.

Argyrosis oculi. Argyrosis of the conjunctiva is a permanent, dirty-

grey discoloration of the conjunctiva, especially of the lower fornix (occasionally affecting the border of the lids), due to precipitation of silver oxide and silver albuminate after prolonged local application of silver nitrate and other silver-salt solutions. This staining of the conjunctival tissues also occurs from other silver salts that do not form a precipitate with albumen, like protargol and argyrol.

Silver workers are occasionally affected. An argyria limited to the caruncle and semilunar folds has also been found in photographers. The condition may occur quite quickly; a solution of silver nitrate as weak as 1 to 500 has produced argyrosis as early as the tenth day. In general argyrosis from prolonged internal use the conjunctiva is also affected.

A bluish-grey discoloration of the eyelids is one of the symptoms of general argyrosis after internal, more rarely after external, applications of silver salts. It is a local phenomenon that appears only after long continued exhibition of argentic preparations.

Lewin and Guillery gave some interesting reports of argyria and its effects on the external ocular apparatus. The conjunctiva of a man who used a solution of silver nitrate in the eye and who applied it for about four months, showed as a result an intense bluish, almost black discoloration. The silver had so penetrated the tissues that the surface appeared a light yellowish color, but in the deep tissues there was a more noticeable deposit, especially in the fine elastic fibres. The intercellular substance was unaffected. Argyrosis of the conjunctiva was also seen in a man who had dyed his beard and hair with silver nitrate for 25 or 30 years. It also resulted from swabbing the larynx twice daily for 10 years. In this case the conjunctiva, the face, neck and gums were discolored. In certain occupations it is likely to occur, as in workers who silver glass pearls. These workmen draw up a silver solution into 3 to 4 cm. long glass tubes held in the mouth; during this occupation some silver solution gets into the mouth. After varying lengths of time (3 to 4 years) a general argyrosis appears on the lids, conjunctiva, etc. In one case a discoloration of the iris was observed, with a beginning double-sided cataract.

The danger of argyrosis is especially great in those who use silver nitrate internally. In the course of a year one patient took 34 grams of silver nitrate in pill form. In nine months a greyish-black coloration of the face appeared and became gradually worse. The patient died, and it was found that not only the skin but the mucous and serous surfaces, the vessels and glands, choroid plexus, etc., contained silver. In the epithelium there was no pigment, nor

was there in the substance of the brain and cord, pia and arachnoid, but there was a deposit on the internal surface of the dural sheath of the optic nerve. There was a granular deposit in all the connective tissue regions of the eyeball, except in the nerves and retina. Silver deposits were demonstrated in the sclera, conjunctiva, the subconjunctival tissue, Tenon's capsule, the tendons and the interstitial tissue of the muscles. In the choroid the demonstration was impossible on account of the pigment, but silver was found in the ciliary vessels; in fact the tissues richest in vessels were most affected, indicating that the silver is imported by way of the vascular system.

Visual disturbances are produced by silver nitrate, especially a true intoxication amblyopia with central scotoma. This symptom was present in a man who had for years dyed his beard with silver nitrate solution. He showed a light, grey-blue coloration of both cheeks, and of the buccal mucous membrane. He also complained of general symptoms, weakness, reduced mental power and some disturbance of hearing. On removal of the cause of the argyria the symptoms disappeared.

Terlinck (*Ophthalmic Year Book*, 1909,) reports two instances of argyrosis of the conjunctiva from long-continued applications of silver nitrate solutions. An attempt was made to remove the stain from one eye by instilling sodium hyposulphite, as recommended by zur Nedden. After two months there was distinct lightening of the stain, but further treatment was unavailing. Microscopical examination of excised tissue showed that the subepithelial granules had been greatly reduced in number, but those deposited on the elastic fibers deeper in the tissues were unaffected.

Argyrosis der Lidhaut. (G.) Argyria; a grayish discoloration of the eyelid, occurring in silver-workers.

Arhinencephalie. (G.) Cyclopia.

Aridura bulbi. (L.) An old term for atrophy of the eyeball.

Arimaspi, The. A mythical people, supposed to dwell in the north of Scythia and to be by nature monocular. According to Aristeas, an epic poet of Proconnesus (whose date is quite uncertain) the Arimaspi fought with the griffins for the gold of the Ural mountains.—(T. H. S.)

Ariovistus. A Gallic physician whose name appears upon one of the ancient oculistic seals. He probably flourished in the second or third century, A. D. Nothing further is known about him.—(T. H. S.)

Aristol. THYMOTOL. THYMOL IODIDE. THYMODIN. IODISTOL. IOSOL.

Iodosol. Annidalin. Dithymol diiodide. $C_{20}H_{24}O_2I_2$. Iodide of thymol (U. S. P.) is a yellow-red powder with faint aromatic odor, insoluble in water, slightly soluble in ether, very soluble in chloroform, containing 45 per cent. of iodine. It is made by the action of iodine, potassium iodide and sodium hydroxide on thymol.

This remedy was much exploited as a substitute for iodoform but, in eye cases at least, has failed of expectation. It is, however, a mild, and, in every regard, inoffensive preparation worthy of trial where a simple, antiseptic, iodine, dry dressing is needed. Vignes thinks it does not irritate the eye or increase secretion. It has been recommended as an application in interstitial keratitis.

Daxenburger also recommends its use in lime burns, blepharitis and phlyctenular keratitis, of a ten per cent. mixture in oil of sesame. This is a transparent, red-brown fluid which does not throw down a deposit or become rancid.

Aristotle. This immortal philosopher, as well as "Father of the Natural Sciences," * was the son of a famous physician, Nicomachus, who was himself descended from another physician, Nichomachus, alleged to have been the grandson of the old Greek god of healing, Aesculapius. Aristotle was born at Stagira (whence his surname, "the Stagirite") near Mount Athos, B. C. 384. Twenty years he spent in company with Plato, at Athens, then three with Hermias, the Eunuch, tyrant of Atarneus. After that, he was called to Macedonia, where, at the court of Phillip, he was appointed instructor to Phillip's son, Alexander, afterwards known as "the Great." While at this court, Aristotle supplicated Phillip to restore the former's native city, Stagira, which Phillip had destroyed, and his entreaty was granted. "He also made laws for the citizens."

Then the great philosopher and founder of modern science went to live at Athens, where, in the covered walks round the temple of the Lycean Apollo, on the east side of the city, he set up his school in opposition to the Platonic school (now under the management of Zenocrates) which was conducted in the Academia gardens on the west side of Athens. Because of his continually walking up and down in the Lyceum with his disciples, "till the time for anointing themselves came," as Diogenes Laertius puts it, he was called the "Peripatetic," and his philosophy "the Peripatetic philosophy." His school of philosophy is also often known as "the Lyceum," while Plato's, for a similar reason, is called "the Academy."

Aristotle was a peculiar looking man, according to all accounts, hav-

* Though not the "father" of philosophy, he was undoubtedly the father of the history of that subject.

ing small eyes and very thin legs, as well as, probably, other unprepossessing physical characteristics. Besides, in the attempt to make himself attractive, he spoke with "a lisping voice," arranged his hair with the utmost extravagance, and even indulged in very conspicuous dress and rings. Very magnetic he was, however, spite of all these adverse circumstances, on account of his abundant flow of new and true ideas, which rapidly produced in the hearer a sweet forgetfulness of his physical imperfections.

For thirteen years Aristotle walked and talked in the Lyceum, and it is more than probable that, in the course of this period it was that he wrote the astounding volumes which, though not appreciated fully in antiquity, ruled in the middle ages not only supreme among all secular writings, but, one might almost add, alone.

Of his genuine works, the following, only, are extant; (there were many others): 1. *Topics.* 2. *Prior Analytics.* 3. *Posterior Analytics.* 4. *On Sophistical Refutations.* 5. *Art of Rhetoric.* 6. *Nicomachean Ethics.* 7. *Politics.* 8. *On the Art of Poetry.* 9. *A Physical Discourse.* 10. *On the Heavens.* 11. *On Generation and Destruction.* 12. *Meteorologics.* 13. *Researches about Animals.* 14. *On Soul.* 15. Appendices to the preceding work—(a) *On Sense anl Sensible Things.* (b) *On Memory and Recollection.* (c) *On Sleep and Waking.* (d) *On Dreams and Prophesying in Sleep.* (e) *On Longevity and Shortlivedness.* (f) *On Youth and Old Age.* (g) *On Life and Death.* (h) *On Respiration.* 16. *On Parts of Animals.* 17. *On Locomotion of Animals.* 18. *On Generation of Animals.* 19. *The Metaphysics.*

Though none of the works in this list is devoted exclusively to ophthalmology, Aristotle is, nevertheless, of great ophthalmologic importance because of the numerous observations and inferences concerning the human and the animal eye, which are scattered about in his various compositions. These can, perhaps, best be grouped as follows: (1) Those Relating to the Human Eye, (a) its anatomy, (b) its physiology (including his theory as to the nature of light), (c) its pathology (to all intents and purposes limited to errors of refraction and senile failure of accommodation). (2) Those Relating to the Animal Eye. Of each of these topics in its turn.

(1) The human eye.—(a) *Anatomy.* In *"The History of Animals"* (Chap. viii, secs. 2 and 5) we find the following mixture of physiognomy and anatomy: "Under the forehead are two eyebrows; if they are straight, it is a mark of a gentle disposition; the eyebrows bent down to the nose are an evidence of an austere temper; if they incline towards the temples, of a mocker and scoffer; if they are drawn

down, it is a sign of an envious person. Beneath these are the eyes, which by nature are two in number: the parts of each eye are, first, the upper and under eyelid, the edges of which are furnished with hair. Within the eye, the moist part, with which we see, is called the pupil; round this is the iris, and this is surrounded by the white. Two corners of the eye are formed at the junction of the eyelids, one in the direction of the nose, the other towards the temple. If these corners are large, they are a sign of an evil disposition; if those near the nose are fleshy, and have a swollen appearance, they are an evidence of wickedness. * * * The eyes of some persons are large, others small, and others of a moderate size—the last-mentioned are the best. And some eyes are projecting, some deep-set, and some moderate, and those which are deep-set, have the most acute vision in all animals; the middle position is a sign of the best disposition. Some people have an eye which is perpetually opening and closing, others have an eye always intent, and others a moderately-intent eye: this last is the best disposed; of the others, the one is impudent, and the other a sign of infirmity."

Aristotle was the very first to describe the iris specifically, and probably the first to mention the diverse colors exhibited by this membrane in different individuals. Thus, "In some it [the iris] is black, in others decidedly gray, in others dark gray, and in some it is the color of the goat's eye, and this is a sign of the best disposition, and is most to be prized for acuteness of vision. Man is almost the only animal which exhibits a variety of coloring in the eye. * * *" He was also the first to observe that all children are born with blue irides. He mentions once that the eye is filled with fluid, because, when the eye is injured, it sends water out. One passage of Aristotle's about the connection of the eye with the brain is hopelessly obscure; another runs: "The eye is also connected with the brain, and each eye is placed upon a vein." It is not at all likely that "vein" is here intended to refer to the optic nerve. That structure was, in fact, first discovered, so far as can now be ascertained, by Herophilus.

Of the conjunctiva, Aristotle, in common with all his predecessors and contemporaries, knew absolutely nothing. The same may be said, with perhaps a trifle less of unqualified certainty, regarding the apparatus lachrymalis. Whether or not the great observer knew of the existence of the semilunar fold, or of the caruncula lachrymalis, is in doubt. He assuredly did not know of the existence of the anterior chamber, nor did anybody else for many hundred years.

(b) *Physiology.* Aristotle's theory of vision and the nature of light was vastly in advance of those of all of his predecessors. Thus,

Alcmaeon, Anaxagoras, and Democritus had taught that colored images were being continually detached from objects, and that these little masks, or casts, pressing into the eye, were fixed in the pupil, until the soul was able to take note of them. Empedocles, Diogenes, and Plato, on the other hand, had taught that rays of light, running out from the object looked at, were met by other rays which had been emitted from the eye, and that these two varieties of rays, meeting somewhere between the object and the eye, begot, somehow, a third variety of rays, out of which the image was produced, and by which it was, somehow, brought to the soul's attention. Then came Aristotle, with his well-formed, unobscure theory, so greatly in advance of his day as now to seem almost incredibly modern. According to this theory, all the higher sense-perceptions are caused to exist in this way: The object perceived excites a motion, in consequence of which the sense organ is acted upon. What we see of an object is its color; but this we do not see directly, but only through the medium of the light, which the color sets in motion and causes to produce an impression in the organ. Without the light we can see no color, hence no object either. However, the light is not a body, nor is it anything emitted by a body. Nor does it occur of itself, but it is begotten by the motion which is produced by the color of the object looked at. * * * It is here exactly as in the perception of hearing and smelling, for neither the sounding nor the smelling body occasions the sensation by touching the respective sense-organ, but it sets in motion, first, a medium, and, through that, the sense-organ; so, out of the changes in the organs thus produced occur the perceptions of the world of the senses. It is hardly necessary to point out here how like the modern theory of light and of vision this explanation of old Aristotle's is. True as was the theory, however, it met with little favor in antiquity, especially among physicians, and, even in the middle ages, it remained without acceptance, save, here and there, by a spirit select, such as the late Arabian, Alhazen, and his successor in these matters, Averröes.

(c) *Pathology.* Aristotle's ocular pathology is limited well-nigh exclusively—and almost as a matter of course, since he was not a physician but a philosopher—to errors of refraction and senile failure of accommodation. This latter affection—to deal with that subject first—he does not understand for what it really is; indeed the very fact itself of accommodation was wholly unknown in his day. He offers—perhaps with only apparent inconsistency—two entirely different explanations of this weak-sightedness of the aged. One explanation is that the body as a whole becomes, in later life, abnormally dry, and that the ocular tissues (especially those of the inner parts—that is to say, the

fluids) participating in this general dessication, do not permit the rays of light to traverse them so freely as happens in the earlier years of life. The second explanation, however mistaken, is of a truly optical character. It runs to this effect, namely: That the visual rays, emerging from the eye (here he is guilty of following not his own theory of light, but that of other, and more mistaken, philosophers) come together—or, as one would express it today, come to a focus—in the case of an old person, at a greater distance from the eye than in youth, and that from this arises the necessity, in the aged, of holding an object farther from the eye than formerly, if it is to be distinctly seen.

As to errors of refraction, Aristotle speaks both of short-sight and of long-sight, and contrasts the two varieties of visual weakness very thoroughly. It is also noteworthy that he gives as the three most salient concomitants of shortsightedness: (1) prominence of the eyeballs (2) squeezing together of the lids (3) a tendency to write with small letters. He makes, too, as we believe, the earliest attempt in history at a correction of myopia when, for this condition, he recommends that the patient look at distant objects through a narrow (of course lensless) tube. In a kind of way, we may regard this rudimentary device as the beginning both of spectacles and of the telescope.

(2) The animal eye.—In comparative ophthalmology, as well as in optics, Aristotle shone as the bright particular star of antiquity. And indeed his achievement in this field can best be exhibited by certain of his own highly condensed passages themselves. From "*The History of Animals,*" then, (Chap. viii, par. 4,) we find the following observation: "Man is almost the only animal which exhibits a variety of coloring in the eye; there are, however, some horses with gray eyes." Not a remarkable passage, perhaps, but exhibiting at least the beginnings of a comparative ophthalmology. In the paragraph next succeeding, we run across this, which is absolutely incorrect: "Those which are deep-set have the most acute vision in all animals." A truer observation occurs in Chap. xii, par. 4: "Man has the eyes closer together, in proportion to his size, than other animals."

The most important passages, however, of Aristotle's comparative ophthalmology, are found, very much scattered about,[1] in his "*Parts*

[1] We may here remind ourselves that Aristotle, though the "father" (among so many other desirable offspring) of "Rhetoric," was himself almost entirely indifferent to literary form. And of all the "crabbed and obscure" works which the "father" of clearness-in-others composed, the "Parts of Animals" is the most crabbed and the most obscure.

of Animals." By way of prelimination, we ought to present, first of all, from this book, Aristotle's view as to the seat of sensation in general. This view we find expressly stated (together with his opposition to the brain-sensation theory) in the second book and tenth chapter, as follows: "These writers see that certain of the senses are located in the head, and are unable to discern any reason for this; they see also that the brain is the most peculiar of all the animal organs; and out of these facts they form an argument, by which they link sensation and brain together. It has, however, already been clearly set forth in the treatise on sensation, that it is the region of the heart that constitutes the sensory center." This is a very peculiar view, to say the least, to be held by the Father of so many good and scientific gifts. But when we consider the reasons on which his view was based, we are not so greatly astonished. These reasons were: (1) when vivisecting certain animals (especially the chameleon) he had noted that the cerebral hemispheres could be cut, and, in fact, manipulated, without the production of pain, or of fear, or of any kind of struggling (2) he could find no brain of any sort or kind in any of the invertebrate animals, excepting alone the Cephalopoda, and yet these animals undoubtedly possessed the power of perceiving sensation (3) he had found (as he believed) that the brain was a wholly bloodless organ, and, throughout the body generally, bloodless organs were devoid of sensation (4) "It is manifest, on inspection, that there is no anatomical connection between brain and sense-organs." The "vein" above referred to, which he mentions as connecting the eye with the brain, he had evidently forgotten, when writing the passage just now cited, or else had not (and this is very probable) as yet observed it.

Referring to our more specific subject, Aristotle remarks (*"Parts of Animals,"* ii, 10): "Now that vision, whenever it exists, should be in the neighborhood of the brain, is but what we would rationally expect. For the brain is fluid and cold, and vision is of the character of water, water being of all transparent substances the one most easily confined." He exhibits a similar passage in his work, *"On Sense and the Sensible,"* Ch. 2, 12: "The faculty of sight does not belong to the eye because it is of water, but because it is transparent, a quality which exists in air no less than in water. But water is less elastic, and more easily kept in place than air, and on this account the eye is made of it. That the eye is made of it, is manifest from the fact that water runs out of it when it is ruptured." Both these passages, of course, show very clearly the strong influence of the humoral theory of disease which not only governed like a tyrant the pathology of Aristotle's time, but that of many a long century to follow.

Passing on to comparative ophthalmology proper, we find the following valuable passages in "*The Parts of Animals,*" Book II: (*Ch.* 13.) Men, and Birds, and Quadrupeds, viviparous and oviparous alike, have their eyes protected by lids. In the vivipara there are two of these; and both are used by these animals not only in closing the eye, but also in the act of blinking; whereas the oviparous quadrupeds, and the heavy-bodied birds as well as some others, use only the lower lid to close the eye; while birds blink by means of a membrane connected with the canthus. The reason for the eyes being thus protected is that nature has made them of fluid consistency, in order to ensure keenness of vision. For had they been covered with hard skin, they would, it is true, have been less liable to get injured by anything falling into them from without, but they would not have been sharp-sighted. It is then to ensure keenness of vision that the skin over the pupil is fine and delicate; while the lids are super-added as a protection from injury. It is as a still further safeguard, that all these animals blink, and man most of all; this action (which is not performed from deliberate intention but from a natural instinct) serving to keep objects from falling into the eyes; and being more frequent in man than in the rest of these animals, because of the greater delicacy of the skin. These lids are made of a roll of skin; and it is because they are made of skin and contain no flesh [a mistake, since, by "flesh," Aristotle undoubtedly means "muscle"] that neither they, nor the similarly constructed prepuce, unite again when once cut. [Again a mistake, but an easy one to make in the time of Aristotle, since very great surgical care is required to bring about union of these parts.]

"As to the oviparous quadrupeds, and such birds as resemble them in closing the eye with the lower lid, it is the hardness of the skin of their heads which makes them do so. For such birds as have heavy bodies are not made for flight; and so the materials which would otherwise have gone to increase the size of the feathers are diverted thence, and used to augment the thickness of the skin. Birds therefore of this kind close the eye with the lower lid; whereas pigeons and the like use both upper and lower lids for the purpose. As birds are covered with feathers, so oviparous quadrupeds are covered with scaly plates; and these in all their forms are harder than hairs, so that the skin also to which they belong is harder than the skin of hairy animals. In these animals, then, the skin on the head is hard, and so does not allow of the formation of an upper [movable] eyelid, whereas lower down the integument is of a flesh-like character, so that the lower lid can be thin and extensible.

"The act of blinking is performed by the heavy-bodied birds [in

fact by all birds] by means of the membrane already mentioned, and not by this lower lid. For in blinking rapid motion is required, and such is the motion of this membrane, whereas that of the lower lid is slow. It is from the inner canthus, that is from the one nearest to the nostrils, that the membrane comes. For it is better to have one starting point for nictitation than two; and in these birds this starting-point is the junction of eye and nostrils, an anterior starting-point being preferable to a lateral one. Oviparous quadrupeds do not blink in like manner as the birds; for, living as they do on the ground, they are free from the necessity of having eyes of fluid consistency and of keen sight, whereas these are essential requisites for such birds as have to use their eyes at long distances. This too explains why birds with talons, that have to search for prey by eye from aloft, and therefore soar to greater heights than other birds, are sharp-sighted; while common fowls and the like, that live on the ground and are not made for flight, have no such keenness of vision. For there is nothing in their mode of life which imperatively requires it.

"Fishes and Insects and the hard-skinned Crustacea present certain differences in their eyes, but so far resemble each other as that none of them have eyelids. [Not quite correct. The shark and a few other fishes do possess eyelids.] As for the hard-skinned Crustacea it is utterly out of the question that they should have any; for an eyelid, to be of use, requires the action of the skin to be rapid. These animals then have no eyelids and, in default of this protection, their eyes are hard, just as though the lid were attached to the surface of the eye, and the animal saw through it. Inasmuch however as such hardness must necessarily blunt the sharpness of vision, nature has endowed the eyes of Insects, and still more those of Crustacea [because their heads are less movable than those of insects] with great mobility (just as she has given some quadrupeds very movable ears), in order that they may be able to turn to the light and catch its rays, and so see more plainly. Fishes however have eyes of a fluid consistency. For all animals that move much about have to use their vision at considerable distances. If now they live on land, the air in which they move is transparent enough. But the water in which fishes live is a hindrance to sharp sight, though it has this advantage over the air, that it does not contain so many objects to knock against the eyes. The risk of collision being thus small, nature, who makes nothing in vain, has given no eyelids to fishes, while to counterbalance the opacity of the water she has made their eyes of fluid consistency.

"(*Ch.* 14.) All animals that have hairs on the body have lashes on the eyelids; but birds and animals with scale-like plates, being hair-

less, have none. [A keen and absolutely correct observation. What appear to be eyelashes in owls, hornbills and parrots are really feathers—a fact sufficiently substantiated by the tiny barbs.] The Libyan ostrich indeed, forms an exception; for, though a bird, it is furnished with eyelashes. This exception, however, will be explained hereafter. Of hairy animals, man alone has lashes on both lids. For in quadrupeds there is a greater abundance of hair on the back than on the under side of the body; whereas in man the contrary is the case, and the hair is more abundant on the front surface than on the back. The reason for this is that hair is intended to serve as a protection to its possessor. Now, in quadrupeds, owing to their inclined attitude, the under or anterior surface does not require so much protection as the back, and is therefore left bald, in spite of its being the nobler of the two sides. But in man, owing to his upright attitude, the anterior and posterior surfaces of the body are on an equality as regards need of protection. Nature therefore has assigned the protective covering to the nobler of the two surfaces; for invariably she brings about the best arrangement of such as are possible. This then is the reason that there is no lower eyelash in any quadruped; though in some a few scattered hairs sprout out under the lower lid. [Absolutely true. Certain monkeys and antelopes do exhibit "a few scattered hairs" "under the lower lid."] * * * * * * *

"(*Ch.* 15.) Both eyebrows and eyelashes exist for the protection of the eyes; the former that they may shelter them, like the eaves of a house, [cf. Shak. "his penthouse lid"] from any fluids that trickle down the head; the latter to act like the palisades which are sometimes placed in front of enclosures, and to keep out any objects which might otherwise get in. The brows are placed over the junction of two bones, which is the reason that in old age they often become so bushy as to require cutting. The lashes are set at the terminations of small blood-vessels. For the vessels come to an end where the skin itself terminates; and, in all places where these endings occur, the exudation of moisture of a corporeal character necessitates the growth of hairs, unless there be some operation of nature which interferes, by diverting the moisture to another purpose." [Aristotle, we need hardly remind ourselves, knew nothing of the circulation of the blood.]

In the same great work, Book iv, Chap. II, occurs the following: "These animals [reptiles] have no upper eyelid, but close the eye with the lower lid. [The truth, of course, is that reptiles have an upper lid, but use the lower almost, or quite, exclusively.] In this they resemble birds, and the reason of the peculiarity is the same as was assigned in their case. Among birds there are some that can not only

close the eye, but can also blink by means of a membrane which comes from its inner corner. But none of the oviparous quadrupeds blink in this manner. [A mistake.] For their eyes are harder than those of birds. The reason for this is that sharpsightedness is of very considerable service to birds, flying as they do in the air, whereas it would be of comparatively small use to the oviparous quadrupeds, seeing that they all live in holes.'' *

Finally, near the close of the same great work, Book iv, Chap. 14, we find: ''On the other hand it [the Libyan ostrich) agrees with quadrupeds in having upper eyelashes, which are the more richly supplied with hairs because the parts about the head and the upper portion of the neck are bare. * * * *''

In spite of the numerous mistakes in the comparative ophthalmology of Aristotle, that branch of the old philosopher's science is certainly remarkable for its keen and accurate observation, as well as for its profound and wide-sweeping reflection. It is, further, decidedly noteworthy because it is in fact the first attempt of its kind in the history of the subject. This fact is well-nigh incredible, when we reflect that dissections, in those days, were practised on the lower animals exclusively. Yet the fact is not to be disputed, and, among so many other subjects, this subject, too, will have to be set down as one of those to which this very identical old philosopher was masculine progenitor.

There is still another extraordinary fact in the history of comparative ophthalmology, to wit, that, despite the continued restriction of dissections to the lower animals exclusively, and that not merely in one land but in absolutely every so-called civilized country, the subject in question was scarcely touched upon again till the time of the great Arabian ophthalmologist, As-Sadili, who flourished near the close of the 14th century, A. D.

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* At the risk of seeming ungrateful to this old philospher, to whom every individual member of the human race is, without exception, indebted deeply, we desire to point out three very conspicuous deficiencies in his ophthalmology—conspicuous because of the fact that, even in his time, they could so very easily have been supplied.

1.—He has nothing at all to say about the visual field. (Hemianopia was mentioned by Hippocrates, who lived before Aristotle. The first attempt at measuring the visual field was made by Ptolemy, who flourished A. D. 150. The ''blind spot''—corresponding to the entrance of the optic nerve—was discovered by the French physicist, Mariotte, in 1666. Finally, the first exact measurement of the visual field was made by the English physicist, Thomas Young, in 1801.)

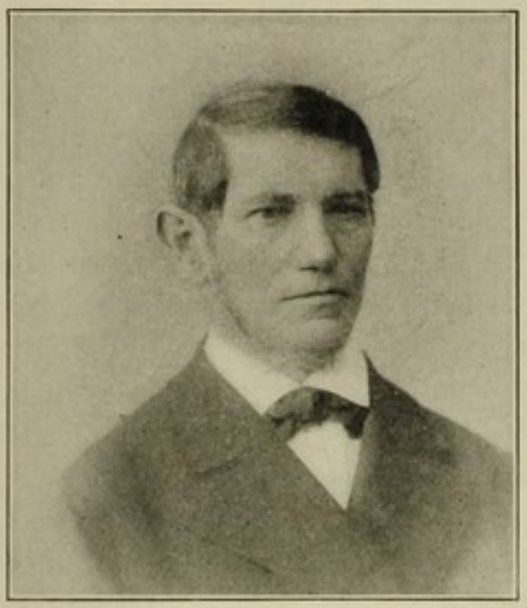
2.—He did not notice the differences which so manifestly exist in the form of the pupil in various kinds of animals—*e. g.*, cats (vertical), cattle (horizontal), dogs (round).

3.—He did not notice the pupillary light-reflex. (For an observation of this very conspicuous and striking phenomenon, the world was in fact obliged to wait until the time of ar-Rhazi, or Rhazes, an Arabian physician who lived from 850 to 932 A. D.)

Then, very strange to say, the subject was summarily dropped, and not resumed again till nearly the close of the all-embracing 19th century.

Even yet there remains a very great deal to be accomplished in the field of comparative ophthalmology. Aristotle, As-Sadili, Beer, Schleich, Wiedersheim, Lindsay Johnson, Hess: thus, by the investigators' names, we may be able to bear in mind a kind of summary of the history of the subject.—(T. H. S.)

Arlt, Ferdinand Ritter von. One of the most distinguished ophthalmologists of all the ages, Arlt was the son of a humble blacksmith



Ferdinand Ritter von Arlt.

at Obergraupen, Bohemia. Here he was born Apr. 18, 1812, and here he spent his boyhood days. He attended the grammar-school at Leitmeritz, and the University at Prague, where he graduated in 1839. An ophthalmologic pupil of Professor J. N. Fischer, he acted from 1846 to 1849 as substitute-professor of diseases of the eye in the Prague University, and, from August, 1849, till July, 1856, as incumbent of the same position in his own right. Beginning in 1856, he lectured with world-renowned success on diseases of the eye at the University of Vienna, until July, 1883, when, as a result of the Austrian law, he had reached the age-limit, and so was compelled to retire. From this time on, however, until his death, he continued in active ophthalmic authorship and in private practice. He died of senile gangrene Mar. 7, 1887.

His writings are very numerous. Aside from journal articles,

these are: *Pflege der Augen im gesunden und kranken Zustande, nebst einem Anhange über Augengläser* (Prague, 1846; improved edition, Prague, 1868). In this little volume, Arlt calls on the medical profession to fit spectacles and eye glasses themselves, instead of leaving so important a matter to opticians. *Krankheiten des Auges* (3 vols, 1851, 1853, 1856). *Injuries of the Eye* (Vienna, 1875). *Die Kurzsichtigkeit, Entstehung und Ursachen* (Wien, 1878). *Klinische Darstellung der Krankheiten der Binde—, Horn—und Lederhaut, dann der Iris und des Ciliarkörpers* (Vienna, 1881). *Operationslehre* (Graefe-Saemisch, *Handbuch der Gesamten Augenheilkunde,* Bd. III, 2 Teil, Leipzig, 1874).

In 1855, he became joint editor with Donders of Graefe's *Archiv für Ophthalmologie.*

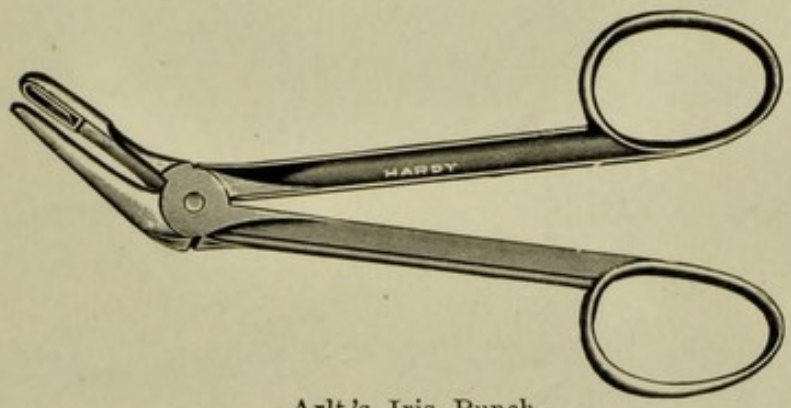
Arlt was distinctly and undeniably one of the "path-makers" in ophthalmology. Indeed, in almost every book and article that he wrote, he exercised a decidedly formative influence on the entire profession. Thus, it was largely due to his influence that the test-types of Jaeger and of Snellen came into use, that oculists began to fit glasses themselves, that the view that short-sight was produced by lengthening of the antero-posterior diameter of the eye was generally adopted, etc. As a teacher, he was even more successful than as a writer. Those who had the pleasure of attending his lectures have declared that even the dullest student would listen to Arlt's every word with almost breathless interest. It was owing to Arlt's influence that Albrecht von Graefe turned his attention to ophthalmology. A long succession of oculists who afterward became famous were trained by this deeply scientific and yet inspiring teacher.—(T. H. S.)

Arlt's enucleation method. Arlt's method of enucleation (1859), described by H. Knapp, is as follows (he used no strabismus hook):

He incises the conjunctiva from 2 to 3 millimeters behind the limbus corneæ, and pushes it somewhat back. Standing on the right of his patient, he, in the left eye, divides first the external, in the right the internal rectus, grasping it with toothed forceps, but leaves a small stump to get a firm hold of the globe with the forceps. After division of the inferior and superior recti, he pulls the eye with the forceps horizontally towards the inner (or outer) canthus, passes a pair of scissors over the posterior segment of the sclerotic, as far as the optic nerve, opens the branches, advances the scissors, so that the nerve lies between the branches, and cuts it close to the sclerotic. He now turns the protruding eyeball to the side of the uncut rectus, divides the insertions of the obliques, and the vessels and nerves, at

the posterior half of the globe, and lastly detaches the insertion of the fourth rectus, together with the overlying conjunctiva, from the sclerotic.—(F. A.)

Arlt's iris punch. Von Arlt first devised and recommended a punch for cutting out a piece of occluding pupillary membrane and the iris attached to it. After an incision through the cornea and iris with a keratome he entered the anterior chamber with the punch (with closed beak) and allowed it to open far enough to get the iris diaphragm between the two blades. Then, on closing the blades with

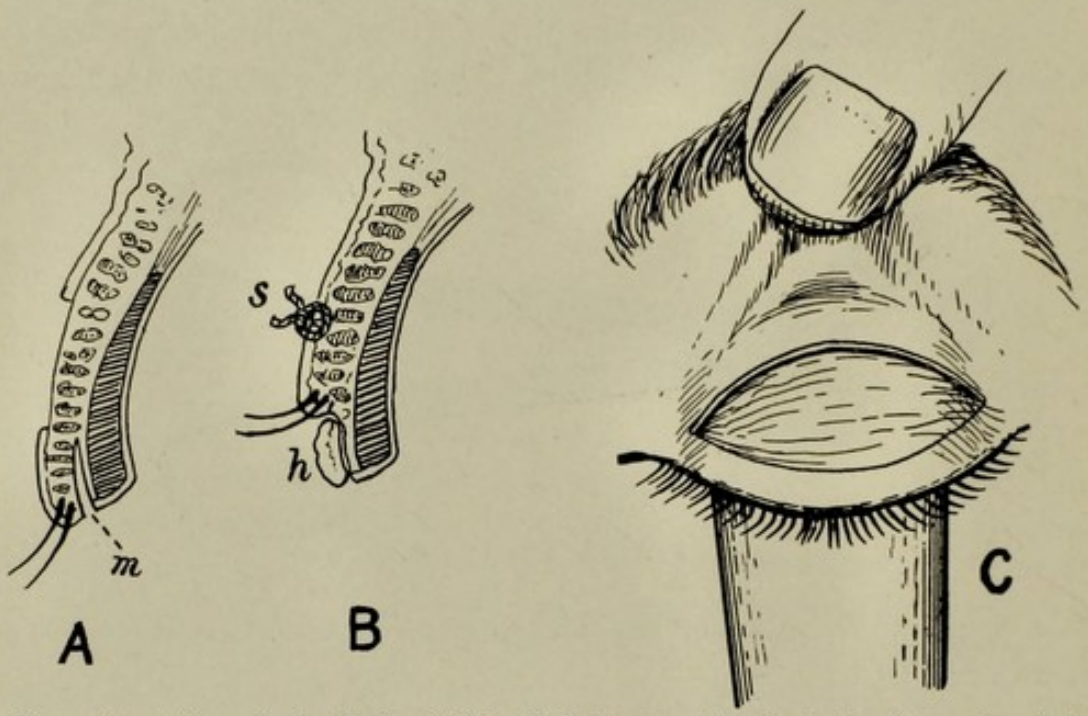


Arlt's Iris Punch.

firm pressure, a piece of the diaphragm is punched out and withdrawn.—(A. A.)

Arlt-Jaesche operation for trichiasis. An intermarginal incision is made along the whole length of the lid, following the gray line on the free border. This incision should be 3 or 4 mm. in depth, and should be so placed that all the lashes will be in the anterior layer which is separated from the tarsus. A fold of skin is next removed from the anterior surface of the lid in the following manner. An incision is made in the skin parallel to the free border and about 4 mm. from it; above this and joining it at each end, there is made a curved incision through the skin, which marks out a crescentic area of skin that at its widest part at the middle of the lid is about 8 mm. This crescentic piece of skin is then dissected off with blunt-pointed scissors or scalpel, care being taken not to buttonhole it, and not to remove the subjacent fibers. The gap produced by the excision of this piece of skin is then closed by five or six sutures. Arlt recommends that, in placing them, the needle first pass through the skin of the upper edge of the cilia flap, then include some of the orbicularis fibers over the tarsus and, finally, the skin of the upper lip of the wound. The sutures are not cut off, but are drawn

upwards to cause the cilia border to take its new position higher up on the tarsus, and are secured to the forehead over the brow by an adhesive strip. The raw surface below the cilia border is allowed to heal by granulation. This objectionable feature is overcome by the plastic modification suggested by Waldhauer of placing the excised strip of skin on the raw border, and the operation



Transplantation of the Bed of Hair Follicles by the Method of Jaesche Arlt.

A. Cutaneous Incision and Incision in the Intermarginal Zone, m.
B. After Tying the Cutaneous Sutures, s, and implanting the piece of Skin, h.
C. Front View after Excision of the Skin has been done, with the Horn Plate inserted.

is usually practised now with this valuable modification. After excising the strip of skin, which should be as thin as possible, it is placed in warm 0.5 per cent. NaCl solution until the wound in the skin has been closed, as described, and the bleeding at the border of the lid has been completely checked. It can then be placed in position on the raw border of the lid, and if necessary trimmed a little to make it fit exactly. This trimming should be done with scissors, only after the flap is in position and held by an assistant. In most cases sutures are unnecessary, but possibly a fine one may be placed at each end and one in the middle, if the flap is not nicely apposed.

Care should be taken not to excise too wide a piece of skin lest ectropion result. To avoid this, before making the skin incision,

the operator should estimate the amount required by pinching up a fold of skin and noting the effect on the lid border.

As in all cases of transplantation of skin flaps, strips of rubber tissue or oiled silk should be placed over the wounds before applying the dressing. The wound should be dressed each day, and at the end of the second day traction on the sutures may be released. The wound should have healed sufficiently by the fourth or fifth day to allow the removal of the sutures. Should the flap slough, it will be necessary to cover the granulating area with a piece of hairless skin taken from behind the ear, or with a piece of mucous membrane from the inner surface of the lip.—(W. H. W.)

Arlt's operation for internal tarsorrhaphy. A narrow strip of skin is resected from around the inner canthus, being very careful not to wound the underlying canaliculi, and the two raw edges brought together by means of fine sutures. The incisions should not, of course, be so extensive as to encroach on the puncta. At the end of a few days union will be complete and the stitches may be removed.—(C. H. B.)

Arlt's orthoscope. This device is a modification of Czermak's similar instrument, intended to make the fundus oculi visible by immersing the eye in water and thus neutralizing the refraction of the cornea. Czermak surrounded the eye to be examined with a thick layer of dough. The cup was then filled with water at an agreeable temperature (about 95°), the patient leaned forward and closed the eye and the edges of the cup were pressed into the dough to prevent leakage. After this the eye was opened and a clear examination of the fundus was obtained.

Arlt modified Czermak's orthoscope by making it of soft rubber, with one side of glass; this simplified the instrument by eliminating the unwieldly dough, and yet allowed it to be closely applied to the eye. Coccius devised a cup, whose bottom was glass and the rim made to fit tightly around the eye. This could be held to the eye close enough to permit an examination. It is claimed that the use of the orthoscope requires less skill than the ophthalmoscope, although more disagreeable to the patient. In cases presenting corneal opacities to be studied carefully, or when the fundus is obscured by an irregular astigmatism the examination under water gives the best results.

Arlt's salve. This ointment is less known and used in America than in Germany. It is prescribed as an analgesic and counterirritant to relieve the bulbar congestion and pain of scleritis, iritis, corneal ulcer, etc., and for the blepharospasm of phlyctenular keratitis. It

may be rubbed into the temples and forehead three or four times daily. Ohlemann, in Oliver's translation, gives the formula as:

℞

Ungt. hydrarg. cinerei (P. G.)	5.0 gm..
Extract. belladonnæ	0.5 gm.

For the first ingredient one may substitute unguentum hydrargyri ammoniati, U. S. P., which it resembles.

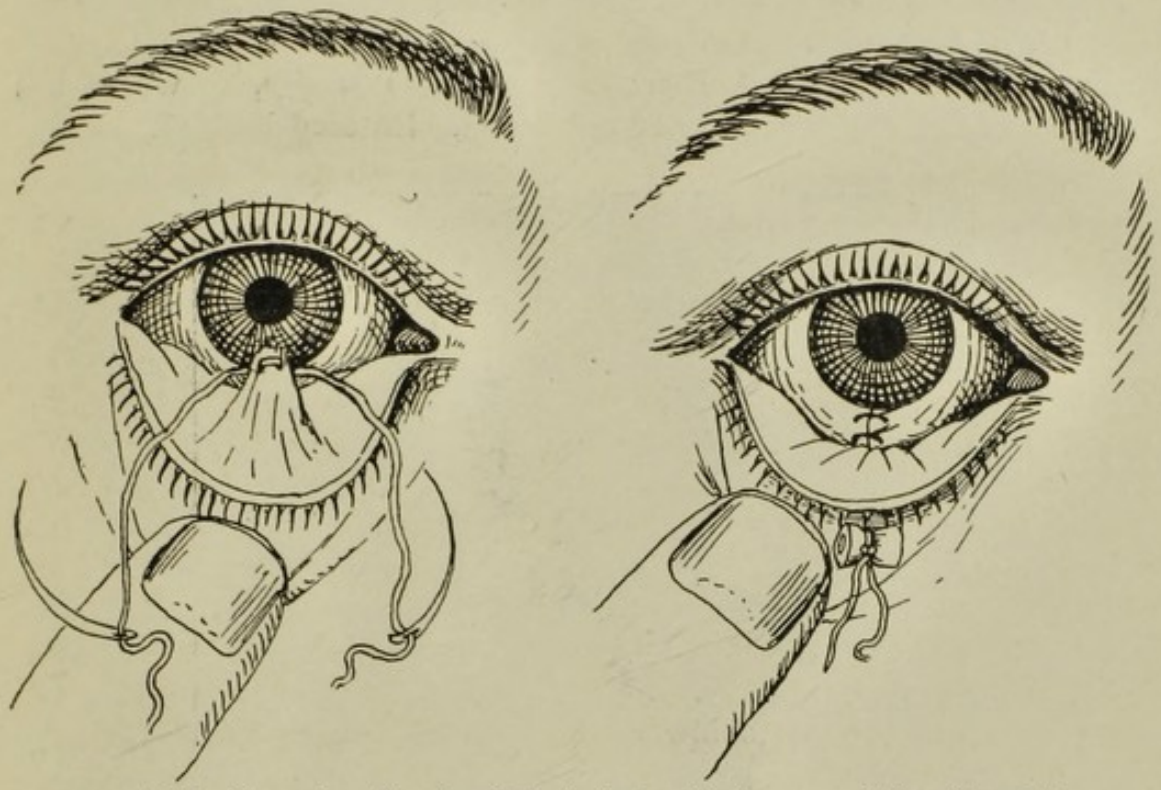
This mixture of a mercurial ointment with belladonna is so compounded that the action of the latter drug may prevent or limit symptoms likely to arise from an overdose of mercury. In so limiting the ptyalism and other disagreeable results of the inunction the surgeon is enabled to give his patient larger doses of the antiluetic drug.

Arlt's scalpel. This instrument is a modification of the knife used by general surgeons and is well adapted to ophthalmic purposes.

Arlt's Scalpel.

Arlt's symblepharon operation. Of the symblephara that include the retrotarsal folds the commonest form is what is known as the columnar type, in which a thin band of adhesion reaches from the fornix for a variable extent up to or involving the cornea. For its relief many operations have been adopted, but that of von Arlt (see the figure) is the one most commonly used. It is performed as follows: If the cornea is involved this portion of the adhesion is grasped with delicate, sharp-toothed forceps and carefully dissected away with a keen-edged scalpel. Some operators prefer first to pass through the apex of the adhesion a double-armed suture by which it may be held instead of with the forceps. This suture should be so inserted as to have the loop lie upon the outside of the adhesion, as it can thus be best utilized when the apex of the cicatrix is buried, in a later stage of the operation. The apex having been freed from the cornea, the adhesion is abscised from the globe by blunt, curved scissors, after which the scar tissue is completely cut out of the loosened bulbar conjunctiva by two incisions made from its apex to its base. This leaves the adhesion a freed tag, or flap, which is turned into the opening at its base and secured by sutures which pass out through the entire thickness of the lids and are tied over a small roll of gauze or piece of rubber tubing. The edges of the bulbar wound are freely dissected loose, or undermined, with blunt scissors, and then united with fine silk sutures. If the corneal involvement has been

extensive it may be necessary to cut the conjunctival flaps free for a short distance around its edge, to secure good coaptation. Especial care should be taken to close the wound in the bulbar conjunctiva well down into the fornix, as it is there that recurrence is most apt



Arlt's Operation for the Relief of Symblepharon. (After Beard.)

to take place. The turning of the tag into the lid produces a pronounced bunch of scar tissue and conjunctiva which, however, usually disappears in time.—(C. H. B.)

Arlt's test. This is a test for ocular malingering, by means of weak (+ 0.25) lenses, with which the simulator pretends that his sight is considerably decreased or improved in the supposed weak eye. It is not as useful as the Fles (q. v.) box, or some modifications of it.

Armaignac's tattooing method. Armaignac (Nouveau procédé pour le tatouàge régulier de la cornée. *Recueil d'Ophtalmologie,* August, 1903, p. 463) has constructed a shield guide which is shaped like a bottomless saucer that exactly equals the size of the intended pupillary area. It is laid in position and fixed by small retaining hooks. It is then filled with the pigment massing, which is brought into direct contact with the area which is intended to be pigmented. The tattooing is performed in the included space. The greatest disadvantage that the contrivance possesses is that the field of operation cannot be made visible without removing the instrument. He has devised a second guide for the corneal size.—(C. A. O.)

Armaignac's test. This device, like so many instruments for the detection of simulated monocular blindness, is a modification of the mirror arrangement in Fles' (q. v.) box. The malingerer, unless he closes one eye and makes a direct observation, is pretty certain to believe that he is seeing with his admittedly sound eye when he really fixes with the alleged amblyopic eye.

Armati, Salvino degli. A Florentine of noble family, to whom has been ascribed the invention of spectacles. He died in 1317.

Modern Bust and Inscription, Copy of Mediæval Tomb of Salvino d'Armati.

For the sake of completeness, it ought to be added that spectacles and eyeglasses were wholly unknown to the ancients. All that the weak of sight, whether from age or from any other cause, could do,

in antiquity, to improve their sorry lot, was (1) to look at letters, one eye at a time, through a little role or tube, innocent of lenses, thus by means of isolation securing a certain amount of distinctness; and (2) to "strengthen" and "clarify" the eyes with local "collyria" or "purifications" of the body generally. Nero's emerald, so often referred to in this connection, was not a lens of any sort, but a concave mirror. Spectacles were really invented by someone, nobody now knows whom, near the middle of the thirteenth century. [Perhaps it was Roger Bacon (q. v.).—(Ed.)] This person would not divulge the secret of their manufacture, and his name has sunk into oblivion. Armati—the subject of this sketch—has been said to be that person, but only on the ground that his relatives, or friends, caused to be engraved on his tomb (a modern reproduction of which is now in the Church of Santa Maria Maggiore, at Florence, Italy) these words: "Here rests Salvino Armato of the Armati of Florence, the Inventor of Eyeglasses. God Pardon him his Sin. In the year of the Lord, 1317." The original tablet (see figure) is preserved in the National Museum at Florence. A writer in 1684, one Leopoldo de Migliore, declares in his *"Florence Illustrated"* (published in that year) that he had in his possession the MS. of another person in which the aforesaid monument and its highly important inscription are mentioned. To show how valueless this monumental testimony from friends and relatives really is Hirschberg relates, with his usual patness, that when on a ship sailing from New York to Bremen, he was approached by an American gentleman, who casually inquired: "While in New York, did you happen to meet my nephew, the inventor of the ophthalmoscope?"

A little after the invention of spectacles by "the man who would not tell," they were re-invented by Alexander de Spina, who "communicated to others concerning them with a willing and joyful heart." See **Alexander de Spina**. Also, **Eyeglasses and spectacles, History of.**—(T. H. S.)

Armature. n. A piece of soft iron attached to the poles of a magnet, to prevent dissipation of its magnetism.

Armitage, Francis Rhodes. This philanthropist, with F. F. (now Sir Francis) Campbell, exercised the largest influence of any man in Great Britain on the welfare and education of the blind. Born in 1824 he spent the earlier years of his life in Avaranches, in Normandy, and later went to school in Germany, where he acquired a fluent use of German. He lived later in Paris, taking lectures at the Sorbonne. In 1840 he began the study of medicine at King's College, taking his degree in surgery and later in medicine, when he became

a member of the Royal College of Physicians. He practised medicine very successfully for a number of years until 1860, when he was obliged to relinquish his profession because of failing sight due to an affection which had already seriously interrupted his studies during the period of his studentship. He became painfully aware that those who are unable to use their eyes freely are debarred from many of the pleasures of life; and when to blindness are added poverty and inefficiency their lot is most unhappy. He therefore became actively connected with the Indigent Blind Visiting Society, and through his intelligent reorganization of the Society greatly increased its usefulness. He had an independent fortune and his private beneficiencies to this charity were not less than seventeen thousand pounds.

His studies of blind institutions in Great Britain and throughout the continent were as thorough and complete as might have been expected from one of his scientific training. He spent much time in Paris at the Institution for the Blind, and found that by means of the very thorough instruction given there, 30 per cent. of those trained as pianists, organists, or tuners were able to support themselves very comfortably by their work. In England not more than one per cent. could do this.

In 1868 he founded the first of his great societies, the British and Foreign Blind Association. At that time there were many forms of raised types in existence, none of which were wholly satisfactory. It became evident to him that most of these were the devices of the sighted rather than of the blind. He therefore invited the assistance of several blind men of judgment and intelligence and together they spent two years in studying the existing types. These were for the most part some form of the raised roman letter.

Although France had been slow to recognize the value of the punctiform type during the lifetime of Louis Braille it was at this time in general use in Paris and upon the continent. It was evident that this type had a practical value possessed by none of the others. Armitage and his coworkers immediately took steps, through the new association which he had formed, to introduce it in England. Besides other gifts Dr. Armitage gave the association, free of rent, a suite of offices in his town house in Hyde Park, paid for the clerical staff and himself met the deficits year after year.

Having gotten the machinery with which to do printing and publishing, Armitage devoted himself to propaganda in favor of his blind protegés. He delivered lectures before the Society of Arts, and elsewhere, showing the possibilities of the Braille notation in litera-

ture and music, and explaining how greatly their opportunities would be widened by adequate educational methods.

Just at this psychological moment he met Francis F. Campbell, recently knighted by King Edward VII, a blind young American who had been travelling in Europe and studying in Berlin, and who was about to return to the United States. Campbell had been a tutor in the Perkins Institution for the Blind in Boston and was a man of great force of character, marked originality of conception and withal broadly educated and thoroughly trained in music. He had already, when in America, demonstrated that the blind are capable of being musically educated, nineteen out of twenty pupils whom he had taught being able to support themselves. Having already the same ideals he quickly became imbued with Armitage's enthusiasm. After many discussions it was decided to found an institution for the blind on new lines, and the Royal College of Music was the result. Campbell became the principal in 1872, and after forty years of successful service he resigned to enjoy in his declining years the leisure which he so richly deserved.

Although Dr. Armitage's money benefactions to the College and to other works for the blind were large and numerous, his greatest gift was his own personal interest and his untiring sympathy and encouragement. [For the above facts the biographer is indebted to *Illingworth's History of the Education of the Blind.*]—(F. P. L.)

Army hygiene. See **Soldiers' eyes, Examination of.**

Army, Visual requirements for the. Although these vary in different countries, yet the following requirements for entering the United States Army are practically identical with those in use elsewhere. Tipler's *Manual,* the official guide in this country, gives as causes for absolute rejection:

Loss of either eye; chronic inflammation of the lids, when they are red and swollen with a collection of more or less dried matter on the edges between and around the lashes; the ball of the eye will also be "bloodshot;" myopia (near-sightedness); hypermetropia (over-sightedness), except when moderate and free from organic disease; astigmatism; inability to read or describe with facility the types or characters on the test cards. This examination requires the greatest care and patience on the part of the recruiting officer; it is made with cards bearing the twenty-feet test-types and test-characters. To use the cards, measure off a distance of twenty feet in a straight line, place the applicant with his back to the light at one end of the line, while the examiner stands at the other and holds the card exhibiting the test types or characters in full view of the applicant so that a good light falls on the card.

Each eye should be examined separately, one being covered with a card (not with the hand) by the assistant, who, standing behind the applicant directs him to read the types on the card held by the examiner; if he cannot read, the card bearing the characters is presented to him, which he is directed to describe. The types should be read first from left to right; the characters should be described as to the numbers of arms seen on each and the direction in which they are pointed, whether upward or downward, to the right or left. If the applicant should be unable to read the test-types or describe the test-characters correctly with either eye he must be rejected.

This standard for vision may be departed from in the examination of candidates for appoinment into the Medical Corps of the Army and in the enlistment of members of the Hospital Corps, and the applicants who are the subjects of refractive errors, viz., myopia, hypermetropia, presbyopia and astigmatism, provided these errors are not excessive, may be entirely corrected by glasses and are not progressive or accompanied by ocular disease.

The object of this test is to exclude from the service men whose visual defects are such as to prevent them from becoming marksmen. Successful use by the soldier of long-range fire-arms demands that his vision shall be normal or so nearly normal that there need be no question of his ability to see the target at all ordinary ranges.

A large percentage of men are the subjects of slight visual defects, not to such extent as to disqualify them for military duty, but sufficient to cause a little blurring or indistinctness in some of the letters of the required test, which may be increased by the nervous apprehension of failure. Ignorance, fear or stupidity on the part of the applicant are factors to be considered in making this examination, and unless the recruiting officer exercises sound judgment he will probably reject men whose vision is in reality good, hence plently of time should be taken and slight errors such as reading a P or T for an F, provided the majority of the test letters or test characters are read with facility, need not be regarded as a failure of the test.

The cards used at recruiting stations for testing vision should be kept locked up when not in use, or otherwise protected from access by prospective recruits. In all doubtful cases a small paddle with a hole in it of such size as to expose only one letter at a time should be used; such a device, intelligently used, would make memorizing of no avail.

In time of war none of the defects mentioned above as disquali-

fying in time of peace should exempt conscripts from service save those caused by extreme refractive errors or organic disease, and as defects of vision are easily feigned the examination of the vision in doubtful cases should be made by a medical officer.

The following modifications have been made by order of the Secretary of War and were kindly furnished from the Surgeon General's office by Chas. F. Mason, Major Medical Corps, U. S. Army:

General Order No. 199. The following methods for determining and recording acuity of vision and color sense are prescribed for the army and will be followed whenever practicable in the examination of applicants for admission to the United States Military Academy and of applicants for commission, promotion and in any case of disease or disability of officers or enlisted men where these senses may be affected:

In case of applicants for enlistment the existing methods of examination will be continued at the general recruiting station, but the methods herein prescribed will be applied at the recruit depots, depot-posts, and other garrisoned posts.

For determining and recording the visual acuity the test-type should be placed in a good light, about the height of the eye. If the room is not well lighted by daylight, an artificial light with a reflector should be used, as it will be more uniform. Place the candidate or patient with back to the window or source of light, at a distance of 20 feet, or 6 meters, from the type. Examine each eye, covering the other eye with a card or an opaque disc in a trial frame. The hand should not be used for this purpose, as it temporarily blurs vision. The right eye should ordinarily be examined first before the candidate becomes familiar with the types. The candidate should be directed to read the test-type from the top of the card down as far as he can see, and his acuity of vision recorded for each eye with the distance of 20 feet as numerator, and the proper distance of the lowest line he can read correctly as the denominator of a fraction.

If the acuity of vision is less than 20/20 and is corrected by glasses, the acuity without glasses and with glasses is given and the correcting formula is noted as:

Vision, R. E. 20/40, corrected to 20/20 by—I. D. cy. 180°.

Vision, L. E. 20/100, corrected to 20/30 by—.50 D. cy. 180°—2.00 D. S.

If he cannot read the type at any distance, the distance at which he can count fingers is recorded as: Vision R. E. can count fingers at 20 inches.

If he cannot count fingers, the distance at which a light can be distinguished is recorded.

If a light cannot be distinguished he is recorded as blind.

As the types are memorized easily, they should not be left where applicants can read them, and it is well in examining the left eye to direct that the lines be read from right to left and to use new type in case of doubt, or to expose one letter at a time by means of a small opening in a card or sheet of paper.

A more correct idea may be obtained by having the candidate read from the top of the card down. Do not direct him to read the lowest line he can see, and always use a card having type from 10 feet to 200 feet.

The distance of 20 feet should not ordinarily be reduced, as a shorter distance leads to some error from the action of the accommodation and from the fact that the type may then be within the far point of moderate myopia.

Color sense is the power which the retina has of perceiving color, or the sensation from the impression of different wave lengths of light.

Color blindness is the absence of the perception of one or more of the primary colors, red, green and violet.

Complete color blindness is the absence of the perception of all color.

Partial color blindness is the absence of the perception of one or two of the fundamental colors, objects of the missing color sense being seen in shades of gray.

When one of the colors is absent there is said to be complete red, green or violet blindness. Violet blindness is rare, the ordinary forms being red and green blindness.

The following method of Holmgren is used for the detection of color blindness and the tests should be applied to all persons examined for admission to the army and the result recorded.

This consists in the power to select various colors in the form of test wools to match certain test skeins.

In recording the results of the examination the terms, "color sense normal," "color sense feeble," "incompletely color blind," "completely red blind," "completely green blind," "completely violet blind" and "completely color blind" (all colors) will be used.

Circular No. 4. The following minimum visual requirements for recruits will supersede such requirements of the Epitome of Tripler's *Manual* as are in conflict herewith:

For the line of the Army and for the Signal Corps: 20/40 for the better eye, and 20/100 for the poorer eye, provided that no organic disease exist in either eye.

Recruits may be accepted for the line of the Army when unable with the better eye to correctly read all of the letters on the 20/40 line, provided that they are able to read some of the letters on the 20/30.

For the Ordnance Department and for the Hospital Corps: 20/70 in each eye, correctible to 20/40 with glasses provided that no organic disease exists in either eye.—(N. M. B.)

Arnemann, Justus. This moderately well known surgeon, writer, and medical historian, was born at Lüneburg in 1763. A man of highly irritable temperament, he was nevertheless possessed, as some believed, of a charming personality, and, as all admitted, of a brilliant intellect. When only 24 years of age, he was made professor at Göttingen. Nine years later he founded his Private Surgical Hospital, and, the year following, his *Magazine for Surgical Science.* He wrote a *System of Surgery,* in which he devoted a moderate amount of attention to the eye, and which secured the mild approval of some of the general surgeons of his day. His *Review of the Best Known and Most Frequently Employed Surgical Instruments of Ancient and Modern Times* fared better. It was, however, severely condemned, the ophthalmic part in particular, by no less a person than Joseph Beer.

Like many another physician, Arnemann was often in deep financial water. In 1803, because of his debts, he fled to Hamburg. There he succeeded for a time, but, in 1806, in a fit of despondency, he took his life by shooting himself in the Wandsbecker forest.—(T. H. S.)

Arnemann's intracapsular cataract extraction. Arnemann (*Systéme de Chirurgie,* Goettingen, 1801, p. 151) extracted the cataract through an upper section made with a Beer knife and expelled the lens by a double-ended instrument, one end shaped like a Daviel curette, the other having a spiral tip like a corkscrew for impaling the lens through the pupil and drawing it out of the eye. This operation seems not to have met with favor. It was severely criticised by Himly and Schmidt as dangerous to the eye and not based on sound surgical principles.—(D. W. G.)

Arnica, Oculo-toxic symptoms from. The arnica flower contains a principle which is capable of producing inflammatory and erysipelatous changes in a sensitive skin.

A man, who had a slight inflammation of the eye, was ordered to use a stimulating eye-wash. He used a sponge that had been

employed in making an arnica application, and as a result, the lower lid became livid and edematous, and the upper not only red and swollen but covered with vesicles. The conjunctiva and cornea were normal. After 7 days the swelling subsided, the vesicles ruptured, the skin desquamated, and in 10 days, except some itching, there was a return to normal.

Arnold, Friedrich A. This well-known anatomist and physiologist was born Jan. 8, 1803, at Edenkoben, near Landau, in the Palatinate of the Rhine, and died July 5, 1890. He received his medical degree at the University of Heidelberg, and was for many years a famous teacher of anatomy and physiology in that institution. He is, however, memorable to ophthalmologists only because of his book, *Anatomische und Physiologische Untersuchungen über das Auge des Menschet* (Heidelberg and Leipzig, 1832). Most of the original views propounded in this work have since been shown to be erroneous.—(T. H. S.)

Arnold's fold. VALVULA LACHRYMALIS SUPERIOR. A fold of mucous membrane found in the lachrymal sac.

Arnold of Villanova (near Montpellier). A famous general physician (1235-1313) who became physician-in-ordinary to Peter III of Aragon, and who wrote a number of important works of a general character. His only ophthalmologic composition, *Libellus Regiminis de Confortatione Visus,* written at the request of Pope Clement V, possesses but little value. It treats merely of ocular hygiene, and is nothing but a compilation, chiefly from the Arab, Mesue.—(T. H. S.)

Arrasi. A renowned Arabian philosopher, physician, and ophthalmologist, who lived from 850 to 932 A. D. See **Ar-Razi.**

Ar-Razi, Mohammed ibn Zakarijah Abu Bekr. He was also called RHAZES, ARRASI, EL RAZI, ER RAZ, ABUBATER, ABUBERTUS, ABUBETER, and BUBIKIR. This great Arabian physician was born at Rai (hence his names, Rhazes, Ar-Razi, Arrasi, El Razi, etc.) A. D. 850. He became at first a cithern-player, later, philosopher, physician, court physician, medical teacher and author. His medical education he received at Bagdad, and there, too, he became a director of the hospital as well as professor in the medical college. In his prime he was one of the most widely known and highly honored of physicians, and patients came seeking his services from the farthest portions of the civilized world. In his old age, however, he fell on evil days, and died, totally blind and in abject poverty, A. D. 932.

He is thought to have been a teacher of rare endowment and a man of great sympathy for the sick. He was, beyond all question,

not only very learned, but wholly independent in his scientific observations—rarest of qualities in mediaeval times.

Ar-Razi, or Rhazes, is chiefly remembered by general practitioners for his little book, *De Variolis et Morbilis* (On Smallpox and Measles) which is truly the earliest monograph on, but not exactly "the earliest mention of," smallpox, in the annals of medicine. The work shows great powers of independent observation and thought. However, Rhazes's magnum opus is *Al-Hawi*, or *Continens* (The Content —i. e., of medicine). This encyclopedic treatise does really meet the exactions of its ambitious title, for it ranges over the totality of the science and art of healing as these were known and practised in the author's time. The second book of this work is the one that chiefly concerns the ophthalmologist. This book, indeed, takes up almost, but not quite, every phase of mediaeval oculistic science. Here, however, we will not exhibit Rhazes's ophthalmology, because, in its essence, it is very much the same as that of Ali ben Isa, which is set forth fully under the name of that author. It may be mentioned, however, that, in the second book of the Continens, occurs the famous passage on cataract extraction which has been so often referred to as proving that the modern mode of extracting cataract was invented by Antyllus. The passage in question runs as follows (in the Latin translation, the Arabic original being lost): "Dixit Antilos: Et aliqui aperuerunt sub pupilla et extraxerunt cataractam; et potest esse, cum cataracta est subtilis; et cum est grossa, non poterit extrahi, quia humor egrederetur cum ea. Et aliqui loco instrumenti posuerunt concilium vitreum et sugendo eam suxerunt albugineum cum ea." The fact, is, however, that, until the absolute demonstrations of Brisseau and Maître-Jean in 1705, it was not even known that a cataract is an opaque crystalline lens, the supposition being that the morbid affair consists of an inspissated humor which has "flowed down" (hence the term "cataract") into the space or chamber imagined to exist between the crystalline lens and the pupil. (See **Antyllus**; also, **History of ophthalmology**.)

A small book of Ar-Razi's, but even better known, perhaps, than the colossal Continens, is the so-called *Medical Work* [dedicated] to Mansur, Mansur having been, at the time, the Prince of Khorassan. In the ninth "book" of this little work, occur the following "chapters," or sections, which deal (in far too brief a manner) with ophthalmologic subjects: (16) Ocular Ulcers, (17) Foreign Bodies, (18) White Spot [Leucoma], (19) Trachoma and Pannus, (20) Itching of the Corners of the Lids, (21) Pterygium, (23) Epiphora, (24) Weakness of Vision, (25) Hyphema Conjunctivæ (subconjunctival

ecchymosis), (26) Trichiasis, (27) Cataract, (28) Nightblindness, (29) Enlargement of the Pupil and (30) Lachrymal Fistula. Highly condensed as the ophthalmic portion of the Mansurian treatise is, it nevertheless contains perhaps the most important contribution of Rhazes to ophthalmology—namely, the first, absolutely the first, mention in history of the pupillary contraction resulting from the action of light, in other words the pupillary light-reflex. The passage in question is as brief as it is memorable: "In the middle of the icy humor (iris) appears a hole which now dilates and now contracts, according as the icy humor feels the need of light; it contracts when the light is strong, and dilates in obscurity. The hole is the pupil, and the membrane is called the uvea." *

Then, too, besides the great Continens and the little treatise dedicated (or rather intituled) to Mansur, Ar-Razi composed a number of medical monographs, some of which are of great ophthalmologic interest. The titles of those of the latter sort are as follows:

1. *Why the Pupils Contract in the Light, and Dilate in Obscurity.* (Ar-Razi was very much interested in this highly important subject.)

2. *On the Nature of Vision*: Wherein is Shown that the Eyes are not Radiators of Light. (The great independent thinker combatted the prevalent theory that beams of energy proceeded from the eye, mingled then with the surrounding atmosphere, and, proceeding to the object of sight, surrounded it, and then returned to the eye with information about the object looked at. However, this view had been combatted before the time of Rhazes.)

3. *On the Conditions of Sight.*

4. *On the Form of the Eye.*

5. *The Book of the Surgical Treatment of the Eye.*

6. *Circular Letter to his Student, Joseph ben Jacob, on Ocular Medicines, Ocular Treatment, and The Combination of Medicines for Certain Purposes.*—(T. H. S.)

Ar-Rhazi. A transliterational variant of Ar-Razi (q. v.) (Rhazes), the famous Arabian ophthalmic surgeon who lived and flourished during the ninth century of the Christian era. See, also, **History of ophthalmology.**

Arrière-image. (F.) After-image, i. e., an impression on the retina which remains for a time after the object is withdrawn.

Arsen. (G.) Arsenic.

Arsenate of copper, Ocular effects of poisoning by. This chemical is employed in the manufacture of artificial flowers and confectionery

* See P. de Koning, *Trois Traités d'anatomie arabes*, 1903.

and in fancy baking. The ocular symptoms produced by it in those who work therewith habitually, are conjunctivitis and swelling of the lids.—(T. H. S.)

Arsenic. Arsenical preparations are particularly useful in ocular diseases of anemic or scrofulous origin, especially in phlyctenular or eczematous corneal inflammations. Arsenious acid is given in doses of 0.001 to 0.005; and as Fowler's solution, beginning with 2 to 5 drops daily after meals.

Arsenical amblyopia. Since the beginning of the eighteenth century there have been published isolated records of acute or subacute arsenical poisoning in which weakness of sight was observed with the gastro-intestinal and cerebral symptoms. At the beginning of the nineteenth century one case was observed in which amblyopia resulted from this form of poisoning. Up to the present time the number of cases exhibiting ocular symptoms has increased so that we are now able to draw a fairly consistent picture of arsenical amblyopia.

Arsenical compounds, including those insoluble in water, after they once get into the circulation, damage the optic nerve and other tissues regardless of the manner in which, or the part of the body through which, the poison finds its way into the system. It may occur during the first attack of acute poisoning, but is more frequently seen as a late result, or from the chronic absorption of small amounts of the poison. It must be remembered that considerable quantities of the metalloid may remain indefinitely in the body, especially in the long bones.

The disturbances of vision caused by arsenic, which were in preophthalmoscopic times designated as "reduction of the power of vision," or "indistinct vision," or "darkness before the eyes," were often described as being accompanied by dizziness and disturbances of hearing.

The amblyopia affects both eyes, often unequally. After acute poisoning the visual defect may be noticeable in a few hours or a few days, and then rapidly disappear, or it may appear after the intoxication and be permanent; while in a case of chronic poisoning from wine containing arsenic, it increased for about three months and left the patient almost blind, requiring three months more for the visual recovery. The pupils may be normal or dilated, but the pupillary reflexes remain normal.

Every arsenical preparation, including paints and dyes (e. g., Schweinfurth's green), the cacodylates, etc., is capable of producing, when given in any form, inflammatory conditions in the

eye and especially of the conjunctiva. The extent of these changes is generally but not always proportional to individual susceptibility, the amount of poison ingested and the length of time the poison is in contact with the parts. Dermal surfaces in contact with arsenious acid for a considerable time develop an erythema with burning and radiating pains. Later, vesicles, or even gangrenous areas may appear, which generally remain for 2 or 3 weeks. Mucous surfaces may also be affected in the same way.

According to Lewin and Guillery the eyes may become inflamed by arsenic, either by direct contact or after systemic absorption.

The most severe changes occur, naturally, from the dusting of arsenious trioxide (common white arsenic) and similar caustic preparations into the eye. In such cases a suppurative conjunctivitis and keratitis are set up. People who handle wall-paper containing arsenic, especially those colored with Schweinfurth's green, become affected with protracted conjunctivitis. In the same way girls suffer, who handle paper dyed with arsenical pigments in the manufacture of artificial flowers. People poisoned in this way also have edematous lids bordered by a scaly eruption.

From remaining in a room from whose walls the green arsenical paper was being removed the absorption affected one patient as follows: depression, hoarseness, irritation of and pain in the eyes. The conjunctiva of the lids was colored a deep red along the tarsal border and at the canthi, the lids were slightly swollen and had a tendency to blepharospasm. Vision was painful.

Arsenical conjunctivitis may also arise from the therapeutic or other internal use of arsenic, in consequence of the impregnation of the tears by the poison and the subsequent contact of the acrid fluid with the conjunctiva. Such a sequel usually appears on the second or third day. This phenomenon was noticed 9 times in 60 cases.

Edema of the lids may be absent in arsenical poisoning or it may occur on only one lid. Sometimes an erysipelatous reddening shows itself at the edge of the lids, soon healing by desquamation. There is with it itching and burning, especially of the lower lid; also hyperemia of the parts, lachrymation and photophobia.

In a patient who swallowed 8 grams of arsenic there appeared a short time afterward a rapid flow of acrid tears that excoriated the eyelids and cheeks; after recovery there remained a disposition to ophthalmia.

In England there have been many cases of arsenical poisoning from adulterated beer, followed by a peripheral neuritis and skin eruptions. These individuals also had lachrymation and swelling

of the lids. The conjunctiva was chemotic and showed hemorrhages at times, while pain in the eyes was often present. Arsenical chronic poisoning may occasionally be responsible for a marked mydriasis with loss of reaction. One case of diplopia with exophthalmus has been observed, in which there was exophthalmus from the beginning, not associated with tumor of any kind.

According to the findings of de Schweinitz *(Toxic Amblyopias,* pp. 145, 146) the poisonous action of arsenic is mainly local on the skin, or it may be absorbed through the stomach, or reach the blood and tissues by inhalation through the lungs. The extensive use of arsenic in the arts has led to many cases of poisoning; for example, from wall paper or articles of clothing.

"The widespread pathological lesions which occur in arsenical poisoning, namely, fatty degeneration and peripheral neuritis, would seem to indicate that visual disturbances from its prolonged use ought to be frequent, and that arsenic should produce optic neuritis, optic-nerve atrophy, and other changes which are common enough from lead and allied poisons. H. Derby has reported optic neuritis and amblyopia possibly caused by arsenic. Casey Wood refers to the fact that makers of Paris-green, painters, and paper-hangers, as well as those who take the drug for medicinal or cosmetic purposes, are liable to suffer visual disturbance apart from conjunctival hyperemia and eczema of the lid."

The recent use of arsenical preparations in the treatment of syphilis has raised the question of the possible involvement of the eye—especially of the optic nerve—as a result of this form of therapy. Steindoriff *(Deutsche Med. Wochenschr.,* No. 26, p. 1226) states that a year after the first use of salvarsan, when at least 50,000 injections of that drug had been given, there were few, if any, cases in which optic nerve disease could be honestly laid at the door of the remedy. This was in striking contrast to the record of atoxyl and related preparations.

J. Igersheimer considers as a reason for this that salvarsan is not split up in the body into derivatives of phenylarsenic acid, as is the case with atoxyl. Hoppe's investigations show that salvarsan has only a slight chemical affinity for nerve tissue; three days after its exhibition he could not find any trace of arsenic in the brain, spine or optic nerves. See, also, **Atoxyl**; **Salvarsan.**

In a case of *spirarsyl toxemia* seen by Hegner in a girl 18 years of age (with syphilis) three injections of 0.3 gm. each, of the drug were given at intervals of from three to six days. Headache, vomit-

ing, icterus, marked edema of the face and an intense exanthema were present. The pupillary actions were normal. The optic papilla was very vascular and its edges were blurred. Central vision and fields were apparently normal. Death occurred under increasing cardiac weakness. The ocular pathologic findings were limited to the papilla and the anterior portion of the optic nerves. There was slight papilledema. The orbital portion of the nerve showed marked nuclear increase, and pronounced aggregation of mononuclear lymphocytes in the vicinity of the lamina and especially in the vascular sheaths and in the trabeculæ. There were no retinal changes.

Schirmer reports a case of *atoxyl poisoning* with ocular symptoms in a male 58 years of age. The patient had previously been treated with sodium arsenite, but had entirely recovered from symptoms of general intoxication when injections of atoxyl in increasing doses were followed at the end of two months by failing vision. The pupils were very large. The vitreous contained fine opacities. The optic papillæ were pallid and sharply outlined. The arteries were contracted. The visual fields were greatly contracted especially to the nasal side. There was no scotoma. The atrophy progressed until absolute blindness resulted. In a second case in which a male 73 years of age was treated for poisoning from sodium arsenite the symptoms and ultimate result were the same.

Birch-Hirschfeld and Koster record two cases of blindness from atoxyl poisoning. They state that the patient is usually doomed to blindness when the first signs of visual disturbance appear. This was so in forty-five of forty-six cases in the literature. The affection is in the nature of a primary nerve degeneration, not an interstitial neuritis. The drug seems to have a selective affinity for the rods, the cones remaining relatively intact. The microscopic findings in animals showed a pure degenerative process in the medullary sheaths of the optic nerve fibres. The cells of the brain are injured but not in one part more than another. They agree with Coppez that this drug should be banished from the therapeutic armament. Hammes reports the case of a man 66 years of age who had received eight injections of arsacetin in 0.1 gm. doses. In about three weeks blindness set in, probably from retrobulbar neuritis, as the papillæ were pale and the blood-vessels narrow. He concludes that because of the many reported cases of optic nerve trouble following the use of the newer preparations of arsenic, they are not suited to displace the older methods of giving this drug. Steindorff reviews the literature and concludes that both atoxyl and arsacetin may prove rap-

idly fatal to the optic nerve. This we can only explain as an idiosyncrasy, but it calls for great caution in the use of these drugs.

Clarke records a case of simple optic atrophy in a man 46 years of age following the use of soamin. The arteries were sometimes of normal caliber and at other times were markedly attenuated. Vision in the right eye equalled hand movements, and in the left 6/12. The fields were greatly contracted. He reports a similar condition in a man 49 years of age following the use of orsudan. He cautions against the use of *arylarsonates* where there is any disease of the arteries, kidney or liver, and doubts whether they should ever be used in individuals over 40 years of age. (*Ophthalmic Year-Book,* 1911, pp. 211, 212). See, also, **Toxic amblyopia.**

Arsensäure. (G.) Arsenic acid.

Arsenvergiftung. (G.) Arsenic poisoning.

Art. (G.) Kind.

Artanthe mollicoma. (L.) A Brazilian plant, the leaves of which are used for the same purposes as jaborandi.

Artefact. n. An histological term used to describe a structure produced by the means employed in investigation; i. e., an apparent, not a real, structure.

Artefacta, Ophthalmia. A name given by H. D. Bruns to repeated, self-inflicted injuries of the anterior parts of both eyes by which the patient (*Trans. Am. Ophth. Soc.,* 1913) that exhibited them reduced herself almost to blindness.

Arterenol. DIOXYPHENYLETHANOLAMIN HYDROCHLORIDE. AMINOALCOHOL. This product is said to be as efficient a vasoconstrictor as suprarenin and from two to three times less toxic. This has been established by experiments on animals; the fatal dose of suprarenin being 4 mgm. subcutaneously and 0.1 to 0.3 mgm. intravenously per kilogram of body weight in rabbits, while twice this amount of arterenol was necessary to produce death. While equally efficient as suprarenin synthetic (q. v.) it is qualitatively equal to suprarenin as regards increase of blood pressure and effect upon respiration and pupil.

Arteria angularis. (L.) One of the arteries of the eyelid.

Arteria capsularis. (L.) The end-capillaries of the hyaloid artery (q. v.), that spread over the posterior capsule of the lens.

Arteria centralis retinæ. (L.) See **Artery, Central, of the retina.**

Arteria, Infraorbital. This vessel is a branch of the internal maxillary artery. It enters the orbit through the fissura orbitalis inferior, and passing forward in the infraorbital canal, makes its exit

through the infraorbital foramen to supply a portion of the lower lid and cheek.

Arteria opticociliaris. (L.) Optico-ciliary artery. See **Anatomy of the eye**; and **Histology of the eye.**

Arterial pressure in ophthalmic practice. Dunn (*The Ophthalmic Year-Book,* 1909, pp. 69, 70) discusses the practical value of the sphygmomanometer to the ophthalmologist. He thinks no case of essential glaucoma can be considered fully examined until the pulse-tension has been measured. He cites 5 cases, one of which with tension of 140 mm. had the disease checked by iridectomy. Another with tension of 170 mm. ran the usual course of chronic simple glaucoma. Three others with pulse tension of 200 to 220 were not benefited by treatment. In such cases the prognosis is very bad, and the higher the blood pressure the greater the danger from using a mydriatic. In corneal ulcerations the blood pressure may suggest a cause of failure to respond to treatment. In operating for cataract, the nearer the blood pressure to normal the better will the case do. In a case of iritis the blood pressure of 220 called attention to acute nephritis, and suggested local bleeding, which greatly relieved the pain. In cases of hemorrhagic retinitis, and in inflammatory conditions of the optic nerve, the blood pressure may throw important light on the case. In chronic headaches and migraine, for which relief is sought by glasses, the same may be true. See **Glaucoma**; **Sphygmomanometer.**

Arterieatherom. (G.) Atheroma of the arteries.

Arterieektasie (G.) Arterial dilatation, aneurism.

Arterieeröffnung. (G.) Arteriotomy.

Arterieerweiterung. (G.) Aneurism.

Arteriehaken. (G.) An artery hook.

Arterien. (G.) Arteries.

Arterien des Augapfels. (G.) Arteries of the eyeball.

Arterienkrampf. (G.) Arterial spasm.

Arterienpuls. (G.) Arterial pulse.

Arterienverschluss. (G.) Occlusion of the artery.

Arterienunterbindung. (G.) The ligation of arteries.

Arterienzange. (G.) Artery forceps.

Arteries, Anterior ciliary. These vessels are supplied principally to the recti muscles, usually two to each muscle, but, as a rule, only one to the rectus externus; occasionally one ciliary artery arises from the arteries of the lids, runs back, perforates the sclera, and is supplied to the conjunctiva. Otherwise the anterior ciliary arteries accompany the straight muscles to their tendinous insertions, where

they perforate the sclerotic near the limbus and furnish superficial branches to the sclera, margin of the cornea, and the conjunctiva. At the sclero-corneal junction they form with the long posterior ciliary arteries the circulus iridis major. They also send branches to the ciliary muscle and to the anterior portion of the choroid. Their tortuous course can readily be seen since a portion of them is clearly visible on the surface of the eyeball.

Arteries, Ciliary. These vessels carry the blood for the entire ciliary system of arterial supply, and are divided into three groups: anterior ciliary arteries, short posterior ciliary arteries, and long posterior ciliary arteries. Each of these groups are separately described. See, also, **Anatomy of the eye; Histology of the eye.**

Arteries, Conjunctival. See **Anatomy of the eye.**

Arteries, Long posterior ciliary. Two of these vessels are supplied to each eye. They arise from the ophthalmic artery precisely like the short posterior ciliary arteries, and pierce the sclera obliquely at the horizontal meridian on the temporal and nasal sides of the optic nerve, slightly in front of the short arteries. The course of one (lateral) artery is slightly above the horizontal meridian; that of the other (medial) artery is slightly below it. After perforating the sclera they run between the choroid and sclera, directly to the ciliary body, entering the ciliary muscle, where each artery branches dichotomously. These branches run diagonally to the anterior segment of the muscle, where they form loops and then join the branches of the other arteries. Horizontal anastomoses connect these arterial twigs with one another. This vascular ring, of which the arterioles of the anterior ciliary form a part, is called the circulus (arteriosus) iridis major. Before reaching this circle both long posterior arteries furnish branches to the ciliary muscle, as well as recurrent rami to anterior areas of the choroid. See, also, **Anatomy of the eye.**

Arteries, Macular. These minute but important arterioles are usually two to four in number. As a rule, they arise as independent branches of the trunk of the central artery of the retina in the papilla, but occasionally from one of its larger branches. They then proceed to the macular region, which they nourish. In a fundus with a macular cilioretinal (q. v.) artery that vessel provides the entire nourishment of the macula.

Arteries of the orbit. With the exception of the infraorbital artery, which arises from the internal maxillary, all of the orbital arteries are derived from the ophthalmic artery (q. v.), which in its turn arises from the internal carotid and enters the orbital cavity (on the lateral aspect of the optic nerve) through the canalis opticus.

All the orbital arteries are characterized by their remarkably tortuous course; they also have heavy walls and are loosely held in the fatty tissues of the orbital cavity. In their origin and course each artery of the orbit shows individual variations. All of them give off small branches that supply the fatty tissues, the muscles, the fascia and the nerves of the orbit. See **Anatomy of the eye.**

Arteries, Papillary. The vessels are given off by the arteria centralis retinæ in its course over the papillæ. There are two primary branches, the arteria papillaris superior and inferior respectively. The papillary arteries may also include those nutrient twigs that enter the papillæ from all sides.

Arteries, Short posterior ciliary. There are from four to six of these small vessels arising either from the ophthalmic artery or its primary branches. As a rule, the ophthalmic gives off an inner and an outer branch and these subdivide into the posterior ciliary arteries, although single ciliary arteries may have independent points of origin. Before reaching the eyeball they frequently divide, pursue a relatively straight course and then pierce the sclera principally in the neighborhood of the posterior pole, although a few of the smaller vessels perforate the globe near and on the nasal side of the optic nerve. After giving off numerous fine branches, they all anastomose in the choroid. See **Anatomy of the eye.**

Arterio-capillary fibrosis. See **Arterio-sclerosis.**

Arterioklerose Opticusatrophie. (G.) Atrophy of the optic nerve in arterio-sclerosis.

Arterioklerose Verschluss der Centralarterie. (G.) Occlusion of the central nerve in arterio-sclerosis.

Arteriopressur. (G.) Acupressure.

Arteriös. (G.) Arterial.

Arterio-sclerosis. Loss of elasticity or fragility on the part of the arterial walls is an important element in the production of certain complications about the ocular apparatus. Unfortunately the treatment of arterio-sclerosis, when the condition is once fully established, is very unsatisfactory. It is important, therefore, to recognize the early onset of this disorder and to immediately adopt those prophylactic means that can, in many instances, prevent the complete development of arterio-sclerotic degeneration of the cardio-vascular apparatus. In the majority of cases, of course, arterio-sclerosis is merely an evidence of senility, premature or normal, and here any causal treatment is manifestly impossible. A small minority of cases of arterio-sclerosis are, however, due to distinct metabolic disorders as gout and goutiness, diabetes, obesity, to a variety of chronic intoxications and chronic forms of intestinal

derangements, as well as to the abuse of alcohol, tobacco and lead, and, finally, to syphilis.

Symptomatic treatment must chiefly concern itself with preventing hypertension of the peripheral vessels, in other words, with keeping down the blood pressure. The general dietetic rules to be observed are the following:

Alcoholic beverages and tobacco, as well as tea and coffee, should be forbidden altogether. Meat should be reduced, and particularly those varieties of meat and meat preparations known to contain extractives, should be eliminated from the diet. A diet, therefore, consisting largely of milk, plenty of fresh fruits and vegetables, cereals and moderate amounts of fats is the best. Above all things, however, great care must be taken not to chronically underfeed the patient. The ingestion of liquids should be somewhat restricted. The same principles should govern the choice of a climate or an altitude, the employment of bathing, or other hydrotherapeutic means in these cases as in cases of valvular heart disease with decompensation.

The medicamentous treatment of arterio-sclerosis consists first in the use of iodides, either of potash or sodium, preferably administered in combination with some alkali, as bicarbonate of soda. A very useful routine method of administering iodides and alkalies is the exhibition of 2 to 10 drops of the saturated solution of iodide of sodium in a glass of milk, to which is added one-third of a teaspoonful of bicarbonate of soda. Iodides are best given after a meal. They should never be administered together with acid foods nor should they be given patients suffering from gastric catarrh, and they should never be administered in a metal spoon. In order to prevent the development of iodism the administration of the iodides should be interrupted from time to time. The exact mode of action of the iodides in arterio-sclerosis is not known, and it is useless to discuss the numerous theories that have been advanced to explain their action.

The nitrites may also be used in order to reduce blood pressure. They are best administered in the form of a nitrate combined with sodium bicarbonate, as the nitrates undergo reduction to nitrites in the body; or nitrite of soda may be given in tablets or solution in the dose of 1 to 2 grains. Heart tonics should be given with care in arterio-sclerosis on account of the inability on the part of the arteries to adapt themselves rapidly to blood pressure changes. In cases of cardiac insufficiency, however, developing later in the disease with low blood pressure, digitalis administered continuously

in small doses, say, for instance, of one drop of the tincture three times a day, is of decided value.—(D. H.)

Arteriosclerosis, Ocular. Changes in the ocular blood-vessels, especially of those supplied to the interior of the eye, may be due to local causes, although they are usually part of systemic alterations.

The importance of these organic changes cannot be overestimated in the diagnosis, prognosis and treatment of the patient exhibiting them, either from the standpoint of the ophthalmologist or of the general practitioner. Although this matter will be fully dealt with elsewhere in this *Encyclopedia,* it may not be out of place to speak of the ophthalmoscopic appearances usually seen in these cases. de Schweinitz, to whom we are indebted for much information on this subject (*Diseases of the Eye,* Sixth Ed., p. 592) includes among them: (1.) Alterations in the course and caliber of the retinal arteries, manifesting themselves as (a) undue tortuosity, which is not significant unless, to quote the words of Mr. Gunn, whose classification is followed, it is associated with other evidence of disease; (b) alterations in the size and breadth of the retinal arteries, presenting, as it were, a beaded appearance. (2.) Alterations in the reflections from, and the translucency of, the walls of the retinal arteries, manifesting themselves (a) in increased distinctness of the central lightstreak on the retinal vessel and an unusually light color of the entire breadth of the artery; (b) loss of translucency, so that it is impossible to see, as is possible in the normal state, through the artery an underlying vein at the point of crossing; (c) positive changes in the arterial walls, consisting of whitish stripes, indicating degeneration of the walls or infiltration of the perivascular lymph-sheaths *(perivasculitis).* (3.) Alterations in the course and caliber of the veins, together with signs of mechanical pressure, manifesting themselves (a) in undue tortuosity, which, as in the case of the arteries, is not significant except in the presence of other disease; (b) alternate contractions and dilatations; (c) an impeded venous circulation where a diseased artery crosses it. The last is a sign of the utmost importance. Ordinarily, as an artery crosses the vein, as it may be seen by an examination of the normal eye-ground, there is no sign of pressure, and the translucent vein permits a view of the artery beneath it. If the walls of the artery are thickened by disease, then it presses upon the vein, pushes it aside, or directly contracts its caliber, so that beyond the point of crossing there is an ampulliform dilatation. (d) Changes in the venous walls, precisely as they occur in the arteries, so that whitish stripes border the vessel, and are indications of degeneration in its walls. Often associated with this one may see varicosities. (4) Edema of the retina, manifesting it-

self (a) as a grayish opacity, which may be present in the immediate neighborhood of the papilla, or in spots over the eye-ground and along the course of the vessels, looking like a fine gray haze, or in little fluffy islands far out in the periphery. (5) Hemorrhages, manifesting themselves as linear extravasations along the course of the vessels, roundish infiltrations scattered over the fundus, or sometimes in a drop-like form.

All these changes have been described by Raehlmann, Friedenwald, Hirschberg, the author, and other observers, and have been especially accurately recorded and classified by Marcus Gunn. See, also, **Retinitis, Albuminuric.**

Arteriosklerose. (G.) Arterio-sclerosis.

Artery. Under this heading a number of important ocular blood-vessels are, for convenience of reference, described, although it is not intended to perform this office for all the arterial branches that supply the eye and its appendages. An account of every ocular, intra-ocular and orbital artery is however, given under **Anatomy of the eye; and Histology of the eye.**

Artery, Anterior and posterior ethmoid. Both these vessels originate from the naso-frontal artery and enter the ethmoid foramen. The anterior branch then passes to and through the lamina cribrosa into the nasal cavity.

Artery, Central, of the retina. This vessel is a branch of the main ophthalmic artery, rarely of one of its branches. Still less frequently is it derived from one of the posterior ciliary arteries. From 15 to 20 mm. behind the eyeball it pierces the optic nerve in its inferior medial quadrant, and runs obliquely to the optic axis. The accompanying vein follows the same course. It sometimes happens that the arteria centralis branches off from the ophthalmic artery before the latter has pierced the dura, in which case the retinal branch is enveloped by a separate, fine, dural sheath or lamella of its own, the whole being attached to the optic nerve.

Together with the vein the artery appears at the center of the papilla and there, (or before it pierces the disk) divides into the arteria papillaris superior and inferior, which again subdivide dichotomously to supply the whole retina. See **Histology of the eye; Anatomy of the eye.**

Artery, Cilioretinal. An ophthalmoscopic examination demonstrates that about one in ten human eyes shows that not all retinal arteries arise from the central artery, but that one or more of them, supplying the macula, have their origin about and within the ring of

connective tissue in the papilla. These vessels, called "cilioretinal" by Nettleship, originate from the corona of scleral vessels, and thus carry blood from the ciliary arteries. Elschnig distinguishes 3 types, according to their origin and course, (1) a branch of the corona of scleral vessels, that enters the optic nerve and, without relation to the choroid, passes through the nerve-fibres into the retina; (2) a branch from the corona pierces the choroid at the periphery of the nerve, and there divides into several branches, one of which perforates the optic nerve and supplies the retina; (3) that artery which takes its origin from one of the choroidal vessels which, again, is a primary or secondary branch of the corona of scleral vessels.

The cilioretinal are end-arteries like the other retinal arteries. As mentioned above, they are supplied to the papillary and macular regions, but they may take various other courses. Thus the entire arterial supply of the retina may be of cilioretinal origin.

Clinically, the cilioretinal arteries are of great importance in embolism (q. v.) of the central retinal artery.

Several writers still maintain the theory that the cilioretinal arteries are branches of a centroretinal trunk that is given off from the central artery behind the scleral lamina and appears on the disk isolated from the visible arteria centralis. But there is no clinical or anatomical ground for this assumption. (*Encyklopädie der Augenheilkunde.*)

Artery, Hyaloid. In many mammals an arterial vessel springs from the optic papilla and enters the vitreous. In the human animal it is well developed in the third foetal month and follows a tortuous course to the posterior pole of the lens, after giving off the vasa hyaloidea propria. Here, the vessel divides into 7 or 8 branches, which spread over the posterior surface of the lens forming the membrana capsularis. The obliteration of these vessels begins in the sixth month, and gradually all the vascular branches disappear completely. The point of entrance into the vitreous body corresponds to the area Martegiana (q. v.), whence, after complete degeneration of the hyaloid artery, a lymph-channel, the canalis hyaloideus, runs through the vitreous, which with the hyaloid vessels is sometimes seen in the adult. See **Artery, Persistent hyaloid.**

Artery, Lachrymal. A branch of the ophthalmic artery. It follows the lateral orbital wall and is supplied to the lachrymal gland, where it divides into the arteria palpebralis externa superior, and inferior. Occasionally a recurrent branch is given off which, by way of the superior fissure, anastomoses with the middle meningeal artery.

Artery, Nasal. The inferior end-branch of the arteria nasofrontalis,

which supplies the dorsum nasi and anastomoses with the arteria angularis.

Artery, Naso-frontal. This vessel is the continuation of the ophthalmic artery. It runs along the lower border of the superior oblique muscle, passes below its ligament, ascends and divides into the frontal and nasal arteries. On its course through the orbit it gives off the two ethmoidal arteries and a few (variable) muscular branches.

Artery, Ophthalmic. The ophthalmic artery arises within the cranium from the internal carotid. Entering the orbit through the optic foramen, it passes along the optic nerve, below and to its outer side. The artery originating within the dura, it must necessarily be included in the dural sheath of the nerve, but it soon pierces the latter and then lies between the nerve and the origin of the external rectus muscle. It then curves inward and forward, crosses over the nerve below the superior rectus and reaches an upper-inner point in the orbital apex. Thence its course is forward, below the external oblique, to the upper lid where it divides into the external oblique and nasal branches. Speaking broadly (Sappey), this important artery divides into three sets, those supplied to the eyeball, those to the appendages of the eye and those that pass out of the orbit and do not go to any part of the visual apparatus.

Meyer gives the following as the origin, in their order, of the branches of the ophthalmic artery; first, the retinal artery with the inner ciliary; second, outer ciliary; third, lachrymal; fourth, upper and outer muscular; fifth, supra-orbital with posterior ethmoidal; sixth, inner and lower muscular; seventh, anterior ethmoidal; eighth, final division into palpebral, frontal, and nasal. Variations of the lachrymal artery are often reported. The other important variation is in the course of the ophthalmic, which sometimes passes under the optic nerve instead of over it. Dwight (Norris and Oliver's *System of Diseases of the Eye,* Vol. I, p. 101) describes these branches and their relations mostly as originally described by Meyer. "There are usually two ciliary arteries, an outer and an inner, each of which divides into many branches which pierce the sclerotic near the optic nerve. The number of these secondary branches may reach twenty, but this is uncommon. Two, called the long ciliaries, after entering the globe, run to the anterior part of the eyeball, but they are not easy to distinguish from the other branches while in the orbit, though said to be larger. The anterior ciliary arteries, some half dozen in number, are twigs of the muscular branches and perhaps of the lachrymal and supra-orbital, which, having divided once or twice, pierce the sclerotic in a ring near the

margin of the cornea. The two posterior ciliaries and the central artery of the retina are the first branches of the ophthalmic. According to Meyer, who has written a very valuable paper on the orbital arteries, the normal arrangement is for the central artery and the inner of the posterior ciliaries to arise in common, very often within the sheath of the optic nerve, while the outer one arises a little later. The central artery pierces the nerve within 1.5 centimetres of the globe. The next branch is the lachrymal, which arises from the outer side of the vessel to run forward to the gland along the upper border of the outer rectus. It supplies by its terminal branches the outer part of the lids and of the conjunctiva, anastomosing with arteries of the face. It has an important connection soon after its origin with a branch from the middle meningeal which enters the orbit through the sphenoidal fissure. The importance of this lies in the changes in the plan of the orbital arteries which may spring from an early variation in the course of blood through this system. This may lead to the lachrymal arising from the middle meningeal, or, more important still, to the ophthalmic becoming a branch of that artery and reaching the orbit through the fissure, or through a special canal. The muscular branches, two or three in number, are pretty uncertain in their mode of origin. The supra-orbital, which is neither constant nor important, runs in the upper part of the orbit at first to the inner side of the levator palpebræ and then above it to the supra-orbital notch. The two ethmoidal arteries leave the orbit by the little ethmoidal foramina between the frontal bone and the os planum of the ethmoid; the posterior may be a branch of the supra-orbital, the anterior comes from the main trunk. It remains only to state that they arise either separately or in common, and pass out of the orbit above the internal palpebral ligament.''

Artery, Persistent hyaloid. This vessel (a vestigial remnant in man) runs from the papilla through the vitreous humor to the posterior surface of the lens where end branches form the membrana capsularis lentis. The central canal which contains the artery is the canal of Cloquet, and in the fully developed eye it follows the course of this vessel.

The hyaloid artery degenerates and shrinks during the last months of foetal life and finally disappears. In rare cases, however, it persists on one or both sides. In cases where the vessel does not disappear in this way a thin, gray, vascular cord is seen, which may contain blood and may have branches. This string-like formation may extend from the papilla to the posterior surface of the

lens. If the artery persists in part only a mere strand of tissue with club-shaped ends extends from the optic disk to the lens or its neighborhood. Frequently a thread-like formation with fuzzy ends, which extends from the papilla or from the lens a short way into the vitreous humor, is observed floating back and forth with the movements of the eyeball. In still other cases a more or less extensive, clumpy, gray and gelatinous formation may be seen directly on the papilla; or a grayish membrane of varying extent is seen at the posterior pole of the lens (cataracta polaris posterior), representing the remains of the arteria hyaloidea, a fact to which Mittendorf some years ago drew our attention. Occasionally, a grayish-white streak is seen in the physiological excavation of the papilla, or at the hilus of the arteria centralis retinæ. This is most likely a vestige of the hyaloid artery and the canal of Cloquet. Many other variations occur. For example, in some reported cases a complete band extends from the disc to the lens. This may persist during life, but, on the other hand, it may be torn away from the lens during the development of the eye, and may be associated with tent-like detachments of the retina in the neighborhood of the papilla; or it may lead to a rupture of the lens capsule, or to the formation of a posterior lenticonus.

Along with the persistent hyaloid artery, it is not unusual to see other congenital disorders, as, remains of the pupillary membrane, various colobomata, a microphthalmus, congenital cataract, axial cataract, rudimentary development of the retina, non-formation of the optic nerve, etc.

The visual acuity may be normal with persistent hyaloid artery, although defective sight is not uncommonly found.

Artery, Supraorbital. This vessel arises from the bend of the ophthalmic artery. It curls around and over the margin of the levator palpebræ superioris muscle and runs, with the supraorbital nerve, directly beneath the periosteum of the roof of the orbit, through the supraorbital notch or foramen, to the forehead, where it anastomoses with the end-branches of the nasofrontal. See **Anatomy of the eye.**

Arthritis. Inflammation (acute, subacute, recurrent and chronic) of the joints, commonly due to the poison of gout, rheumatism, gonorrhea, etc., is frequently associated with ocular changes, especially iritis and other inflammatory diseases of the uveal tract.

Arthritis in connection with the purulent conjunctivitis of the newborn, is occasionally mentioned in ophthalmic literature. It would probably be more frequently found if carefully looked for and if the

infant were watched for a longer period after the conjunctivitis had been cured. A tabular statement of 19 cases of the kind has been collected by Dahlstroem, including one of his own. These, with a case reported by Neuburger, make 20 cases reported from Europe, of which three, each, had come from two observers, Lucas and Hoeck. The joint affection began at the 8th to the 43rd day. The presence of the gonococcus was fully established in nearly all cases, and most of the cases had other lesions traceable to the same cause. Two of the cases terminated in death. All of the larger joints seem to have been affected, often two or more of them in the same case.

Rheumatic iritis is rare, although rheumatism is usually placed after syphilis as the next most frequent cause of iritis. Yeld, who analyzed 159 cases of primary iritis, found that in no single instance was the evidence of true rheumatism conclusive. He also found among 250 cases of rheumatic fever, and 100 cases of chorea, no case in which iritis had occurred. Nevertheless, he found the association of iritis with joint affections very common; and he ascribes them to common causes, especially gonorrhea and septic conditions. The joint conditions associated with iritis are usually fixed, not fugitive like those of acute rheumatism. But iritis does occur with acute rheumatism. Forster reports a case, and Jackson another.

Artificial blood serum. PLASMA. Murray McFarlane uses a tablet which contains osmotically active salts of the blood which, added to 1,000 drops of water, makes a solution of the same alkalinity, specific gravity and cryoscopic index as the liquor sanguinis. In diseases of the eye, characterized by increased secretion he uses this plasma solution for irrigation of and cleansing the cul-de-sac. It may also be employed instead of distilled water in collyria containing such remedies as are not incompatible with sodium and potassic salts. He has also used it with good results, with or without dionin, mercuric cyanide and other drugs, in subconjunctival injections.

Artificial daylight.

Running around the ceiling of a room at the Bureau of Standards, in Washington, writes Robert Franklin (*Technical World Magazine,* Sept. 1912), is a glass tube about three inches in diameter, filled with silvery white light. It throws off a very brilliant illumination, and in color is the nearest approach to the light of the sky that has been obtained up to date. The pipe, nearly a vacuum, contains a small quantity of carbonic acid gas, which is rendered luminous by passing a mild current of electricity through it. An interesting point about this kind of light is that it has already

come into industrial employment, being used—by reason of its likeness to daylight—in silk mills and other places where textile materials are manufactured or handled, to make sure that perfect "matches" of the goods are obtained. Other gases used there in glass tubes are helium and neon, the latter an ingredient of ordinary air. The newest idea for obtaining artificial daylight is to combine a mercury vapor tube with the tungsten incandescent lamp. For this purpose the tungsten lamp (which gives off many red rays, wholly absent in the mercury glow) is placed in the middle of a ring-shaped glass tube containing mercury vapor. Then both are enclosed in a big ground-glass globe. The effect is that of an enormous luminescent opal, most beautiful as well as agreeable to the eye. Since a high temperature is required to get white light resembling daylight, the usefulness of the rare metal, tungsten with a melting-point of over 5,400°, is very great. It gives three times the amount of light for a given power as the carbon filament, and is proportionately more economical.

Artificial eyes and similar devices. A substitute for the eyeball is also known as a prothesis, or ocular prothesis. The derivation of the term is not very clear. It is probably not only a synonym but a contraction or corruption of prosthesis, meaning an imitation or substitution.

The final success of an enucleation, bulbar evisceration or Mules' operation may easily depend upon the shape, size, adjustment and manner of wearing a prothesis—details that only an experienced or, at least, trained surgeon can superintend.

Not only is it well established that the Egyptians, the Arabians, and the early Greeks were acquainted with the fact that an artificial eye can be worn in place of one lost by accident, disease or operative measures, but it is also certain that the oculists of ancient times were generally in the habit of adjusting these cosmetic articles.

Ambrose Paré (1579) was the first to give a precise description of the artificial eye. His work is illustrated by several drawings of protheses that show both surfaces much like the shell eyes of our own time. He describes these as made of metal, painted and enameled to imitate the human eye. Another variety, made of metal and painted leather, was edged with silk, to the outer border of which was attached a cord that passed under the hair and over the ear. By this means the eye could be removed from the orbit any time the wearer desired.

At the beginning of the 18th century artificial eyes began to be manufactured of glass. Heister, for example, in his *Institutiones Chirurgicæ*, 1750, devotes a whole chapter to the artificial eye.

Pansier quotes the description given by a Nevers jeweler of his method of making (about 1750) artificial glass eyes. It does not much differ from the manufacture of shell eyes in our own day.

Most of the information regarding artificial eyes, as they were made and used about this time, is derived from the thesis of Mauchart, Tübingen, 1749. From it we learn that there were at least two varieties worn in his day, ecblephari kept in place by an iron circlet about the head and hypoblephari, the ordinary shell-eye. A third class, the ancient variety, at that date rarely used, was the silver and gold eyes of the Egyptian and Arabian oculists, in more modern times painted or covered with colored enamel, to represent the iris and pupil.

Mauchart gives explicit and sensible directions regarding the care of the prothesis—how to put it in place, how and when to remove it, how to cleanse the conjunctival sac or orbit, and how and when to use detergent lotions of most value for the latter purpose. He gives the formulæ of these collyria; an important one being a warm mixture of rose water; another with "eyebright"—all of them to be applied with a sponge. He fully recognizes the disadvantages as well as the advantages of the prothesis, the danger of irritation of the socket, as well as the possibilities of harm to the fellow eye.

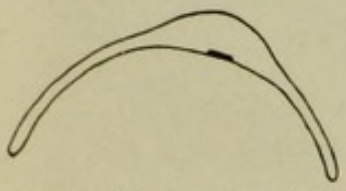
For a long time Venice enjoyed a monopoly of the manufacture of glass eyes and the strictest laws were enforced to prevent the secrets of the trade from being carried abroad. Eventually, however, France, Bohemia, and other countries became such rivals of the Venetian artists, that at the end of the 18th century the glass eyes of Murano no longer enjoyed their former commercial supremacy.

About this time Storck invented or discovered a successful method of manufacturing glass eyes, and, finally, in 1818, Hazard-Mirault published his practical treatise on the artificial eye in which most of the details of manufacture, including the rules for closely imitating all the parts in the front of the human eye are plainly set forth. After him (almost with him) came the two Desjardins and Boissonneau. The last named optician was among those who made Paris the headquarters for artificial eyes for the next half century.

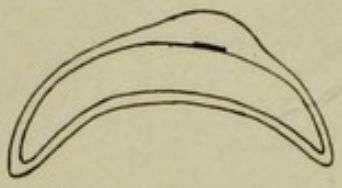
The manufacture of enameled eyes was introduced into Germany by Ritterich in 1850. That country before very long displaced France in the output of artificial eyes and at length acquired possession of most of the foreign trade and has held it ever since.

At the present day we in America are dependent almost entirely

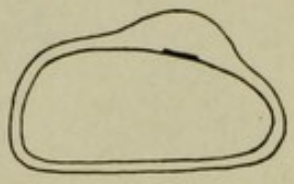
upon the output of German factories—especially those of Wiesbaden—for all forms of protheses. The exception is that a few American firms are beginning, with imported workmen, to furnish specially designed eyes to suit unusual sockets, as well as eyes specially painted and prepared to imitate exactly the fellow eye. The ordinary protheses, as generally employed, are the old shell-eyes very little changed or improved during the past 100 years, and the new "Reform-Auge," the larger, thicker, solid or hollow eye, introduced by Snellen. The latter has the advantage of filling more completely the conjunctival sac, of pushing forward the upper cul-



Profile View of an Ordinary Artificial Eye.



Profile View of a Snellen Eye.



Profile View of a Snellen Eye.

de-sac and so removing the sunken appearance (less easily remedied by the shell-eye) at the superior margin of the orbit. The effect of the Snellen eye is to produce a better prothesis; in most cases the eye stands out well. One of the purposes, also, of the "Reform" eye is to render needless such operations as that of Mules, Fox and Lang—the introduction of sponge, gelatine, globes of glass, metal or other foreign substance into the vitreous or orbital cavity or Tenon's capsule for the purpose of forming a more prominent or better stump for the superimposed artificial eye. There are cases, of course, in which even the thickest Snellen eye cannot take the place, in this respect, of some one of the above mentioned procedures but, on the other hand, a specially prepared "Reform-Auge," suited to the case in hand, will go far to imitate the prominent globe or the receding orbital walls of the opposite eye.

Apart from the ordinary uses of the artificial eye it must not be forgotten that glass and porcelain shells are occasionally employed to good purpose to prevent symblepharon after wounds, burns and operations on the lids. These are of two kinds; one sort, almost exactly like the artificial shell but adapted to the particular requirements of the case; a second variety, like the first, only pierced with a central aperture for the protection of the cornea, to permit the escape of secretions and to allow the entry of collyria to the globe and sac.

Other artificial shells, called by the French "contact glasses,"

of transparent glass, were adjusted closely to the eyeball and were recommended in irregular astigmatism and keratoconus to give a regular contour to the front of the cornea and so improve the visual powers and cosmetic appearance of the eye. In some cases there was a space between the outer layer of glass and the cornea (or the shell was hollow) to be filled with a 50 per cent. glucose solution which is of the same refractive index as the cornea. Sulzer found these non-irritating and of great benefit in improving vision. About 1871 Albini invented a plate or cover of aluminum for the front of

Artificial Eye with Gold Spring.

Snellen's Improved Eye.

the eye, to be held in place by the lids. He called this device an opistoblepharos and claimed that it is useful (a) in staphyloma corneæ upon which it might exercise beneficial mechanical pressure; (b) to protect the bulbar conjunctiva from cauterants applied to the lids; (c) as protection to the cornea in ulceration of the latter; (d) when covered with a certain composition it would take the place of the artificial eye; (e) it might act as a frame to carry minute quartz lenses and thereby be a substitute for ordinary glasses; (f) it might be useful as an electrode in applying electricity directly to the globe. Few of these claims have been justified in practice.

The vitreous protheses of the present day are made of enamel (a fusible, opaque mixture of silicon, potash, lead and tin) colored with various pigments; they are not prepared of ordinary glass as was once the case.

Pansier sets forth the advantages of the artificial eye from the social and commercial side. For the well-to-do it conceals what would otherwise be a terrible disfigurement; for the poor man it also serves to conceal what would infallibly prevent him from obtaining most kinds of work, since nobody cares to engage an artisan who presents the appearance of having but one eye.

The functions it subserves from the medical side are several. (1.) It regulates the movements of the lids. The upper lid deprived of its support by the loss of the eyeball, falls flat and flaccid; it sometimes turns in because the contracting marginal fibres of the orbicularis have nothing to oppose their action. (2.) The artificial eye relieves the friction of the lashes upon the lining of the sac due to

this form of entropion. (3.) The artificial eye directs the drainage of the sac, especially of the tears. (4.) It protects the walls of the cavity from infection and from foreign bodies. (5.) When the prothesis is worn over a globe still sensitive to light-impressions, the artificial eye may serve to cut off the light rays that, in some instances, are a source of acute annoyance to the patient. (6.) In children a large sized, well-fitting eye is a necessary stimulant to the development of the orbit and face. Deprived of the globe the infantile orbital cavity on the affected side does not increase pari passu with its fellow. The prothesis prevents to a large extent this one-sided growth provided, always, that the artificial eye is as large as possible and is almost constantly worn.

Practically whenever an eye is removed its place may be taken by an artificial one. Pansier ordered a prothesis for an infant 18 months old, and cases where they were worn at two and three years are not uncommon.

After an enucleation the artificial eye may be fitted as soon as the wound of operation has fully cicatrized. There can be no fixed rule, but the adaptation of the prothesis should not be deferred too long or done too early. An average period of four weeks is about right, although Klaunig, Galezowski and others believe that fourteen days is generally long enough to wait.

When adjustment of the artificial eye is too long delayed the lid tissues contract, the cul-de-sacs diminish in depth and there is some difficulty in adjusting an eye that is large enough, that is satisfactory to surgeon or patient or that, sometimes, is easy to retain in its proper place.

After exenteration of the orbit, especially if any portion of the lid tissues has been involved in the operation, it is extremely difficult to fit a prothesis that will produce a satisfactory cosmetic effect. Since the introduction of the Snellen eye and the possibility of having artificial eyes specially made and adjusted by competent artisans this difficulty has, in a measure, been overcome. Still, the adjustment of a prothesis after an extensive orbital exenteration remains very unsatisfactory and the majority of patients prefer to cover their deformity with a skin-colored shade—preferably of celluloid—adjusted closely to the orbital margins, rather than wear an eye that fails to disguise the defect.

An artificial eye can generally be worn with satisfaction over an atrophic globe or one from which the intraocular contents have been removed. When the cornea has been preserved it is well to order an eye whose margins mainly support the prothesis, thus pre-

venting as far as possible undue pressure on the sensitive corneal surface. There are cases in which sympathetic irritation has appeared in the fellow eye—a condition commonly calling for complete enucleation. It is even possible that an ill-fitting, or even a properly adjusted shell may light up a cyclitis in the underlying globe, an inflammation capable of transmission to the opposite eye.

The eye, whether it be a shell or a Snellen eye, should exactly resemble the fellow eye in coloration of the sclera and iris, size of the cornea, tint of the sclera, medium dilation of the pupil, in the appearance of anterior chamber, position of the visible blood vessels, location of the cornea, and convexity of the globe. Its size should conform as nearly as possible to the conjunctival cavity and orbit. In people with sensitive orbits it is well to first introduce a prothesis somewhat smaller than the one we expect them to wear finally. After an interval of a few weeks adjust the permanent prothesis. It may be put down here that the patient, if he can afford it, ought to be supplied with at least two such permanent eyes in case one is lost or broken. When these eyes are specially made for him two should be ordered.

Artificial eyes should be perfectly polished, and without defect; especially should they be free of those pin-point airholes in the glaze one occasionally sees in the cheaper grades of protheses, which are likely to harbor secretions that in a short time render the surface rough and irritant.

In passing, it may be noticed that worn, scratched or roughened artificial eyes may be polished and their life of usefulness extended, although the newly polished surface does not endure as long as the original glaze.

The edges of the prothesis ought not to be too thin—at least a millimetre thick—nor should the body of the eye be too delicate; it is then easily broken.

That the very particular patient may be prepared for most contingencies he should have two differently colored artificial eyes, one with a comparatively small pupil for use during the daytime, when he is exposed to a full illumination and the pupil of the healthy eye is somewhat contracted, and the other, with a larger pupil, for evening wear when the pupillary expansion of the seeing eye is greater than during the daytime.

The artificial eye must necessarily be adapted to variations in the capacity, depth and height of the conjunctival cavity. As a rule, however, the cornea is placed below the horizontal line (because of the greater depth of the superior fornix and width of the upper

lid) and towards the inner canthus, where the narrow part of the eye is adjusted. It thus follows that the right eye will not generally receive a prothesis intended for the left socket, and vice versa. This is, however, not always the case; indeed, Boissonneau sold an "oeil symétrique," to fit either side, but it was not a very satisfactory device.

Vendors of artificial eyes generally keep a few on hand for such anomalies as symblepharon, partially obliterated or contracted sulci, cicatricial deposits on the floor of the orbit, atrophic globes, etc., but the variations in these respects from the average socket are so numerous that it is generally difficult to secure an accurately fitting prothesis from even a very large stock; it is much better to secure the services of a competent artisan, who will make a prothesis for the particular case.

Pansier's test of a properly adjusted artificial cornea is chiefly that when the patient fixes a point three metres distant the optic axes should both appear to cut that point. That is to say, for the distance there should be a slight, apparent convergence. Better a decided convergence than the slightest divergence. He also believes that the motility of the prothesis depends as much on its perfect adaptation to the lids and stump as to any other consideration. He prefers the Bonnet method of leaving the musculature intact, a fact long ago observed by my confrere, Frank Allport, who sutures the tendons of the straight muscles at the medial incision, thus obtaining the fullest effect of their action upon the ocular pad, whether it be that resulting from a Lang's operation, an abcission, or an ordinary enucleation.

The reader is reminded that a very effective method of measuring the excursions of the artificial eye is to examine them with the á candle on the carrier of the perimeter, as in determining the angle of squint. If this is done it will be noticed that the most extensive excursion of the shell is downwards, then inwards, then outwards, and least upwards, as Truc and others have demonstrated.

Introduction is generally quite simple. Hold the small end of the prothesis between the thumb and finger of the right hand, apply the thumb of the left hand to the eyebrow and raise the upper lid, at the same time asking the patient to look down. Introduce the larger end of the eye well into the upper sulcus. Remove the left thumb from the eyebrow. Rotate the prothesis on its axis so that the smaller end almost corresponds to the inner canthus. With the left forefinger draw down the lower lid; the artificial eye will slip

into its place. Further adjust the prothesis by gently separating the two lids for a moment.

If the patient introduces his own eye he uses the left hand where the surgeon employs his right. As a matter of experience the patient soon learns not only to adjust, but remove, his own prothesis better than anyone can do it for him.

The majority of artificial eyes may be removed from the socket by drawing down the lower lid with the forefinger and at the same time pushing its point below the edge of the prothesis as it is felt beneath the lid-skin. The eye readily drops out over the margin of the lower lid. This maneuver failing, draw down the lower lid, insert the head of a pin beneath the lower margin of the shell at the inner canthus of the eye, and slowly pass it along towards the middle of the shell; the prothesis will be readily drawn out over the edge of the lid.

The patient can easily be taught both procedures and instructed to remove the prothesis over a cushion or other soft object, to avoid the danger of breakage.

For the first week or two, or until the patient and his orbit become accustomed to the presence of what is to some extent an irritating foreign body, the eye should be worn only for a few hours daily. At first it may be kept in place for an hour at a time, say, three times daily, after which it can be worn for longer periods until it is eventually retained all day.

The prothesis should be removed on retiring at night.

I have a number of patients who, for various reasons—generally cosmetic—wear their prothesis day and night, and I cannot see that any harm has arisen from following this plan, but, as a rule, the wearer should be told that it is conducive to the health of the parts to give the orbit a rest during the night.

After the removal of the shell at night the conjunctival sac should be washed out with a warm, saturated solution of boric acid, or with any other simple detergent wash, and the lid edges should be similarly cleansed.

The materials (enameled glass and glaze) from which the artificial shell is made, undergo chemical changes as the result of friction with the lid edges and exposure to the secretions from the conjunctiva. For this reason it is a mistake to add to these sources of deterioration by keeping the prothesis in solutions of any kind —even water—over night. The eye should be cleansed with warm water in which a little baking soda has been dissolved, wiped perfectly dry with a soft, clean and old linen or cotton handkerchief

or towel, polished and placed in a small box to protect it from dust until it is ready for use in the morning. Treated in this way it ought to last for one or two years. As soon as it loses its pristine polish, or sets up irritation about the orbit, or loses its motility, or looks as if it were too small or too large, it ought to be changed. The most sensible thing for the patient to do is to return to the oculist every six months for the purpose of having his artificial eye and the socket critically examined; if any change is called for, the surgeon is more likely to perceive it.

Although, in most instances, the prothesis masks an evident defect, protects the socket and its lining, and insures proper drainage of the eye, there are some possibilities of danger that inhere in the wearing of the shell, especially if it is not carefully selected, properly adjusted and duly cared for.

The depression below the upper margin of the orbit (which is always more or less marked after enucleation or evisceration) is due chiefly to the contraction of the levator palpebræ superioris that in the absence of a globe of normal size pulls the upper edge of the tarsus (into which it is inserted) directly backwards instead of upwards over the eyeball, as it usually does. In his anxiety to correct this part of the deformity, the surgeon (more frequently the optician) may introduce too large a prothesis, especially if it be of the flat type of artificial eye. This act results in the inordinate stretching of the parts, discomfort to the wearer and interference with the proper movement of the lids.

Several observers have recorded instances of damage to the socket and the remaining eye as the result of the introduction and attempted use of too large or an ill-fitting shell. Among these are sympathetic irritation, migratory ophthalmia, obliteration of the cul-de-sacs, atrophy of the lid muscles, abnormal stretching of the lid skin, symblepharon, chronic catarrh of the conjunctiva and epiphora.

If the depression caused by the action of the levators is not remedied by the artificial globe, there are several operations (those of Critchett and deWecker, for example) to which one may have recourse, although it may be said in passing that the Snellen eye, as well as the specially constructed shells, have much reduced the proportion of these defects.

Most of the obstacles have been mentioned, but it is as well to repeat some of them. As a general rule, when the sac is for any reason too small to admit an artificial eye, it will require, and may, as a rule, have a satisfactory operation performed upon it.

Conjunctival bridles may be incised, and conjunctival symblepharon treated, while even total adherence of both lids and obliteration of the sac may be remedied in consequence chiefly of the labors of American surgeons—notably Weeks and Hotz.

In some cases the artificial eye, acting as a foreign body, sets up or perpetuates a perviously existing conjunctivitis, or encourages exuberant granulations along the line of incision. Especially in the case of the shell eye, it may prolong an original vice of the conjunctiva by preventing the escape of secretions. This is especially true of that variety of artificial eye that has a rounded margin with an opening, however large, into the body of the prothesis. The concavity holds fluids that readily undergo decomposition. If the borders or surfaces have been eroded, or have lost their polish, this is all the more likely to happen. It is needless to point out that the eye should not be again worn until the disease has been cured, and that no prothesis should be kept in place that has not perfectly smooth surfaces throughout.

If the surgeon lives in a city and can send his patient directly to the optician, so that the coloration, prominence and other characteristics of the remaining eye may be noted and a selection of, say, twenty protheses returned, that a properly fitting shell can be chosen, it is, of course, the best plan to adopt; but if patient and surgeon reside at some inconvenient distance from the vendor of artificial eyes, some other course must be pursued. To meet this latter difficulty, numerous suggestions have been made and carried out—such as the preparation of models in wax, paraffin, soft tin, lead or aluminum; or of gutta percha softened in hot water, or carving them out of such materials as ivory, wood and bone. As for the coloration of the remaining eye it was either described or a painting of the eye in pastels or oils accompanied or formed part of the model; or a large photograph was taken of the eye properly colored.

In addition, the diameter of the cornea, the length and height of interpalpebral space, the average width of the pupil, the coloration of the conjunctiva and the distribution of its vessels, the degree of bulbar prominence and other necessary details were written upon the photograph. As a matter of practice nowadays, most wholesale opticians issue blanks upon which the surgeon writes the information just referred to, as well as a record of other necessary details. On the arrival of a selection of shells he proceeds to choose from the consignment and adjust a properly fitting eye.

In the larger cities expert workmen can almost always be found

who manufacture on the spot a supply of protheses in exact imitation of the remaining eye. This making of artificial eyes "while you wait" is, on the whole, the most satisfactory method for providing one or more eyes that not only resemble the living organ, but whose adaptation to the needs of the individual case is most certainly secured.

Owing to the fragile character of enameled eyes, many substitutes have been proposed. These have been chiefly protheses of lead, aluminum, ivory, bone, caoutchouc, vulcanite and celluloid.

Nieden and van Duyse devised protheses of which the body is made of material not readily broken, with a superimposed enameled iris and cornea. The substitutes (of French manufacture) are made of celluloid, but although much cheaper than the vitreous shell, are expected to last only a few months. Moreover, they lack the peculiar brilliancy of the enamel eye, their margins are thin and irritating, they readily corrode and lose their polish, and their single virtue—freedom from danger of breakage—does not compensate for these defects. On the other hand, protheses made by a competent workman, of enamel glass, resist the action of the tears and mucoid discharges from the conjunctival cavity, as well as damage from other sources of deterioration for one or two years.

Practically the same remarks apply to all other substitutes for eyes made of enamel glass. With a large supply both of the irregularly ovoid Reform protheses, as well as of the older shell plates to choose from, not to speak of the possibility of securing the services of a competent artist to make and adjust artificial eyes to almost every unusual form of socket, no patient can complain that he cannot have a satisfactory companion for his remaining eye.—(Ed.)

Artificial Eye, Improved. Grossmann (*Ophthalmic Year Book*, 1908, p. 297), to remedy the sinking of the lid often seen after enucleation, experimented by molding a piece of wax upon the upper part of the artificial eye, and finally found a maker of glass eyes who carried out the idea in glass. The prominence is situated near the upper edge of eye, and must be especially adapted to each individual case. For this reason Grossmann urges that patients should be sent direct to the maker of the eyes and that in this way a much better fit may be obtained.

Artificial house and office lighting. The rules that govern this important department of hygiene are much the same as those applicable to the illumination of school rooms (q. v.). In other words the illumination should be of proper amount and quality and should

shine upon the work to be done and not directly or by reflection into the eyes of the observer. For the general illumination of any room the best light is that which imitates diffused daylight—the sort of illumination most satisfactory to the whole visual apparatus. If these facts be borne in mind any form of artificial light may, with proper modifications to suit individual requirements, be employed. The problems involved in many office buildings, stores, banks, etc., are not easy of solution but we may, perhaps, arrive at the best light available by recollecting the following aphorisms:

(1) Electric arc lights should never be used for indoor illumination; it is too brilliant, too dazzling and too concentrated; (2) owing to the heat evolved, the danger of fire, and the vitiation of the atmosphere by gas, electric lamps are preferable; (3) the Welsbach or Auer light is too powerful for near work. If hung well out of range it is a good light for large rooms and show windows; (4) the naked filament or wire light of the electric lamp gives an irregularly shadowed field of illumination upon the printed page or other near work; it should, in consequence, always be covered by a ground or porcelain glass when employed close at hand; (5) diffusion of this light, as well as that from incandescent mantles with gas of all sorts, has lately been accomplished by prismatic globes or holophanes, so disposed that the light rays are mostly deflected downwards; (6) apart from the heat and vitiated air engendered by it, there is probably no better reading light than the old-fashioned argand burner (or "students' lamp") with gas or kerosene. (7) An imitation of the students' lamp has recently been accomplished by using with a 16 c. p. electric lamp a dull aluminum reflector. It acts very well, throws parallel rays on the printed page and does not shine into the reader's eyes.

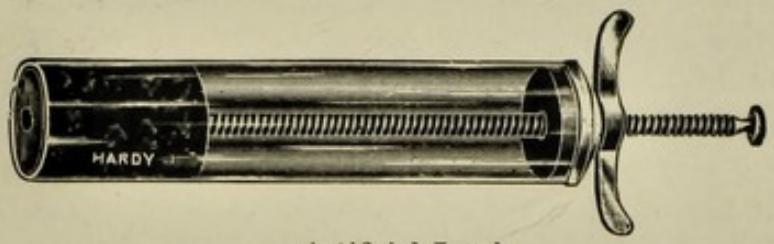
Luxfer prisms are a patented device for refracting light into the dark rooms of buildings, especially in crowded cities. They are often inserted into sidewalks and used as "batteries" before otherwise badly illuminated windows.

In this connection see also the sections on **Illumination** and **Arc lighting.**

Prismatic panes are of great value when, as in crowded cities, the lower stories in buildings are rarely or never reached by direct daylight. These prisms are arranged as ornamental panes or as canopies in front of the dark windows. For basements or cellars they are inserted in the pavement, with secondary screens below the sidewalk to assist reflection into rooms beneath.—(Ed.)

Artificial illumination of school-buildings. See **Conservation of vision,** and **Hygiene, School.**

Artificial leech. This form of local bleeding or "wet" cupping is a valuable agent for the reduction of most acute, deep-seated inflammations of the eye, such as iritis, iridocyclitis, glaucoma, choroiditis, etc. The pressure exerted upon the sensitive nerve-endings by the dilated blood vessels (and increased quantity of blood in the congested tissues) is thereby removed and the severe pain which



Artificial Leech.

usually accompanies these abnormal conditions is often promptly relieved. Although there are several methods in use for the abstraction of blood in this neighborhood, such as scarification of the conjunctiva, opening an artery in the temple or the application of the leech, the last named is the most popular. One may use either the living animal or its substitute, the artificial leech. The latter is preferable, as it is not only more certain in its action and more agreeable to the patient, but the amount of blood abstracted can be easily regulated.

The artificial leech consists of a glass cylinder in which works a piston connected with a thumb screw. This is attached to the piston rod by means of which it can be raised and lowered. The skin of the temple, half an inch from the outer margin of the orbit, is the most desirable place for its application. Here the skin is first scarified, either with a small instrument containing a punch that cuts two crescentic wounds, or a number of small incisions are made with a fine scalpel. The end of the cylinder is then applied over the wound and the blood withdrawn by exhausting the air in the cylinder. At least half an ounce of blood should be withdrawn if a decided effect is to be produced upon the intraocular circulation.

A rubber "cup," or a glass cylinder attached to one, and a small lancet are all that are needed for cupping. The skin of the temple is highly scarified by criss-cross incisions, or by dermatome, and the blood drawn by suction. The cup of the Victor or other machine, used in giving massage, may also be used.

Theobald has suggested that the best result from this method of blood extraction is obtained by pinching up a fold of skin with a pair of dressing forceps and, using a Graefe knife, "nicking out" a small, thin disc of tissue, 3 mm. in diameter, involving the epidermis and superficial layers of the cutis. The suction cylinder was then employed as usual. He found this convenient, practically painless and much more efficient than the scarifier. He also found by experiment that a few drops of a 1½ per cent. solution of ammonia carbonate dropped on to the wound or placed in the cylinder of the artificial leech increased considerably the free flow of blood. There was not the usual tendency to the formation of a clot in the instrument.

The leech may be used every day or two without diminution of its effects but one must not forget that the scarifications are more or less subject to infection. The operative area should be carefully disinfected before each use of the instrument and it may be painted over with collodion when the operation is concluded.

Artificial pupil. Originally the operation of iridectomy (q. v.) was designed and performed only to make an artificial pupil, that is, for optical purposes. The object of an optical iridectomy is to permit light to penetrate into the interior of an eye in which the pupillary area for some reason is not sufficiently transparent for this purpose. The obstructing opacity may lie in the cornea, or in the space of the pupil, or in the crystalline lens, and be of a permanent or progressive character. As was later on found, an iridectomy may, also, be a curative agent, especially in eyes with increased intraocular tension, or in cases in which for a time at least it seems useful to reduce the intraocular tension, as for instance, in ulceration of the cornea, in certain sequelæ of iritis, and for the removal of tumors of the iris.

The excision of a piece of iris was practised occasionally in some cases of cataract extraction by Daviel. A kind of iridectomy for purely optical purposes was first introduced by Wenzel. However, he made only subcorneal iridectomies. This led frequently to an injury to the lens and cataract formation. In consequence his advice was to extract the lens at once after iridectomy, whether it was opaque or not.

Beer was the first to introduce into ophthalmic surgery the abscision of the iris outside of the eye, the precorneal iridectomy. To him belongs the credit of having invented and practised iridectomy as we still perform it. That since his time the procedure has been improved upon and that its field of usefulness has been greatly enlarged, especially by von Graefe, does not alter this fact. He made a corneal flap with the triangular knife which bears his name, then he drew the

iris out of the wound by means of a sharp cataract hook and quickly snipped it off with scissors, and this, in a general way, is still the method of performing precorneal iridectomy nowadays.—(A. A.)

Artificial ripening of immature cataract. The maturation of an "unripe" lens is undertaken that it may be readily extracted without leaving remnants within the anterior chamber and so producing a secondary opacity, or setting up inflammatory changes, or giving rise to both these complications. Generally speaking the operation should be confined exclusively to the cortical form, beginning between the fortieth and sixtieth years. In young subjects when the nucleus is as yet very small, or non-existent, a discission is quite enough to hasten the process. In senile cataracts, a sharp distinction should be made between those affecting mainly the cortex and an undue hardening and increase of the nucleus.

The simplest classification of the different types of cataracts is the one founded on a structural basis, viz.: nuclear, cortical and capsular. All forms of cataracts involve one or more of these structures. The greatest number begin in the cortex as opaque striæ at the periphery and gradually involve the entire lens. When the process is complete, transmitted light thrown with the ophthalmoscope in the eye, gives no fundus reflex and oblique illumination casts no shadow of the iris on the lens. The patient has light perception but if the projection is good the lens is "ripe" and suitable for extraction. However, to apply this standard of "ripeness" to all forms of senile cataracts would lead to serious error, either in advising patients half blind from sclerosis of the lens to await an indefinite number of years for the cataract to become ripe, or to attempt artificial ripening in such a case.

The nucleus increases in size with age; even at forty it is an appreciable factor to be considered in cataract extraction. Between fifty and sixty it usually forms the major part of the lens, and later in life it forms no small part of a cataract even when the entire body becomes sclerosed. Here, the usual standard of ripeness fails utterly. Transmitted light in many nuclear cataracts gives a pronounced reflex from the fundus. A shadow from the iris is cast on the lens by oblique illumination and shows a gray or brown-yellowish opacity deep in the lens. This condition of affairs is in marked contrast to the brilliant fundus reflex often obtained with the ophthalmoscope.

The standard of ripeness for a sclerosed lens should be the inability to transact ordinary affairs, or the necessity of holding fair-sized type within a few inches of the eye.

On the whole, the sclerosed lens can be extracted more completely than the cortical variety which is so apt to leave some unexpelled lens matter to cause future trouble.

In the past most surgeons had an undue dread of attempting to remove an immature cataract, but at the present time the majority do not hesitate to extract as soon as the amount of vision does not come up to the patient's actual needs.

McKeown showed that immature cataracts could be safely removed. He was the first to advocate washing hard, cataractous masses out of the anterior chamber with a stream of warm normal salt solution.

Various methods have been advocated for the artificial ripening of cataract and at one time they were extensively employed.

Muter was the first to advise an operative procedure for the artificial ripening of cataract, his plan being laceration of the anterior capsule. He was followed later by von Graefe and other surgeons, but the writings of Förster on artificial ripening awakened most interest and he had a host of followers.

Among the principal methods employed for the artificial maturation of cataract are the following: (a) Paracentesis (T. R. Pooley); (b) Paracentesis with massage of the cornea (J. A. White); (c) Paracentesis with massage of the anterior capsule; (d) Division of the anterior capsule; (e) Division of the anterior capsule with corneal massage; (f) Iridectomy with division of the anterior capsule (Mooren); (g) Iridectomy with massage of the cornea (Förster); (h) Iridectomy with division of the anterior capsule; (i) Intra-capsular injection of normal salt solution (temperature of 100° F.) with a special syringe (McKeown). [To these may be added the method of Homer Smith in which an extensive capsulotomy is made from 24 to 36 hours before the extraction. For a complete account of this method see **Cataract, Senile**.—(Ed.)]

Förster believed that the sudden emptying of the anterior chamber and the subsequent rapid change in the shape of the lens would, by a kind of rubbing together of their already partially disorganized fibers, bring about a further opacification of the tissues. He, however, did not rely upon this agent alone but, in his artificial ripening operation, after an iridectomy, firmly stroked the cornea with a strabismus hook for two or three minutes. There can be no doubt but that this massage of the lens through the cornea is effective in many cases. Förster and others have reported many instances where six or eight weeks after corneal massage the immature cataract was found to be quite ready for extraction. Pagen-

stecher used a glass rod instead of the strabismus hook for making the massage. In any event, after either an iridectomy or a paracentesis the well-cocainized eye should be steadied with fixation forceps and the massage instrument employed to stroke firmly, regularly and slowly, in both radial and circular directions, the whole cornea. The time occupied should not exceed three minutes. As Förster pointed out, the main difficulty of the proceeding is

Anterior Chamber Irrigator for Use in the Extraction of Immature Cataract.

the proper amount of force to be applied to the cornea; if it is too great the zonula of Zinn may be torn and the subsequent extraction be followed by extreme loss of vitreous. If the massage is too gentle the effect is nil, the lenticular fibers not being disturbed by the massage.

In American literature one finds a number of writers who have reported their experience of various ripening operations. Among these are Noyes and Mittendorf, who report their experience of Förster's plan of trituration of the lens; the former rather favorably, but the latter has seen iritis follow the procedure and thinks it a dangerous plan. Jackson modified the Förster method by employing indirect massage of the lens with the upper lid, after emptying the anterior chamber. Boerne Bettman was probably the first to introduce a spatula into the anterior chamber and apply "direct" massage to the anterior capsule.

It is questionable if any of these various methods is necessary. When one has to deal with an immature cataract one should per-

form a preliminary iridectomy some six weeks prior to the extraction, which generally aids in making the cortex more opaque. Following this, at the time of extraction, the corneal section should be made a trifle larger than the usual two-fifths of the limbus, and the capsulotomy should include one-third of the lens periphery. After the expression of the nucleus and opaque part of the cortex, the free use of a warm normal, salt solution injected into the

The Simple Anterior Chamber Irrigator Ready for Use in the Extraction of Immature Cataract.

anterior chamber and capsule with a suitable syringe, so as to wash out as much as possible of the unexpelled lens matter will be found very satisfactory. There has long been in use at the New York Eye and Ear Infirmary a round, soft, rubber bulb with a diameter of 50 mm., having a capacity of two and a quarter ounces. To this is attached a glass tube 55 mm. long, and having the diameter of an ordinary eye dropper. Towards the end it tapers at an angle of 140°, is contracted at the mouth and flattened, having an opening 1 mm. broad. (See figure).

An iridectomy preliminary to any form of cataract extraction enables the operator to remove leisurely and more accurately a definite amount of the iris. Besides this advantage at the time of extraction, there is less liability of the iris falling over the cutting edge of the knife. This makes the extraction safer and easier, enables the surgeon to estimate the condition of the cataract itself, and indicates how the patient is likely to act during the remaining steps of the operation.—(P. C.)

Asad ad-din Yaqub b. Ishaq al-Mahalli. A Jewish physician of Mahalla, Egypt, who flourished at the close of the 12th century, and who wrote a work entitled, "*Concerning the Vision.*"—(T. H. S.)

Asagroea officinalis. The systematic name of the plant from which the mixture of alkaloids called veratrine is obtained.

Ascaris lumbricoides. This is a (nematode) round worm, an intestinal parasite whose presence in the alimentary canal has only the barest relation to ophthalmic practice. Haffner (*Berl. Klin. Wochenschr.*, No. 24, 1880) once discovered an ascaris in the lower left

canaliculus of a child suffering with whooping-cough. The worm, which was 3 cm. long, protruded from the punctum. It is probable that the parasite had reached the postnasal space during vomiting, and thence crawled up the nasal duct to the lachrymal canal.

Ascending paralysis, Eye-symptoms in. The ocular disturbances in the so-called Landry's disease are confined to occasional loss of the light reflex, dilated pupil, paresis (or paralysis) of accommodation, and of the extrinsic muscles.

Ascesso del cervello. (It.) Abscess of the brain.

Ascesso della palpebra. (It.) Abscess of the eyelid.

Asclepiades of Bithynia. A famous physician who flourished at Rome in the first century before Christ. He was the founder of the school of "methodists." He composed no work on ophthalmology, but, from a passage in Galen, it would seem that, in a book of his which was devoted to external remedies, there was a part, or division, which treated of external remedies for the eye. The passage in question runs as follows: "Asclepiades furnished the best and most complete exposition concerning both dry and fluid remedies, and the collyria of the Asclepiadean Collection, in the first book of External Remedies."—(T. H. S.)

Asemia. Lack of ability to comprehend or express any sign of thought or feeling.

Asepsis. Surgical cleanliness; freedom from morbific germs or their toxins. See **Antiseptics.**

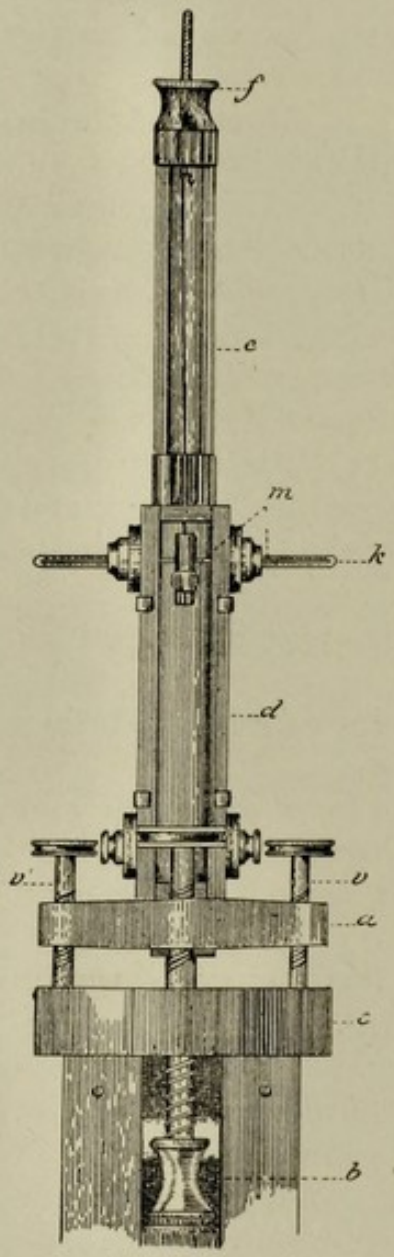
Aseptin. This compound is an antiseptic and astringent mixture of alum, one part, and boracic acid, eighteen parts, intended to be used both as a dry powder and as a solution in various diseases of the external eye.

Aseptol. Sozolic acid. Orthophenolsulphonic acid. Orthosulphocarbolic acid. $C_6H_6O_4S$. The solution marketed by Merck under the trade name of aseptol contains one part in three of sozolic acid and is a clear, yellowish liquid with an odor of carbolic acid. It is very soluble in water; less soluble in ether and alcohol; a disinfectant much less toxic yet more efficient than phenol. It should not be exposed to light. In from one to ten per cent. watery solutions it may be used as a germicide in most external diseases of the eye.

Askulap. (G.) Esculapius; a physician.

Asmus, Sideroscope of. Prior to the discovery of the Roentgen rays, the diagnosis of the presence of a particle of iron or steel, or other foreign substance within the globe, was often a very difficult matter. As the majority of foreign bodies that enter the globe are of mag-

netizable material, the magnetic needle has been used in a variety of ways as an "indicator." The first to use the magnetic needle for this purpose was Thomas R. Pooley, who performed numerous experiments and demonstrated the delicacy of the method. He tabulated the deflection of the needle by particles of different sizes at



The Sideroscope of Asmus.

various distances from the needle, both magnetized and unmagnetized. This was the first use of the method in connection with the eye, although it had been used in general surgery. The idea was later elaborated by Asmus, who constructed an instrument containing a magnetic needle suspended by a silk thread in a glass tube, as shown in the figure. This apparatus consists of a box of wood 15 cm.

high (d), closed before and behind by a plate of glass sliding in a groove. This box stands upon a disc of iron (a), which is levelled by three screws (v), thus allowing the instrument to be made perfectly vertical. These screws rest upon a second disc (c), which is fixed to a north and south wall. A fixation screw (b), maintains the position. Above the box of wood is a tube of glass (e), and in this tube hangs the silk thread which holds the magnetic needle. This thread is attached to a regulating screw (f), which allows one to raise and lower the needle, and also to turn it so that it may hang free. At the lower end of the thread is hung an aluminum tube which supports a small mirror and the magnetic needle (m). The needle is 11 cm. long and extends from the box of wood for a distance of 4 cm. on each side. Each end of the needle is enclosed in a tube of glass (k) which is 6 mm. in diameter.—(E. S. T.)

Aspergillus flavus. One of the moulds which occasionally exhibits a distinct growth on various cutaneous, mucous and other surfaces of the human organism, including the eye structures.

Aspergillus fumigatus. (L.) This is a mould fungus belonging to the Acomycetes. It forms a greenish, often bluish-grey growth, quite like that of the common mould fungus—Penicillium glaucum. In the cornea it produces a swelling that resembles the compact mass of a corneal slough. Experimental injections of this fungus into the cornea and the vitreous have resulted in suppuration of the surrounding tissues.

Aspergillus glaucus. (L.) This, like Aspergillus fumigatus (q. v.) belongs to the Acomycetes. It has occasionally been found as an accidental growth on the lid-margins and in the conjunctival glands, but its presence is not a serious source of ocular discomfort.

Aspergillus keratitis. See **Keratitis, Mycotic.**

Aspidium, Amblyopia from. See **Filix mas.**

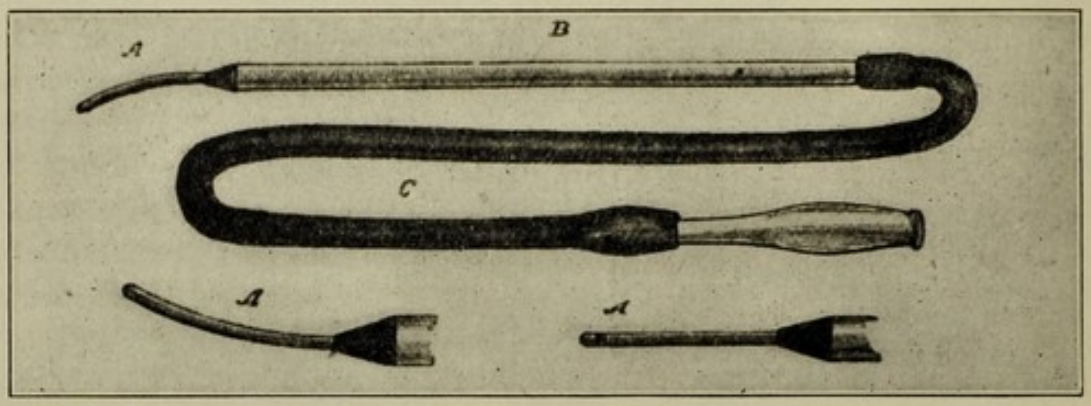
Aspiration of cataract. Suction operation for the removal of soft cataract. This procedure is mentioned by Phazes as the invention of Antyllus, who flourished about the fourth century A. D. According to Albucasis, this method was in use in both Persia and Arabia.

The operation was not entirely forgotten in the later centuries, as Guillemeau claimed that the lens was not removed thereby but simply the aqueous humor. Barbette in the seventeenth century ridiculed the method.

During the subsequent two centuries it fell into complete disuse, until it was revived by Peccholi in 1829. He made a corneal section (after the discission had fully matured the cataract) and through

the opening introduced a hollow needle by which the soft lens matter in the anterior chamber was drawn off by a pump.

The next recorded advocate of the operation was Langier, who entered the needle through the sclera, perforated the posterior capsule and removed the soft lens matter by means of a foot-pump.

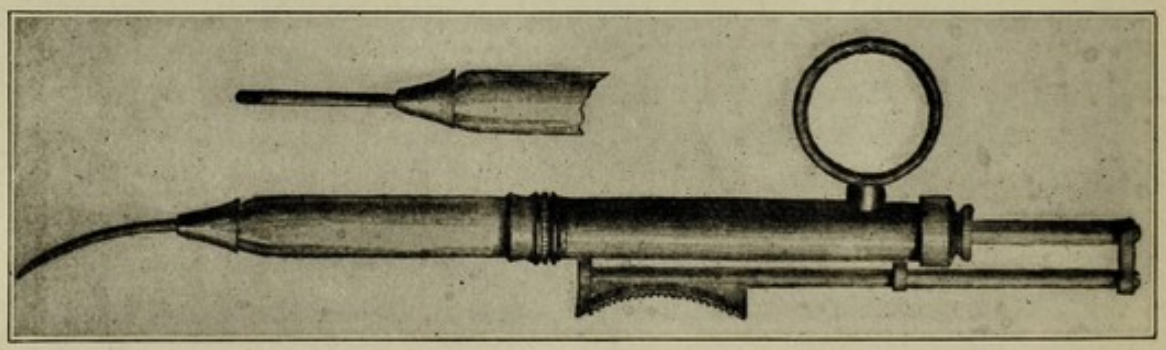


Teale's Suction Operation for the Aspiration of Cataract.

A, A, A, points to be introduced into the anterior chamber; B, glass tubing; C, rubber tubing and mouth-piece.

The operation was adopted in England in 1863, by Teale, Bowman, Lawson, and Greenway, and for a time was quite in vogue. Teale devised a special canula to which was attached a glass and rubber tube, using the mouth for suction, as seen in the accompanying figure.

Bowman devised a special syringe with which to make suction and thereby avoided aspiration by the mouth. (See figure.)



Bowman's Syringe-pump for the Aspiration of Soft Cataract.

About ten years subsequent to the revival of the operation in England, it was employed at the Mass. Charitable Eye and Ear Infirmary. Hasket Derby states: "As regards results from the suction operation, the reports of the Mass. Charitable Eye and Ear Infirmary for the last eleven years show the performance of 107 operations by suction." In 65 cases the results are as follows:

Full suction, 46; partial, 18; loss, 1. In five instances the visual result was perfect. In 1887 Coppez in Belgium and Redard in France, called attention to the advantages of the operation. The latter made an improved apparatus on similar lines to Teale's instrument.

Rogman in 1899, operated on the clear lens in high myopia in 20 cases by discission and suction, with no loss.

Howe and others in America have also extensively employed the method.

The operation of aspiration should be confined to soft, liquid and traumatic cataracts. In old patients, with a hard nucelus, it is unsuitable and in young subjects with partially clear lens matter, as in the perinuclear type, it should not be attempted until a discission has softened the entire lens mass.

The pupil should be dilated ad maximum. The corneal incision should be made with a keratome 4 mm. from the limbus; in the left eye in the superior nasal quadrant; in the right eye at the superior temporal quadrant. Then a large opening is made by the point of the instrument in the anterior capsule. Introduce the canula, with its point towards the cornea, into the anterior chamber through the cut capsule against the substance of the lens. Then, suction is made either by the syringe-pump or by the mouth.

Care should be taken to retain the end of the canula within the capsular wound and not to push it behind the iris or into the vitreous.—(P. C.)

While the alternative of irrigation of the anterior chamber to the artificial ripening operation is properly considered in discussing the removal of immature cataract—especially in the unripe cataracts of comparatively young subjects—yet there is a third procedure worthy of consideration, viz.: the *Smith-Indian method.* This procedure fully described elsewhere, seems well adapted to overcome the difficulties of dealing with unripe cataracts. If there is a place in ophthalmic surgery for this operation it is certainly in these very cases in which soft matter remnants and post-operative capsular tags are such a menace to the eyesight of the patient and, as a matter of fact, form the one obstacle to the realization of good post-operative vision. Surely it is worth an effort and the risk accompanying that attempt to get rid of the whole lens with both its capsules.—(Ed.)

Aspirin. ACETYLSALICYLIC ACID. $C_9H_8O_4$. A compound obtained by heating acetyl chloride in a flask to 302° F. (150° C). It is found

as small, acidulous, colorless crystals, slightly soluble in water, more so in alcohol and ether.

This willow preparation, allied to salicin and salicylic acid, given in gram doses three or four times daily, is of decided value in severe cases of iritis and other uveal affections. It is best administered in capsules, with or without sodic bicarbonate. Wicherkiewicz has employed it with success in chronic conjunctivitis due to long standing gonorrheal infections, in iritis, iridocyclitis, scleritis and episcleritis, rheumatic choroiditis with vitreous exudations and glaucomatous manifestations. It is less prone to produce tinnitus, and gastric disturbances than the salicylates.

Wm. G. Craig employs aspirin, generally in doses of 15 grains night and morning, in all such painful eye diseases as iritis, keratitis, corneal ulcer, glaucoma, and after injuries and operations. He is so impressed with the value of this drug that he uses it to the exclusion of all other anodynes.

In most acute diseases of the uveal tract where the pain is frequently recurrent or intermittent in character and generally plagues the patient at night the best plan for administering aspirin is to give a large dose, say, 20 grains, half an hour before the usual painful attack, to be followed by a smaller amount—5 to 10 grains—every hour until relief is obtained. This agent often acts, in this way, as an innocuous soporific since by the relief of nocturnal pains the sufferer is able to sleep without the use of opiates.

Asportazione della margine ciliare. (It.) Displacement, or transplantation, of the ciliary margin of the lid.

As-Sadili, Sadaqa b. Ibrahim al-Misri. This author was one of the latest of the Arabian ophthalmologists. He flourished in the second half of the 14th century and was the author of the last Arabian text-book on the eye. This work, which bears the somewhat tautologic title, *Oculistic Aids for Diseases of the Visual Apparatus,* is divided into five chief parts, in each of which theory as well as practice is given its appropriate share of attention. The first division treats of the necessity for the functions of the eyes, and of the anatomy of the organ in question; the second, of general medical, as well as oculistic principles; the third is devoted to such diseases of the eye as are perceptible to the senses, their symptoms and their treatment; the fourth, so far as possible, to ocular diseases not perceptible to the senses; while the final chapter discusses the names, nature, and values of general as well as of ophthalmic medicines.

Especially interesting, in the fourth section of the first division of this book, is the exposition of the three theories at that time held

regarding the nature of vision. These theories are: (1) The visual object sends in something to the eye. (2) From the eye emanates perceptive power outwards to the object. (3) Emanations take place from both the object and the eye, and then commingle somewhere between the two. As-Sadili then concludes that, "The third of these views is correct, and comes close to the truth that the air surrounding us, when it is clear and shining, becomes as it were an organ for vision and continues the activity of the hollow nerves in relation to the brain."

Also interesting is the fact that, in this book, the first brief attempt in all scientific history is made toward a comparative anatomy and physiology of the eye. It constitutes the sixth division of the first "Part" of the book, and runs as follows: On the Differences between the Eyes of Animals Compared with Those of Men, and on the Special Peculiarities of the Latter.

1. Presence or Absence of the Eyes. The sponges and many of the snails have no eyes at all.

2. Number of the Eyes. Alone the Moses-fish has only one eye. Nor has any animal more than two eyes, excepting the leech.

3. Substance of the Eyes. In the crab, the eyes are long-handled and hard; not so in men.

4. Form of the Eyes. In the mole, both eyes are covered with a skin: thus it comes about that this animal beholds shadows but not forms; thus, too, is the manner of its movement and the fact that it seeks for nourishment in the dark. Many birds possess, beneath the lids, a white skin, which is capable of covering the eyes. Hard-skinned animals have neither lashes nor lids, except a few of the fishes. The most of such animals as bring forth their young alive, possess lashes; men, however, more than all.

5. Compass of the Eyes. The eye of the owl is large; that of the vulture small, likewise that of the elephant, in spite of the size of its body.

6. Comparison of the Parts of the Eye. The white of the eye in man is larger than the black; not so in other animals.

7. Consistency of the Eyes. In animals with a hard skin the eye is hard, on the other hand soft in those with a soft skin.

8. Peculiarities in the Form of the Eye. In animals with a hard skin and in those with a white skin the eye is roundish; in those which bring forth their young alive, almond-shaped.

9. Color of the Eye. The eye of the lion and of the lynx and of the cat is fire-colored—not the case in men, horses, and other animals.

10. Situation of the Eye. The eyes of the crab are at the sides, on processes, or prolongations—not so in other animals.

11. Mutual Situation of the Eyes. The two eyes of man are near one another, not so in other animals.

12. Situation of the Parts of the Eyes. Animals with a hard skin have lids, which close themselves together and possess no motion.

13. Activity of the Eyes. Most of the birds are strong in vision, the bat weak, the mole still weaker.

14. Time of Seeing. Bat and owl see by night, the cat by night and by day, differently from nearly all the other animals.

15. Clearness of Vision. The fish sees better in water than in other media; the crocodile sees well in water and badly on land.

16. Manifold Activity of the Eyes. Animals with thin skin have in their eyes, besides the visual power, the power of voluntary movement.

17. Sensitiveness of the Eyes. The eye of the bat suffers great injury from sunlight, in direct opposition to the eye of the chameleon and the swallow.

18. Strength of the Impression Produced by Eye-Diseases. Pterygium in the eye of the horse exerts a deadly effect upon the latter, not so in the case of man.

19. The Frequency of Eye Diseases. This is greater in men than in other animals.

20. Difference in the Effect of Injury to the Eye. When the eye of a swallow is pierced with a needle, whether in the white part or in the black, the wound is merely of assistance to the eye and increases its health. They say that the eyes of the adder behave in a similar fashion.

"But the eye of man himself offers strange qualities and peculiarities. Among such is this, that they possess shading projections from above—the eyebrows. Their lower lids possess lashes, something that no other animal presents in that situation. Further, man's eyes are almond-shaped. Still further, man can move his upper lid, something of which no other animal is capable. Again, his two eyes are set near together. Once more, his eyes possess an especial protection in the strongly forward-projecting nose; this keeps off many injuries from the front. Still again, his flow of tears is abundant. Then, too, he is oftener attacked by diseases of the eyes, on account of the multitude of substances which mount aloft to his brain.

"The brain of man is very convex, in order that room may exist for that which portrays itself for him in that organ. The bones around the brain are porous, in order that the various materies may

easily excrete themselves away from it. Many superfluities befall this organ: therefore are diseases numerous—among the most frequent, catarrhs, colds, coughs, sneezings, bleedings from the nose and hoarseness.

"Most of the mischances which befall the eye come from the brain. For the former has its place of origin in the latter, the parts of the former arise out of the latter. For this reason it is that the eyes of different men are different.

"The eyes of the negro are goggly and dark on account of the increase in the moisture of their brains, together with the heat, which comes from the hotness of their land and the nearness of the sun to their heads.

"The eyes of the Turks are narrow-slit, on account of the abundance of moisture in their brains, together with the bitter cold of their land; the most of them are flat-nosed.

"The eyes of the Bedouins are broad, owing to the dryness of their brains, in conjunction with the dryness and scantiness of their food.

"The eyes of the city-dwellers are like those of the people from Irak and Syria and Egypt; they are small in spite of the size of the nose, on account of the injuriousness and great variety of their nourishment.

"The people of Egypt have the most ophthalmias, in comparison with others, on account of the clouds of dust and sand in their country; the frequency of their eye-diseases arises from the weakness of their brains."

Nor is it so extremely remarkable that the world had had to wait until the time of As-Sadili for its first attempt at a comparative ocular anatomy and physiology, as it is that, after Sadili's time, it had to wait again till the latter half of the nineteenth century for anything more (worth mentioning) on this extremely interesting subject.—(T. H. S.)

Assalini's operation. One of the forms of iridodialysis. The iris is detached with forceps through a large corneal incision.

As-Samarqandi, Abu Hamid Muh. b. Ali b. Omar Nagib ad-din. This distinguished Arabian physician of the middle ages perished in the conquest of Herat by the Tartars, A. D. 1222. His writings are: *On the Causes and Symptoms of Diseases* and *On the Anatomy of the Eye*. As the latter possesses considerable ophthalmologic interest, we subjoin a complete translation thereof:

"Know that the eye is composed of 7 membranes and 3 humors.

"When the hollow nerve passes down to the eye, clad in the two membranes of the brain, for its own protection, and arrives at the

orbit; then it expands, and, with it, expand the two membranes and embrace the humors of the eye. All then together become three membranes of the eye, after the intermingling with the branches of the brain and arteries. The nerve with its two membranes, they are like three layers laid on one another, the head pointing forward and the tail backward. The outermost layer arises from the hard membrane of the brain, which touches the inner surface of the skull; the second from the thin membrane of the brain; the third is the terminal expansion of the optic nerve and lies in contact with the humors of the eye.

"The first layer of the eye, which touches the bones of the orbit, is called the hard membrane, because it grows forward out of the hard, thick membrane of the brain. The second is called the after-birth membrane, because it is rich in veins and arteries. The third, which touches the vitreous and crystalline humors, is called the retina.

"From these posterior layers others grow forward, like three dishes set one within another. The hinder ends of the forward are directed toward the forward ends of the hinder, the periphery of each single one of the forward being united with the corresponding periphery of the hinder. Of these three anterior, the first, which proceeds from the hard membrane, is called the cornea; its middle is arched in the place which is opposite the pupil. The second, which grows forward out of the after-birth membrane, is called the uvea. The third, which takes its origin from the retina, is called the arachnoid membrane. The uveal membrane is perforated in the middle; it increases and diminishes in the light and in the darkness, in order that the appropriate quantity of light may always attain to the interior of the eye—not excessive light injure the eye, and not darkness render the visual power incapable. Its inner surface is formed into numerous tufts, in order that the aqueous humor may be able to cling to it and not pour itself through the perforation opposite the crystalline humor.

"These, then, are six membranes, with their points of origin and their situation; and the seventh is the white, which surrounds the dark of the eye, also the lids of the eye—according to the right conception; it is called the conjunctiva, its origin is outside the skull from that membrane which enwraps the skull upon its outside.

"Of the humors, that which is next behind the retina is called the vitreous, thereafter follow the crystalline humor, and, in front of this, the egg-white humor. In the middle, between the two latter, lies the arachnoid membrane, which forms a partition between both. The office of the egg-white humor is to moisten the crystalline; the former

gives the latter to drink because of its purity. God knows it best.''—(T. H. S.)

Assimilation. Hering has applied this term to the renewal of the visual (purple) substances with the assistance of the oxygen of the blood, a process that continues and conserves the function of the color-perceiving organs.

Assimmetria. (It.) Asymmetry.

Associate (conjugate) ocular movements. All normal movements of the eyes are in a sense associated, that is, they are so coördinated that they give rise to (correspondingly) equal and symmetrical movements of both globes. These associated movements consist chiefly in an equal movement of both eyes from any given position to any other. See **Muscles, Ocular,** and **Movements, Ocular.**

Associated movements of eyelid and jaw. Quite a number of these curious co-movements are recorded in the literature of the subject. For example: Harlan reports a case in a boy aged 4 years. The abnormality was not congenital but had appeared when the boy was 2 years old, after an attack of typhoid fever. During mastication energetic and rapid winking of the left eye occurred, entirely beyond the patient's control and giving the idea of blepharospasm. Coincident with the opening of the mouth there was contraction of the levator, more decided when the patient looked down. Harlan thinks well of the suggestion of Harman, ascribing ''jaw winking'' to reversion to an ancestral type similar to the shark, in which the fifth and seventh nerves are closely associated. This seems to best explain this case, which was not congenital but arose after sickness, that might have left a weakened levator.

Cases of similar elevation of the upper lid with movement of the lower jaw are reported by Wilkinson and Coburn. In both these cases the condition was congenital. Coburn's patient was unable to open his left eye, the one affected, except when he opened his mouth. Harlan's patient also presented a slight ptosis. But Wilkinson's patient was able to open and close the eyes normally, except that when he made an extra effort, the right, or affected eye opened a little wider.

Coburn mentions the old explanation of an unusual relation between the levator portion of the nucleus of the third nerve and the pterygoid portion of the nucleus of the fifth. Harlan, however, seems inclined to accept the suggestion of Harman mentioned above. He thinks a relaxation of the orbicularis associated with contraction of the pterygoid permitted a weak levator to raise the eyelid.

In Stephenson's case of ptosis of the left eye *synkinesic* movements occurred of the right upper lid and the lower jaw when the latter was

opened or shut or moved from side to side. The peculiarity of the case was that the abnormal association involved not the lid with ptosis but the unaffected eyelid. In Sym's case there was partial ptosis of one eye, with excessive elevation of the lid upon depressing the lower jaw, due apparently to some confusion in the joining up fibres and cells belonging to the fifth and third nuclei.

Associated movements of head and eyes These consensual or coöperative movements are rather rare. Hamill and Posey report three cases in infants. In one the movements did not appear until the child was over three years of age. In the others they were first noticed at three and fourteen months respectively. All the children showed marked evidence of rickets, the probable predisposing cause; and the gastro-intestinal irritation generally conceded to be an important exciting cause. On closing or bandaging the eyes the movements diminished or ceased. It was not thought, however, that the head-nodding and jerking was an attempt to compensate for the eye movements. The two sets of movements were not synchronous; the eye movements being much the more rapid. Then in some reported cases the head movements have appeared before the eye movements. Hamill and Posey incline to accept the explanation of Hadden, that such movements depend upon a disturbance of the cerebral cortex. "The child has acquired certain voluntary or purposive movements of the head and eyeballs, but these have not yet become thoroughly organized and fixed in the psychomotor areas of the brain." They therefore become disordered after a weakening of the cortical centers. Relief must be sought in the direction of improved brain nutrition, and subsequent training.

Associated movements of the eyeballs. See **Muscles, Ocular.**

Associated paresis or paralysis of the eye muscles. These are paretic or paralytic defects of muscles associated in the production of certain definite visual movements. Diplopia is usually not a symptom of the disease and there is little or no secondary contraction of the antagonists, because, as a rule, the paralysis is uniform. The cause of this peculiar form of paralysis is an affection of the oculomotor nuclei or the visual centres in the pons. See **Muscles, Ocular.**

Associationslähmungen. (G.) Paralysis of associated muscles or groups of muscles, as of rectus internus of one eye and rectus externus of the other.

Associirte Augenablenkungen. (G.) Associated deviations of the eye.

Assorted light. According to Jackson (*Manual of Diseases of the Eye*, p. 104) for complete vision each luminous point must make its

distinct impression on a single point of the retina, and through it upon a single nerve-cell or group of nerve-cells in the brain. To accomplish this, the light falling on the retina must be *assorted* or focussed. To support the retina so that it shall properly receive assorted light is the function of the eyeball. The assorting is effected in the human eye by refraction, and the whole function of the eyeball being to support and protect the retina so that it may receive properly refracted rays, the refraction of the eye is of primary importance in its physiology and pathology.

Assoziationsbahnen. (G.) The association paths.

Assoziierte Lähmungen. (G) Paralysis of associated muscles.

Assyrians, Ophthalmology of the ancient. See **Ardi-Nana** and **History of ophthalmology.**

Astegiano's test. This device, for detecting simulated monocular blindness, is a modification of the Fles (q. v.) box. It measures the visual acuity of the pretended blind eye, the malingerer imagining that he is seeing with his admittedly sound eye.

Astenopia isterica. (It.) Hysterical asthenopia.

Asteriscus. (L.), m.n. An old name for a star-shaped opacity of the cornea.

Asterol. A soluble, antiseptic preparation of mercury sulphocarbolate, used in surgery as a bactericide.

Asthenie. (G.) Extreme debility.

Asthenopia. (L.), f.n. Weak or impaired vision. Inability to use the eyes continuously, especially for near work, without one or more symptoms.

Although this term is not as definite as it might be, yet it is generally understood to include all those symptoms that arise from weak accommodation and anomalies of refraction. Prominent among them are blurring of print, pain on attempts to look close at hand, frontal headaches, and such symptoms as burning, smarting, or redness of the eyes, brought on chiefly by reading, sewing, painting, or other forms of near-work. Asthenopic symptoms are not confined to the discomfort produced by attempted near-work. Many of them, such as vertigo, nausea, photophobia, indistinct vision, pains in the eyes, frontal headache, lachrymation, etc., appear both as "panorama" symptoms, on visiting the theatre, by gazing at moving pictures, from shopping, riding on railway trains, automobiles, or street cars, and in other occupations where the eye mostly fixes distant objects. These symptoms will be fully considered under **Eyestrain, Refraction and accommodation of the eye, Ocular muscles,** and under various other sub-headings.

Asthenopia, Accommodative. When eyestrain is not relieved by appropriate treatment the effort to see even distant objects distinctly causes marked discomfort until eventually the patient is no longer able to use his eyes for any purpose, even for a few moments, with comfort.

Asthenopia, Heterophoric. This form of asthenopia is due to imbalance of the eye muscles, apart from the ametropia or other abnormal condition that may accompany it. Oliver (*System of Diseases of the Eye,* Vol. IV, p. 404) does not believe that it is as rare as is generally supposed. He thinks that even when emmetropia is found, asthenopic symptoms of the heterophoric type may be present. Moreover, idiopathic or primary heterophoria, particularly hyperphoria, may not only produce a heterophoric asthenopia, but also provoke an active ametropic one from a latent ametropia which would not have been brought into evidence had there been a normal equilibrium and action of the ocular muscles.

Considered broadly, asthenopia or eye-strain is a complex symptom-grouping. As a rule, it is an expression of the combined workings of the two ocular end-bulbs and their accessories. Granted a manifest esophoria of one, or possibly two, degrees as the normal average for combined distant vision, each individual, and even the same individual under different circumstances and during varying states of fatigue and health, has dissimilar degrees of physiologic tone and power given to his ocular muscle-series both far and near vision. What may be the normal state of any visual apparatus to-day need not be that of the following day, while the amount of ametropia that in some instances must be considered abnormal may bear a sufficiently harmonious relationship to the muscular portion of the visual apparatus to produce temporarily comfortable binocular vision. Orthophoria, like emmetropia, is a theoretic, a mathematic, and a geometric standard, and is not more expressive of normality of tissue and harmony of action than the latter. Normality can be assumed, no matter what inequality may exist, as long as the two series of ocular muscle-groupings are in balance, and continue so during activity. See **Muscles, Ocular.**

Asthenopia, Hysterical. See **Amblyopia, Hysterical.**

Asthenopia, Muscular. See **Asthenopia, Heterophoric.**

Asthenopia, Neurasthenic. See **Copiopia.**

Asthenopie, Akkommodative. (G.) Accommodative asthenopia.

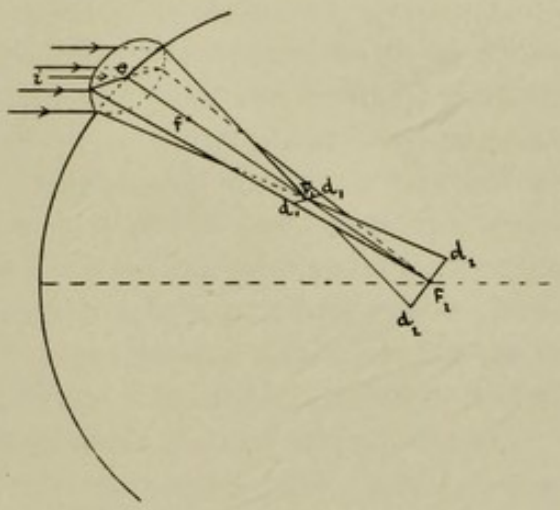
Asthenopie, Muskuläre. (G.) Muscular asthenopia.

Astigmagraph. An instrument used to demonstrate the presence of ocular astigmatism.

Astigmatic. adj. Affected with astigmatism.

Astigmatisch (G.) Astigmatic.

Astigmatism. In *optics,* the failure of rays which are refracted or reflected at a surface to converge to a single point. For instance, in the case of refraction of an oblique bundle of rays near the periphery of a spherical surface, the meridian rays, of which the chief ray, i, is the center, come to a focus sooner upon the refracted chief ray, f, than the sagittal rays, which suffer refraction to a lesser degree in a plane at right angles to the meridian plane at the same point, e. The point F_1, which is the vertex of the meridian rays, is called the primary image-point; and the point F_2, which is



Astigmatism.

the vertex of the sagittal rays in the plane at right-angles to the meridian plane, is called the secondary image-point. The lines $d_1F_1d_1$ and $d_2F_2d_2$ through both of which all the rays of the refracted bundle pass, and which may be regarded as straight lines in their respective co-ordinate planes, are the two image-lines of the narrow refracted bundle. In other words, the primary image-line lies in the primary principal section, and the secondary image-line lies in the secondary principal section, both of which are at right-angles to each other and perpendicular to the chief ray f of the astigmatic bundle. This principle was established by Sturm, the originator of the theory of astigmatism. Matthiessen contends that the image-lines may not be, and, generally, will not be, perpendicular to the chief ray f, but it is more convenient and quite permissible to consider both of the image-lines, according to Sturm's definition: "perpendicular to the chief ray of the astigmatic bundle." In fact, they are so located for the cornea of the eye having regular astigmatism, and whose surface at the point of incidence, the vertex

of the cornea, may be considered to be asymmetrical, owing to the difference of curvature in the principal sections or meridians exposed to *homocentric rays* (those that emanate from one and the same point on the axis) as well as *paraxial rays* (those that are incident within a very small area around the vertex of the surface). All other rays which do not lie in the principal sections will be refracted so as to intersect corresponding points within the limitations of the image-lines (as shown in the description of **Ophthalmic lenses and prisms,** which see). As the refracted (or reflected) bundle of rays thus formed does not anywhere pass through a point, it is called an astigmatic bundle or pencil. The same principle applies to a normally incident homocentric bundle of rays, provided the bundle is refracted or reflected by a toric surface; that is to say, a rotary surface in which the meridians of greatest and least curvature are at right-angles to each other. The toric surface is well illustrated through its comparison with the peripheral surface of an inflated rubber tire, which has a greater curvature along the circumference of the wheel than in the transverse plane of a spoke. When incident paraxial and homocentric rays proceed from infinity and are refracted by a toric surface, or its equivalent in form of a sphereo-cylindrical lens, the image-points and image-lines are called *focal points* and *focal lines,* respectively. Hence, the primary and secondary focal points on the axis are in their corresponding *primary* and *secondary focal lines,* these being located in their correlated *primary* and *secondary focal planes,* which are perpendicular to the axis. The distance between the focal lines or planes is known as the *"Focal interval"* of Sturm; and a third plane, situated between and parallel to the focal planes, contains a circle, defined by the outermost rays of the astigmatic bundle, which has been somewhat misleadingly called the circle of least confusion, although here perhaps is obtained the image-point having least distortion. The locus of this circle, if named: The Region of Transition, would more definitely define its characteristic property and position, since it is that place, between the focal planes, where the constantly varying elliptical cross sections of the refracted (or reflected) bundle, on the side of the approaching wave in front of the circle, are again converted into successive and similarly inconstant elliptical cross sections whose diameters are reversed behind the circle, which is, therefore, a characteristic cross section of the astigmatic bundle (see diagrams, **Ophthalmic lenses and prisms).** The theory of astigmatism also applies to any spheroid surface, that is to say to any rotary surface approaching a spherical

form and that may be generated through rotation of one of the conic sections, such as the ellipse, the parabola or the hyperbola, and which are known as ellipsoids, paraboloids, and hyperboloids, respectively. For instance, a lens of the latter type is called a hyperbolic lens (rather difficult of production), and is occasionally used, with more or less success, to correct conical cornea, which has an acute curvature near its apex that flattens out and steeply approaches the limbus. This shape of the cornea suggested the possibility of correcting the defect by means of a hyperbolic lens, which also has this characteristic form. In practice, however, a difficulty is encountered through the necessary movements of the eye in its orbit, causing the apex of the cornea to wander from the center of the lens, which should at all times be in collimation with the apex of the cornea, in order to make the lenticular correction efficient at the fovea centralis. For this reason hyperbolic lenses can only achieve their greatest efficiency when the apices of both the cornea and the lens are coincident with the line of fixation.

The astigmatism of conical cornea may, therefore, be said to be the dividing line between corrigible *regular* and *irregular stigmatism*, the latter comprising a variety of malformations of the corneal surface, or of the lens itself, that precludes satisfactory correction by lenses. Regular astigmatism is commonly corrected by means of cylindrical or toric surfaces such as are described under **Ophthalmic lenses and prisms.** The various types of astigmatism capable of correction by lenses are explained under **Astigmatism of the human eye.**—(C. F. P.)

Astigmatism, Compound, is that form of regular astigmatism in which both principal meridians are either myopic or hypermetropic, one of them of greater refraction that the other. If both are myopic, we have compound myopic astigmatism, (AsMM). If both are hypermetropic, we have compound hypermetropic astigmatism, (AsHH).

Astigmatism, Irregular. Irregular astigmatism is generally produced by the cornea; notably by corneal scars which have remained after superficial ulcerations. It is less frequently due to an anomaly of the lens, as in cases of incipient cataract. Both forms are recognizable by transmitted light; corneal astigmatism is demonstrable with Placido's disk or keratoscope, with the ophthalmometer, or by means of skiascopy.

Astigmatism, irregular, Shells for. See **Conical cornea, Shells for.**

Astigmatism, Mixed. This is the most complicated form of astigmatism. One of the principal meridians is myopic; the other hyper-

metropic. This variety of astigmatism was formerly difficult of exact measurement, but since the introduction of skiascopy, it is as easily recognized as any of the others.

Astigmatism of the human eye. ASTIGMIA. A state of irregular ocular refraction, usually congenital, in which the rays of light diverging from a single point cannot, owing to an anomaly of the cornea, sometimes of the lens, be brought to a common focus on the retina.

In irregular astigmatism the rays have different foci in the same meridian. This is usually caused by irregularities of the corneal surface or changes in the lens substance. Corneal ulcers, leaving scars and facets on healing, are the common source of irregular astigmatism. Vision is much impaired and can be very little improved by glasses.

In regular astigmatism one principal meridian of the cornea has a greater curve than the other. These two principal meridians are always at right angles to one another, the meridian of greater curvature being usually situated in the vertical and that of less curvature in the horizontal meridian. When this is the case the astigmatism is said to be "with the rule"; when the reverse the astigmatism is said to be "against the rule." Regular astigmatism comprises:

The simple form, in which one meridian is ametropic while that at right angles to it is emmetropic. When the rays focus behind the retina it is simple hypermetropic, and when in front of the retina simple myopic astigmatism.

The compound form, in which neither set of rays of light entering the eye focuses upon the retina, but does so either in front of or behind the retina, according as it is a compound hypermetropic or a compound myopic astigmatism. In either form the rays have a different focusing point for the two principal meridians.

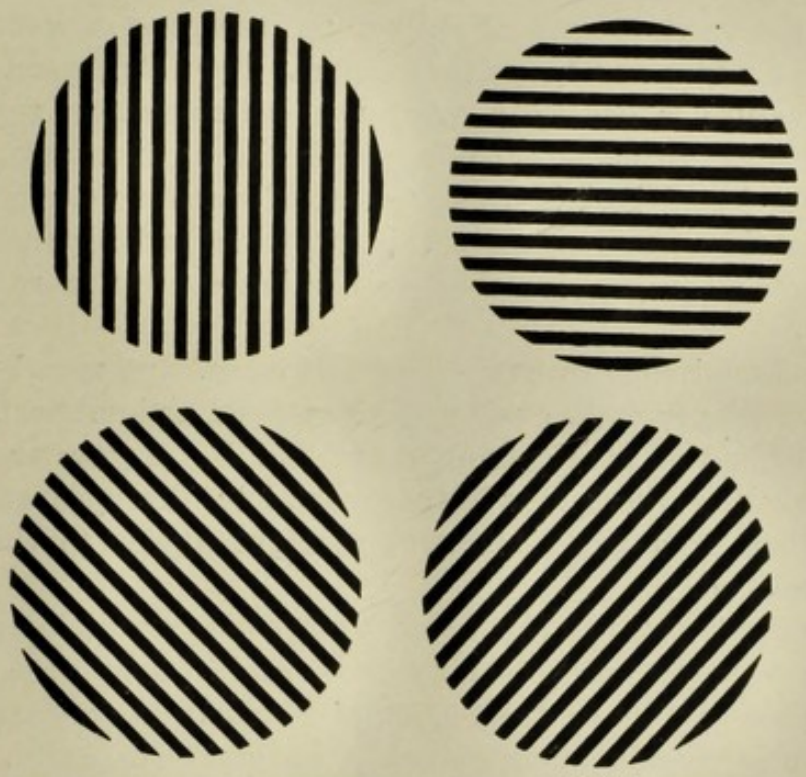
The mixed form, in which one set of rays of light entering the eye focuses at a point behind the retina (hypermetropic meridian) while those entering through the meridian at right angles focus at a point in front of the retina (myopic meridian).

Inasmuch as the majority of the forms of astigmatism are due to the abnormal shape of the eyeball it is usually congenital, but in some instances (after operation, injury, etc.) it may be acquired. Astigmatism may be detected and its amount accurately measured by a number of objective means.

A highly valuable subjective test for the presence of this defect is the astigmatic chart, one form of which is pictured herewith. It is sufficient for the patient to look, with each eye separately, at

the figures on the chart. If astigmatism be present one or more of them will appear more blurred (or more distinct) than the others.

Astigmatism generally produces discomfort when the patient attempts to use the eyes for reading, sewing, or other forms of near work. All the asthenopic symptoms met with in eyestrain due to hypermetropia or myopia are more or less aggravated by the addition of astigmatism, even of low degree, especially if the patient be in a poor state of health and of a neurasthenic disposi-



Test Figures for Detecting the Presence of Astigmatism.

tion. Distant as well as near vision may also be materially interfered with and rendered decidedly uncomfortable.

Astigmatism should be corrected with a cylindrical glass either alone (in simple astigmatism) or in combination with a spherical lens in compound or mixed astigmatism. The axis of the cylinder is placed in the meridian of greater corneal curvature in hypermetropic astigmatism, and lesser corneal curvature in myopic astigmatism, i. e., the meridian of normal refraction in simple astigmatism, and the meridian of least ametropia in compound astigmatism. Even low degrees of astigmatism should be corrected in the majority of instances and glasses in the form of spectacles should be worn constantly.—(Ed.). See, also, **Refraction and accommodation; Examination of the eye.**

Astigmatismo regolare. (It.) Regular astigmatism.

Astigmatism, Post-operative. This anomaly, according to Treutler, is due both to vertical flattening of the cornea and to increase in the horizontal curve. In some cases the astigmatism, found a fortnight after the operation, persists or is even increased later. In other cases it diminishes somewhat or may entirely disappear in the course of a few months. This reduction may be ascribed to a readjustment of the wound surfaces which had been displaced by over-riding of the corneal flap. In sclero-corneal sections it may be that the down-growth of epithelium interposes a wedge between the wound edges and keeps them apart. For this reason the abnormal curvature is generally greater in sclero-corneal sections than in those that are made entirely within the clear cornea.

Jackson found that in 15 per cent. of cases a permanent degree of astigmatism was reached within two months after the operation; in 20 per cent. regressive changes continued after more than three months.

Rollet found that in examining 150 cases, five months after the operation, 25 per cent. exhibited no marked astigmatism, while the remainder had an average amount of 2.57 D. A year or more after the extraction there was either complete disappearance of the astigmatism or a small amount (at right angles to the original) had developed.

Astigmatism, Simple. In this form of refractive error the main meridian is emmetropic; the other hypermetropic (simple hypermetropic astigmatism, AsH); or the principal meridian is emmetropic while the other is myopic (simple myopic astigmatism, AsM).

Astigmia. Jackson prefers this term to **astigmatism,** (q. v.) and agrees with Burnett who urged the employment of the former word because the derivative meaning as well as brevity and unity argue in its favor. The French equivalent *astigmie* has been growing in favor, and both in England and America the shorter word has been officially adopted by several journals. J. L. Moffat has long been an enthusiastic advocate of "astigmia."

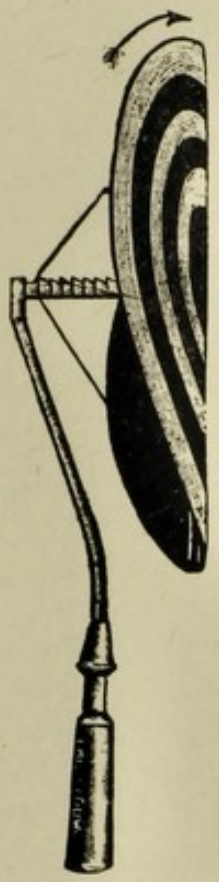
Astigmatismus. (G.) Astigmatism.

Astigmatismus, Abnormer unregelmässiger (G.) Abnormal irregular astigmatism.

Astigmatismus, Einfacher. (G.) Simple astigmatism.

Astigmatismus, Einfacher hypermetropischer. (G.) Simple hypermetropic astigmatism.

Astigmatismus, Einfacher myopischer. (G.) Simple myopic astigmatism.
Astigmatismus, Erworbener. (G.) Acquired astigmatism.
Astigmatismus, Gemischter. (G.) Mixed astigmatism.
Astigmatismus, Hypermetropischer. (G.) Hypermetropic astigmatism.
Astigmatismus, Irregulärer. (G.) Irregular astigmatism.
Astigmatismus, Linsen. (G.) Mixed astigmatism.



Roth's Astigmoscope.

Astigmatismus, Myopischer. (G.) Myopic astigmatism.
Astigmatismus, Postoperative. (G.) Postoperative astigmatism.
Astigmatismus, Regelmässiger. (G.) Regular astigmatism.
Astigmatismus Strahlengang. (G.) Astigmatism of the ciliary duct.
Astigmatismus, Unregelmässiger. (G.) Irregular or abnormal astigmatism.
Astigmatismus, Unregelmässiger normaler. (G.) Normal irregular astigmatism.
Astigmatismus, Zusammengestzter. (G.) Compound astigmatism.
Astigmatismus, Zusammengesetzter hypermetropischer. (G.) Compound hypermetropic astigmatism.

Astigmatismus, Zusammengesetzter myopischer. (G.) Compound myopic astigmatism.

Astigmatometer. An instrument for measuring the amount of astigmatism, especially of the corneal astigmatism.

Astigmometer. n. An instrument for measuring the amount of the corneal astigmatism by determining the difference in refraction between the least and the greatest meridians of the cornea. Also called an astigmatometer. The term by which astigmometers are most commonly described is ophthalmometer. These instruments will be fully described under that name as well as in the section, **Examination of the eye.**

Astigmoscope. An ingenious form of Placido's disk (shown in the accompanying figure) has been suggested by Roth, who calls it the *astigmoscope*. The black and white rings are painted on a thin plate of elastic steel, which can be bent back by a cord attached to the margins and caught on the notches made upon the arm which supports the disk. The bending back of the plate renders the rings oval instead of circular, and the reflection of these oval rings from an astigmic cornea becomes circular when the plate is bent to the proper amount in the direction of the meridian of least corneal curvature. The degree of astigmia can be read from the notch in which the cord is placed to give the necessary curvature.

Astigmoskop. (G.) Astigmoscope.

Astringents, Ocular. Agents that contract the tissues of the eye by reducing the size of the vessels in them, by their superficial destruction, by forming chemical combinations with them or, indirectly, by removing one or more irritants that serve to stimulate their growth or to bring about a state of hypertrophy. Many astringents are also germicides, antiseptics, cauterants, etc., under different conditions of concentration, locality of application and other considerations.

Indeed, the difference between these agents is largely one of degree since astringents are all more or less irritating and, like cauterants, to some extent destroy or alter the parts to which they are applied.

Some astringents, especially those insoluble in water or alkaline fluids, exhibit a feeble and transient action on the tissues and are but mildly astringent and irritant; others are more distinctly irritating and cauterant.

As a rule, astringents of the severer type increase an acute inflammation without exhibiting the distinctive astringent qualities for which they are generally prescribed. For this reason they are not nearly so useful in recent as in chronic inflammations and

should be ordered with considerable hesitation in the former conditions.

The vegetable astringents owe their powers chiefly to the presence of tannic acid, tannins or tannates, substances belonging to an ill-defined group, possessing an astringent action as their best defined property. Other organic acids, even salicylic acid and the salicylates, are but feebly astringent.

An important group of astringents are zinc salts, especially the acetate, iodide, sulphate and chloride, long used in $\frac{1}{10}$ to $\frac{1}{2}$ per cent. solution in the simple forms of conjunctival catarrh and, in recent years, discovered to be a specific in the treatment of (Morax-Axenfeld) diplobacillus-conjunctivitis.

Alum, either in the solid form (pencil, crystal, powder), as a solution or in combination with other agents, has long been used as a mild astringent in the simple forms of follicular conjunctivitis and trachoma.

Copper sulphate, citrate and other salts, especially preparations of the first named, form a well known group of astringents. Like alum, they may be applied in "stick" form. Other astringent copper compounds are the ammoniosulphate, the sulphocarbolate, and cuprol.

Silver nitrate and some of its substitutes—especially protargol, argyrol, argentamine, itrol, largin, nargol, actol, argentose and collargol—are generally regarded as our most valuable germicide-astringents. The first named has been employed in the treatment of eye diseases since the earliest times and has since held its place as an essential part of our armament. (See **Silver nitrate** and **Silver salts.**) The comparative clinical values of argentic preparations are discussed under the foregoing and individual headings.

Alexander Randall quotes Risley as teaching 30 years ago that it is wise to use astringents early, so as to obtain their good effects and so avoid their irritating qualities which, later, are pronounced and at times outweigh their good effects. He believes that employed in this manner silver nitrate is still the safest and most effective application in purulent conjunctivitis in its secreting stage, aided, generally, by hot applications.—(Ed.)

Astroscope. An astronomical instrument composed of two cones on the surfaces of which the constellations with their stars are delineated. It was formerly used as a substitute for the celestial globe.

Astroscopy. Observation of the stars.

Asylums and institutions for the blind. See **Blind, Institutions and occupations for.**

Asymmetry. n. Anomalous development of an organ, a pair of organs or of the two sides of the body.

Asymmetry of the eye. Variations in the ideal form of the refracting surfaces of the eye produce several forms of astigmatism. Irregularities in the shape of the lens was the first to be recognized, by means of entoptic observations of the lens "star." It was soon realized, indeed, that the cornea varies a good deal from the ideal spheroid form, as shown by a number of keratoscopic investigations. This fact can also be demonstrated by skiascopic examination through the dilated pupil, as well as by the numerous astigmometers (q. v.) now in common use.

Asynergia. This term has been used in connection with anomalies of the ocular muscles—especially in treating of heterophoria—to express a condition of antagonism or, rather, lack of assistance (synergism) from the muscles that usually help the action of another muscle.

Asynergy. n. The lack of proper proportion in the action of two or more related organs or parts.

Atavism. [From *atavus* (L.) a great grandfather's grandfather.] This biological term indicates a reversion, as a result of hereditary influence, to ancestral characteristics. The operation of this law is often seen in ophthalmology. For example, as stated in *Science*, Vol. IV, 367, "of the 11.6 per cent. of children born with eyes of other than the parental color, a part must be attributed to atavism, that is, to intermittent heredity."

Ataxia, Friedreich's. See **Hereditary ataxia.**

Ataxiagram. The appearance presented by a line drawn by an ataxic patient. It is made with both open and closed eyes, and the deviations from a straight line, under both these conditions, are supposed to be of diagnostic importance.

Ataxiagraph. An instrument for determining the amount of swaying in ataxic cases.

Ataxia, Hereditary. FRIEDREICH'S ATAXIA OR DISEASE. This condition is an anomally of spinal development, and has little in common with tabes dorsalis. It usually affects several members of the same family and rarely presents any eye signs except nystagmic movements when an object is fixed. As nystagmus is not a sign of true tabes and is almost always present in hereditary ataxia, this symptom will help to distinguish juvenile tabes from the former disease.

Ataxia, Locomotor. See **Tabes dorsalis.**

Ataxmir. (Arabic). A mediaeval term for the treatment of distichiasis, said to have been first mentioned by Albucasis.

Ateroma dei vasi sanguigni. (It.) Atheroma of the blood vessels.

Athene the Eye-Preserver, Temple to. Concerning this structure, Pausanias, has the following passage: "And on the way to Alpium, as it is called, you come to the temple of Athene the Eye-Preserver, erected they say by Lycurgus, who had one of his eyes knocked out by Alcander, because he did not find Lycurgus' legislation agreeable. And he took refuge at this place, and the Lacedaemonians prevented his losing his remaining eye; so he built a temple to Athene the Eye-Preserver."—(T. H. S.)

Atheroma. This term, as its Greek radicles suggest, was first applied to cysts containing soft material; or to any soft, encysted tumor. More recently and properly, however, it describes fatty and other late degenerative changes in the walls of the blood-vessels, especially in the intima of the larger arteries. These alterations are responsible for many intraocular degenerations, especially of the lens system, choroid, retina and, sometimes, of the optic nerve. See **Arteriosclerosis.**

Atheroma of the choroidal vessels. In this degenerative process the arteries and veins appear thickened and outlined by a white border in certain regions. The blood column is often more or less decreased in width. As the disease progresses the vessels appear as bloodless, whitish lines. Choroidal hemorrhages are not infrequent, and they may even be the only signs that point to choroidal atheroma. This is especially true if the various choroidal elements cannot be made out ophthalmoscopically because of changes in and about the epithelial layer.

Atheromatöse Degeneration der Aderhautgefässe. (G.) Atheromatous degeneration of the choroid vessels.

Atheromcysten. (G.) Atheromatous cysts.

Atherom der Blutgefässe. (G.) Atheroma of the blood-vessels.

Athetosis, Eye-muscle symptoms in. In rare cases the muscles of the eye are the subject of cramp. In their symptomatology, these contractions resemble those in the extremities, in the jaw, in the throat muscles, etc. There is the same uncertain, hesitating movement, the same inability to relinquish rapidly any position which has been assumed, the same apparent lack of purpose in the form of the movement and of its execution. The affection is one of true spasm of the external muscles of the eye; there is a defect in the motor-sensory region coordinated with the affected muscles. The contractions are slow and tonic, and do not always involve the intraocular muscles.

Athmungsorgane, Erkrankungen der. (G.) Diseases of the respiratory tract.

Atmospheric air. See **Air.**

Atmotherapy. This is the term given by Golesceano to his method of applying heat directly to the eye by a mixture of hot air and steam. He uses a boiler like that of the steam atomizer and connects it with the outer tube of a double canula; through the inner tube of which fresh air is forced by a rubber bulb. At the end of this double canula the air, now heated, is mixed with the vapor; and the mixture conducted to a receptacle in contact with the orbit, somewhat like that used by Ostwalt; or the mixture of vapor and air is projected against the cornea from a distance of 4 cm. The mixture of air and vapor thus brought in contact with the eye has a temperature of from 40° to 50° C. Its application causes conjunctival and pericorneal hyperemia, lachrymation, and increased conjunctival secretion.

These applications can be made without the use of a local anesthetic. Each one is continued five to ten minutes, and they are repeated from once to four times daily. Beneficial effects are reported in marginal and strumous blepharitis, phlyctenular keratitis, and conjunctivitis, corneal abscess, interstitial keratitis, herpes of the cornea, rheumatic iritis, and chronic diffuse sclerotitis. It is probable that a simple, convenient and easily controlled method for the direct application of heat to the eyeball will prove a valuable addition to our therapeutic resources.

Atoleine. A name given to one of the soft, or liquid, paraffins, used as a menstruum for various therapeutic agents employed in ophthalmic practice.

Atonia del sacco lagrimale. (It.) Atonic condition of the lachrymal sac.

Atoniatoublepharon. (Obs.) A relaxed condition of one or both eyelids.

Atonic ectropion. Too great laxity of the lid tissues so that the border falls away from the eyeball. In this affection there is manifestly too great laxity of the lid. Operations for its relief have been devised with the idea either of shortening the excessively long free border, by excising a V-shaped piece from its center, elevating and shortening by means of sliding flaps and excising tissue from the outer canthus, or supporting the drooping lid by attaching it to its fellow above.—(W. H. W.)

Atoxyl. This compound has been successfully employed in the internal treatment of ocular syphilis by several authorities, among them Darier, Gifford, Bargy and others, in iritis, interstitial keratitis, as well as in sympathetic ophthalmia and trachoma. Sydney Stephenson declares that, after a considerable experience of the drug he has obtained in parenchymatous keratitis results that he had not

been able to accomplish in any other way. In this disease, as well as in other cases, subcutaneous injections of from 0.25 to 0.50 grammes are given in the buttocks two or three times weekly until a dozen injections have been taken, the total dosage not to exceed 6 grammes. These exhibits may be presented in conjunction with other treatment.

Patients stand the treatment very well, though nausea, epigastric pain and vomiting are likely to follow 0.75 to 1.50 grammes—10 to 23 grains.

I have had some experience with the hypodermic use of this remedy in tubercular iritis and chorioretinitis, and so far as can be judged from its effects in a few cases, the results were decidedly favorable, and no untoward toxic symptoms showed themselves. This has not been, however, the report from all quarters. R. Koch, during treatment of "sleeping sickness," reports 22 cases of blindness without ophthalmoscopic signs, while Fehr, Krudener, Nonne and Terrien all report loss of vision from optic atrophy (mostly post neuritic) following its use. Morax gives a complete review of the amblyopia from atoxyl showing that if a powerful and effective remedy it is also a dangerous one, especially when employed in maximum doses. These poisonous effects may be avoided, as the report of Morax teaches, by giving small doses frequently rather than occasional larger ones. No visual disturbances follow the use of half a gramme (or 7½ grains), and this should be regarded as the maximum dose. See **Arsenical amblyopia**; **Toxic amblyopia**. —(Ed.)

Atrabilin. The name given to the first of the suprarenal extracts to be placed on the market and to Dor and Bates we are indebted for its introduction into ophthalmic surgery.

This remedial agent is practically identical with adrenalin. It was also warmly recommended by Zimmerman and Wolffberg, who advise that it be used with formalin 1:5000, as a preservative.

Darier and Dor both pointed out the advantage of combining cocaine with atrabilin in operations on and affections of the eye.

Atresia. (L.), f.n. The occlusion or absence of a normal opening or channel of the body.

Atresia of the lachrymal canaliculi. Imperforation of these ducts may be either congenital (See **Congenital anomalies**) or acquired. The former condition is rare and the defect is generally associated with other ocular deformities. In both instances there is nearly always an epiphora which calls for operative interference. See **Lachrymal apparatus, Operations on.**

Atresia pupillæ. (L.) An obsolete term for anterior synechiæ.

Atresia pupillæ congenita. (L.) Congenital atresia, or closure of the pupil, has occasionally been observed as the result of an intrauterine, usually specific iritis or iridochoroiditis. The differential diagnosis of this form of pupil-closure from persistent pupillary membrane depends partly upon the fact that in the latter the play of the pupil, in contrast to cases of true atresia, is not limited in the least. Moreover the bands that produce the atresia arise from points in the iris distinct from those of pupillary membrane.

Atresie der Thränenpunkte. (G.) Atresia of the punctum lachrymale.

Atretopsia. (L.), f.n. Atresia, or imperforation, of the pupil.

Atreya. An ancient East Indian physician and priest, of unknown date. Author of the Sanhita, in which are mentioned diseases of every portion of the body.—(T. H. S.)

Atrofia del bulbo. (It.) Atrophy of the whole eyeball. Phthisis bulbi.

Atropa belladonna. The belladonna (deadly nightshade, common dwale) is an erect perennial European herb, from three to five feet high, bearing dull-green, ovate, entire leaves having a peculiar heavy odor and a fatty feel, with solitary, axillary, dull-purplish, bell-shaped flowers on drooping stalks. The fruit is a dark, shining, many-seeded berry, resembling a cherry in shape and attached in the base of the permanent calyx. The branches, the inferior surface of the leaves, and the peduncles are pubescent. The root is carrot-shaped, branching, dirty-yellow externally, white within. The root and leaves are official. (Foster.)

Atropamine. See **Apoatropine.**

Atrope lines. In physiological optics (q. v.) the lines normal to the axial plane of ocular rotation.

Atrophia bulbi. (L.) Atrophy of the eyeball (q. v.).

Atrophie der Aderhaut. (G.) Atrophy of the choroid.

Atrophie der Netzhaunt. (G.) Atrophy of the retina.

Atrophie der Sehnerven. (G.) Atrophy of the optic nerves.

Atrophie, Descendierende. (G.) Descending atrophy.

Atrophie des Opticus. (G.) Atrophy of the optic nerve.

Atrophie, Einfache. (G.) Simple atrophy.

Atrophie, Glaukomatöse. (G.) Glaucomatous atrophy.

Atrophie nach Blutverlust. (G.) Atrophy after hemorrhage.

Atrophie nach Schädelbruch. (G.) Atrophy after fracture of the skull.

Atrophie, Neuritische. (G.) Neuritic atrophy.

Atrophy of the various tissues and organs (optic nerve, choroid, retina, eyeball, iris, conjunctiva, tarsus, etc.) of the ocular apparatus not especially mentioned or described as minor topics will be found

under the appropriate major headings. Thus, for **Atrophy of the iris,** see **Iris, Atrophy of** and **Iris, Diseases of.**

Atrophy, descending, of the optic tract, Visual field in. See **Neurology of the eye.**

Atrophy, Fuchs' optic. Atrophy of the peripheral bundles that compose the optic nerve.

Atrophy of the eyeball. PHTHISIS BULBI. ATROPHIA BULBI. A reduction in size and contents of the eyeball, accompanied by lowered tension and complete blindness. Flattened areas on the surface of the otherwise round eyeball are seen, corresponding to the course of the four straight muscles and, when the atrophy is far advanced, these markings show more plainly as deep furrows. As a rule the cornea is reduced in size, is flattened and frequently loses much of its transparency. Sometimes, however, it is proportionately rounded, or exhibits groove-like impressions, if the atrophy is associated with anterior synechia and an up-drawn pupil. The depth of the anterior chamber varies; although it is often entirely abolished. The iris is atrophied, and occasionally covered by a membranous or scar-like exudate that fills the entire pupil. The lens is invariably clouded, and frequently shrunken, but not always visibly so. The intraocular tension is lowered and occasionally one may feel hardened areas through the sclera, pointing to a possible ossification of the bulbar wall. (See **Bone formation in the choroid.**)

Phthisis bulbi develops slowly through a series of months, or years, and then usually stops when a certain degree of shrinkage has been attained.

The etiology lies in a series of inflammatory infections of the uveal tract, due to such chronic or acute dyscrasiæ as syphilis, tuberculosis, typhoid fever, gout, or to injuries, including operations. Sympathetic ophthalmia may also lead to atrophy of the globe. As a rule, atrophied eyeballs the subject of recurrent inflammatory attacks are a constant menace to the sound eye; they may set up migratory ophthalmitis, and are better excised.

Regarding the pathology of this condition, one occasionally finds changes in the sclerotic coat similar to those appearing in band-like keratitis. One further finds proliferation and thickening of the epithelium, accompanied by formation of vacuoles, and newly formed vessels in this coat. The atrophy of the iris involves all of its layers, and the iridic vessels are sclerosed and destroyed. The nerves of the iris also show degeneration to a great extent. The most resistant elements are the sphincter iridis and the retinal pigment. The chief new element in the atrophied iris is fibrillar connective tissue. The pupil is closed by masses of exudate, which

either partially or wholly fill the anterior chamber and are joined to the ciliary processes in the posterior chamber. In the advanced stages the exudates become organized into tough, vascular membranes, which tightly surround the lens. Similar changes occur in the ciliary body and choroid, while, as a result of the shrinking of the exudation-membrane, the ciliary processes are thinned and much spread out. The lens becomes cloudy and disintegrated by contact with and penetration by the exudate through the ruptured capsule.

Ossification of the surrounding tissues may lead to an apparent ossification, but really a hardening, of the lens itself. The vitreous is also infiltrated by the infective exudates and these together form a connective tissue mass which on contracting detaches the retina (and often the choroid coat and the ciliary processes) from the sclera.

The nervous elements of the retina are atrophied, partly as a result of degeneration of the fibres of the optic nerve.

The choroid coat and the scar (or connective) tissue of the exudate frequently undergo a genuine ossification, all the elements of true bone being found in the hardened coat.

The therapy is determined by the causes of the original infection and the stage of the disease. If the eye is quiet it may be allowed to remain in the socket, but a blind, irritable or irritating globe ought to be removed. Where the cause may with relative certainty be assumed to be syphilis, a practically harmless condition may be induced and indefinitely maintained by proper treatment; and the same may be said, with less confidence however, of tubercle, as well as of any other removable cause.—*Encyklopädie der Augenheilkunde.*

Atrophy of the optic nerve. Although various phases and relations of individual forms of this symptom will also be considered under numerous headings throughout this *Encyclopedia* it is considered wise to give, as an introduction to them, a general review of the more common forms of the disease.

The term atrophy of the optic nerve is applied to conditions in which there is a degeneration of the nerve-fibres and an overgrowth of connective tissue. The disease may be primary or secondary.

Primary optic-nerve atrophy develops without previous visible signs of inflammation. As a rule, both eyes are involved, the process being more advanced in one than in the other. The optic disc is shallowed and changed in color, and the disc-margins are clearly defined.

Secondary optic-nerve atrophy develops as a result of a previous inflammatory process, which may be located in the brain or its

membranes, in the choroid, in the retina, or in the nerve-head. The disc-margins are blurred by the deposition of connective tissue upon them. The distinctions given above are based on clinical appearances. Pathologic studies have shown that, in many cases, what clinicians call simple or primary atrophy of the optic nerve is due to parenchymatous neuritis (Nuel). The external appearance is that of the normal eye, except that in total blindness the pupils will be dilated and irresponsive to light. In some cases, particularly those due to tabes, the pupils are small, reacting to accommodation and convergence, but not to light (Argyll-Robertson pupil). Pain and photophobia are generally absent. The disturbance in vision is manifest in a lowering of visual acuity, a contraction of the form-field and a contraction of the color-field. The loss of central vision varies from a slight reduction to complete blindness. Any existing error of refraction should be corrected before deciding that a loss in visual acuity is present. If the atrophy is bilateral, the loss of vision is generally greater on one side. Vision is impaired both for distance and for near.

Contraction of the field for white is found at an early date. The common defect is a concentric contraction which progresses until only a small central vision-area remains. Quadrant-shaped defects, hemianopsia, and central and ringshaped scotomata have been observed. Contraction of the color-field is an almost constant symptom, the colors being lost in the following order: Green, red, blue, yellow. The light sense is diminished. Ophthalmoscopic changes are found in the nerve-head, in the surrounding tissues of the fundus, and in the blood-vessels. In primary atrophy the margins of the optic disc are well defined. The disc itself presents a stippled appearance, and is of a grayish or bluish color. The surface of the disc is slightly concave, and the physiologic cup is not filled. The vessels are slightly reduced in calibre. The fundus looks normal.

In secondary atrophy the disc-margins may be irregular, and are blurred in places. The disc is of a dead-white color. It may show a network of newly formed blood-vessels. The surface of the disc is flat, the physiologic cup being filled. The vessels are diminished in calibre and white streaks accompany them. The fundus has lost some of its brightness.

Optic-nerve atrophy, which is secondary to retinal degeneration, will show a picture different from those described above. The disc will appear yellowish, or, as Frost says, waxy or of the color of dirty parchment. The surface of the disc will be flat, and often it will be surrounded by a narrow ring of atrophic chorioid.

In embolic atrophy the disc shows a dense, opaque white or yellow-

ish-white appearance. Retinal changes are present. Any cause which may produce optic neuritis may also lead to optic-nerve atrophy. Brain-tumors, injuries to the nerve-trunk, congenital malformations of the skull, erysipelas, orbital cellulitis, hemorrhage into the orbit, blows upon the head, spinal injuries, syphilis, tabes, tumors of the pituitary body, disseminated sclerosis, progressive paralysis, cerebral softening, severe hemorrhages, lightning-stroke, internal hydrocephalus, etc., are among the etiologic factors. The abuse of alcohol and tobacco is responsible for some cases. Others are congenital or possibly may be due to injury during instrumental delivery. In probably 60 per cent. of the cases there is not a discoverable cause. Many of these must be attributed to the influence of certain toxic substances which are generated in the system as the result of perverted metabolism. This view of the endogenous origin of certain cases of optic-nerve atrophy was suggested by Horner. Recent studies of the excretions of patients suffering with tobacco-amblyopia have shown excessive excretion of enterogenous decomposition-products in the urine together with a more or less marked urobilinuria (de Schweinitz and Edsall).

Of 117 cases of optic-nerve atrophy, Derby found no cause in 71; abuse of alcohol and tobacco, 11; syphilis, 8; injuries to the head, 9; brain disease, 6; apoplexy, 1; epilepsy, 1; locomotor ataxia, 1; meningitis, 2; optic neuritis, 2; erysipelas following lachrymal abscess, 1; mumps, 2; tumor of pituitary body, 1; following pregnancy, 1. The pathologic changes will depend upon the etiologic factor. In the atrophy found in tabetic subjects the nerve-fibres lose their medullary coverings and are changed into fine fibrillæ. Fatty granular cells are found between the fibrillæ. There are no signs of a true inflammatory process. Holden believes that the primary change is an atrophy of the retinal ganglion-cells.

In the post-neuritic type of atrophy there is a formation of connective tissue in the nerve-stalk and in the nerve-head. The coats of vessels are thickened. The sheaths or the nerve-fibres show varicosities and either shrink or disappear. In advanced cases the nerve forms a hard, distorted cord. This is always grave, and will depend on the cause of the disease, the stage at which the patient applies for treatment, etc. In primary or progressive atrophy the course of the disease is slow. Several years may elapse before the patient becomes blind. The damage done to vision in the neuritic or secondary form will depend upon the amount of contraction which ensues in the inflamed tissue. A progressive narrowing of the field is a sign of grave import.

Treatment must be directed in accordance with the cause. Syphili-

tic cases will require mercury or potassium iodid, or both remedies. Strychnin must be given by the mouth or hypodermically. It should be administered in rapidly increasing doses and should be pushed to the limits of tolerance. If administered hypodermically the beginning dose will be 4/100 grain. Given by the mouth the beginning dose will be 1/60 grain three times a day, increased rapidly until the patient takes 1/6 or 1/5 grain at a dose. According to Derby, improvement follows the strychnin treatment in 30 per cent. of the cases. Nitroglycerin or nitrite of amyl may be used. Other proposed remedies are preparations of arsenic, silver, iron, phosphorus, lactate of zinc, hypodermics of antipyrin, and galvanism. Vibratory massage may be tried.

If no improvement follows the use of such remedies as have been enumerated, the author removes the superior cervical ganglion of the sympathetic nerve, in the hope that an increased blood-supply will bring about improvement in vision. Although it is yet too soon to pass final judgment on this operation, the author has had one successful result out of four advanced cases of optic-nerve atrophy which he has treated by operation. To be of value, the operation should be done while the patient retains vision equal to or better than the counting of fingers at two or three feet. Suker and Renaud have also reported cases in which sympatheticectomy was followed by improvement in vision.

Hereditary optic-nerve atrophy. This is a variety of atrophy of the optic nerve, which, as a rule, affects several members of a given family at about the age of twenty years. It has been known to affect as many as six generations (Gould). The disease is found chiefly in the male members, the inheritance being through the unaffected females. About 14 per cent. of the cases reported have occurred in females. There are on record 317 cases, occurring in 80 families. The onset of the disease is sudden. It begins as an acute retrobulbar neuritis, which reaches its height in five or six weeks. After this period it either progresses slowly or remains stationary. Central scotoma is present, which at first affects colors only and ultimately involves the form-field. Peripheral vision is either normal or slightly altered, thus permitting the patient to get about, while central vision is often so much reduced that reading is impossible. The color-changes are central at first, the periphery becoming involved later. Blue and yellow are seen more clearly than red. In anomalous cases a ring-scotoma or a sector-shaped defect may be found. Nyctalopia is a common symptom. During the stage of inflammation the patient may complain of red vision or of seeing colored stars or flames. Photophobia and headache may be

present. The ophthalmoscopic signs include hyperemia of the nerve-head with slight haziness of its outline. The arteries are either normal or dilated (Leber). A fine striated appearance of the retina around the nerve-head may be present. In the later stage the papilla becomes white, with slightly hazy borders and an accumulation of pigment. The pallor of the disc generally begins in the temporal half. Atrophy always follows the neuritis. Heredity is an undoubted factor. Some cases have been attributed to the abuse of tobacco and alcohol. The tower-shaped skull has been regarded by some writers as a cause, it being supposed that the optic nerve is compressed by the bone. Prognosis is unfavorable. Leber has seen a family in which all the patients recovered their vision. Partial recovery has been noted by several observers. Treatment does not differ from that which is appropriate for other types of retrobulbar optic neuritis.

Hemorrhage into the sheath (apoplexy) of the optic nerve. Although hemorrhage into the subdural and subarachnoidal spaces of the optic nerve has been described by Magnus, de Wecker, and others, there is no evidence to show that it exists as an idiopathic affection. There are no reasons for believing that hemorrhages situated at the border of the optic disc, or in the vitreous humor, are indicative of apoplexy of the optic-nerve sheath (Gonin). Intervaginal hematoma may occur after cerebral apoplexy or following trauma. In such a case there will be rapid and great loss of vision. Early ophthalmoscopic examination may show nothing abnormal, or may give a picture resembling that which is found in embolism of the central retinal artery. At a later date the disc will be atrophic. —(J. M. B.)

Those forms of optic atrophy not described above or as individual topics will be found under the major headings, **Nerve, diseases of the optic, and Neurology of the eye**.

Atropina. (L.), f.n. Atropine.

Atropin bei Iritis. (G.) Atropin in iritis.

Atropine. ATROPIA. $C_{17}H_{23}N_3$. An alkaloid obtained from atropa belladonna (q. v.) and other plants of the same family. It occurs as colorless or whitish, acicular crystals with a bitter-acrid taste, soluble in 450 parts of water, 1.50 parts of alcohol, 17 parts of ether, at 77° F. It is also soluble in glycerin, benzine and olive oil. Its best known salt is the sulphate, but it must be remembered that the alkaloid, the borate, iodate, oleate (for ointments), salicylate, santoninate, valerianate and other salts have been used in ocular therapy.

The alkaloid is obtained from atropa belladonna and other plants

of the same family and is isomeric with daturin. It is the salt of an organic base called tropin (tropin tropate), but in ophthalmic practice is generally employed as the sulphate which it closely resembles.

Atropine and most of the other cycloplegics are chemically incompatible with the alkalies, tannin, the salts of mercury; physiologically incompatible with opium and its derivatives, pilocarpine, muscarine, aconitine and eserine.

Atropia is a powerful cycloplegic and mydriatic and may act as a poison even when instilled into the conjunctival sac. In toxic doses it causes dryness of the throat, vertigo, frequent pulse, a scarlatinous rash, hallucinations and delirium. A single drop of a one per cent. solution of atropia sulphate produces mydriasis in about 15 minutes and cycloplegia in two hours. It stimulates the radiating muscular and sympathetic fibers of the iris while it paralyzes the peripheral cells of the motor oculi supplied both to the iris and to the ciliary muscle. Instilled thrice daily for two days the cycloplegia lasts from seven to twelve days—the dilation of the pupil somewhat longer. Atropia also increases the intraocular tension, and this fact should always be borne in mind in cases of suspected glaucoma.

Most of its effects have been noted during the internal administration of belladonna or its derivatives, during its use as a liniment, as an ointment and as a plaster. The tears that flow from an eye under treatment by an atropine collyrium may act as a mydriatic if accidentally introduced into the fellow eye or the eye of an attendant.

Owing to the extreme susceptibility of many patients to the poisonous effects of eye-drops I rarely use the drug in stronger solutions than one per cent., ordering one drop only to be instilled at a sitting and then, when possible, after meals, when absorption takes place most slowly. The eyelashes are then wiped perfectly dry with cotton from the inner canthus outward. Many surgeons advise pressing the finger over the region of the lachrymal sac at the time of the instillation, but I believe the precautions just mentioned are much more effective and apply with equal force to the use of all poisonous collyria. A single drop of a 1:45.000 solution of the atropin will dilate the normal pupil in less than an hour.

Michel thinks the toxic danger point is reached when, at one sitting, eight drops of a one-half per cent. solution are instilled into the conjunctival sac, but the conditions under which it is used and the idiosyncrasy of the patient chiefly determine the toxic effect.

Hirschberg in severe cases of acute iritis instills the drug every

hour or two the first day; afterwards every two hours daily, and night if need be. As Noyes has said, "atropia is the beginning, the middle and the end of the treatment of all forms of iritis," and there is much to justify such a sweeping statement. Judiciously exhibited in conjunction with general treatment, hot applications, dionin and cocaine its fullest effects are apparent in relieving the symptoms and preventing the serious sequelæ of this disease. It gives rest to the musculature of the inflamed organ, relieves its morbid vascularity, prevents the formation of (or breaks up) posterior synechiæ and acts as a sedative to the irritated nerve-endings.

In scleritis, choroiditis, retinitis and the majority of cases of corneal ulcer atropia is also indicated. It is contra-indicated in glaucoma and in total (ring) synechia.

Atropine irritation and conjunctivitis form an idiosyncrasy which may be suspected from the roughness of the palpebral skin, the dry throat and other toxic symptoms following an ordinary dose of the drug. When atropia is thus badly borne, scopolamin or duboisin (in one-tenth or one-twentieth the dose of atropine) may be tried, or the drug in reduced dosage used as an oily solution or in the form of ointment.

For the double purpose of increasing its cycloplegic effect and of inhibiting its poisonous tendencies D. M. Griffin makes use of the following formula when employing atropine in refraction work:

℞

Atropiæ sulph.	gr. iss
Dionin.	gr. ss
Aquæ dest.	fl. ʒii

When solutions of atropine fail to produce the desired effect H. H. Martin employs finely powdered atropine sulphate, as much as can be picked up on the point of a pen knife, placed in the lower conjunctival sac. The eye is cocainized previous to this application and the patient or nurse directed to exert pressure with the finger over the lachrymal sac for five minutes.—(Ed.)

Atropine conjunctivitis. Formerly, every one believed with Kobert that this conjunctivitis is a direct effect of atropine. Now, however, many assume that the toxic symptoms are due to infection of the solution by a mold fungus, and that the atropine, as such, has no effect on the conjunctiva, with the exception of cases of idiosyncrasy (q. v.). However that may be, in some subjects a single application may cause violent irritation; continued use may result in the development of typical follicular catarrh with a good deal of follicle formation. Replacing the atropine with duboisin or some other mydriatic, or

regularly sterilizing the solutions before using them in most cases effects an early cure.

Atropine glaucoma. The most noteworthy toxic effect of the instillation of atropine is glaucoma. A large number of recorded cases show that a single atropine instillation may not only induce an acute attack in a latent, chronic glaucoma, but may set up in apparently normal eyes the same symptom-complex. Some observers assume that such eyes could not have been normal, that at least a definite predisposition must have been present, and that in healthy eyes atropine does not produce such serious changes. Perhaps some of the earlier observations of blindness following the use of belladonna or atropin can be explained by its production of acute glaucoma.

Of thirty-two cases of glaucoma collected by Myles Standish, nine were believed to be due to atropin, two to homatropin, and one each to scopolamin, duboisin, and cocaine, (*Ophthalmic Record,* 1902, p. 243).

No age seems to be exempt from such a possibility. The collected data show that children from 5 to 10 years, as well as adult men and women may be subject to this trouble. The climacteric period is said to predispose to it; likewise senile changes in the arterial system have been supposed to contribute to the rise of intraocular pressure produced by atropin as well as by glaucoma, but incorrectly. The strength of the atropin solution seems to be unimportant, for a solution of 1 to 2,500 may produce glaucoma as well as a solution of 1 to 100. The time required for the appearance of the glaucoma is variable. In one case it appeared in half an hour; in others in 1, 2, 3, 5 hours or even after several days.

Atropine irritation. This idiosyncrasy against belladonna shows itself in swelling of the conjunctiva and roughness of the palpebral skin. It is never accompanied by pain but generally is attended by some itching and ocular discomfort. It is commonly observed several days after the first instillation of the drug, and may be associated with considerable thickening of the skin surface and a sero-mucous discharge from the eye. It is an alarming sign to one who has not previously encountered it but is not, fortunately, as serious a complication as it appears. The form of the mydriatic should be changed to duboisin or hyoscin, the dose reduced to the minimum and a simple ointment applied to the roughened lids.

Atropine methylbromide. See **Methylatropine bromide.**

Atropine methyl nitrate. See **Eumydrin.**

Atropine, Ocular signs of poisoning by. These are, swelling of the

lids, excessive lustre of the cornea, mydriasis, and paralysis of the accommodation. Exophthalmia has been observed, probably as a result of paresis of the recti muscles, together with a similar condition of the orbicularis, permitting the lids to be widely separated by the exophthalmic globe.—(T. H. S.)

Atropine santoninate. (Not the "santonate.") A white powder quite soluble in water.

This salt is particularly mentioned to draw attention to the fact that while quite equal in solubility and medicinal action to the methylbromide, nitrate, salicylate, sulphate, borate and other favorite compounds of atropia used in ophthalmic practice, it does not so readily as they undergo decomposition and if kept in dark bottles retains its cycloplegic and other qualities almost indefinitely.

Atropine, Systemic poisoning from. A too liberal application of atropin or of its related poisons will sometimes produce symptoms that show themselves occasionally after a very few minutes. These are chiefly dryness of the throat, hoarseness, difficulty in swallowing, deep redness of the face, and a scarlatina-like eruption. In addition there is noticed quickening of the pulse, headache, vertigo, and delirium of a peculiar, restless, "merry" variety. In one case Raphael observed (1889) glycosuria, which disappeared with the other symptoms.

If the dose is a fatal one (statistics of lethal doses vary greatly) death takes place in from 2 to 20 hours, preceded by violent quickening of the pulse and respiration, coma and paralysis of the sphincter muscles of the bladder and rectum.

When serious symptoms of atropia poisoning set in, vomiting should be induced and the stomach washed out. Injections of morphia (0.01-0.02) are recommended, and repeated hypodermics of pilocarpin (0.01). This medication should be continued until the mucous membrane of the mouth becomes moist. In cases of cerebral congestion, energetic antiphlogistic treatment is called for.

The eye signs and symptoms are discussed under **Atropine** and **Toxic amblyopia.**

Atropinidiosynkrasie. (G.) Atropine idiosyncrasy.

Atropinism. Poisoning by atropine. See **Toxic amblyopia.**

Atropin Katarrh. (G.) Catarrh produced by the use of atropine.

Atropinvergiftung. (G.) Atropine poisoning.

Atropinwirkung. (G.) Effects of atropin.

Atropism. n. Poisoning by atropine or belladonna. See **Toxic amblyopia.**

Atroscine. IOTA SCOPOLAMINE. This cycloplegic alkaloid, found as

transparent, colorless crystals, sparingly soluble in water, is derived from commercial hyoscine or scopolamine.

Macklin prefers it to other cycloplegics for determining refractive errors, and uses it as a one per cent. solution in castor oil. He says it acts as a rapid and powerful mydriatic and cycloplegic, is as potent and reliable as atropine sulphate, while the power of accommodation returns in five days. Of course, with homatropine the ciliary paresis ceases in twenty-four hours, which is undoubtedly a great advantage in many cases, yet homatropine has disadvantages which must be apparent to all who use it. Mydriasis with atroscine begins in ten minutes and is complete in twenty. Cycloplegia begins in ten minutes and is complete in about fifty.

The hydrobromide is very soluble in water and for that reason is to be preferred to the pure alkaloid.

There is an inactive form of atroscine (Merck) with the formula $C_{17}H_{21}NO_4+H_2O$, colorless, transparent crystals, very slightly soluble in water, that in one per cent. solution (preferably castor oil) acts as a miotic.

At-Tabari, Abul Hasan Ali b. Sahl b. Rabban. This distinguished son of the still more distinguished Jewish physician, Rabban at-Tabari, was the teacher of the immortal Rhazes and body-physician to the Caliphs Mutasim and Mutawakkil. He flourished in the 9th century A. D. He wrote a comprehensive treatise on general medicine, in 30 books and 360 chapters. He also made a number of translations, presumably excellent, from Indian works on ophthalmology, but none of these have descended to our day.—(T. H. S.)

At-Tamuni, Abu Abdallah Muh. b. Abmad b. Said. This famous Arabian physician, who flourished in the latter portion of the 10th century, practised first in Jerusalem; after A. D. 980, however, in Egypt. His only ophthalmic writing is, *A Chapter on the Nature of Ophthalmia, its Kinds, its Causes, and its Cures.*—(T. H. S.)

Attollirender augenmuskel. (G.) The superior rectus muscle.

Ätzmittel. (G.) Phagedenic; corrosive, caustic.

Ätzpulver. (G.) Corrosive; caustic powder.

Ätzstoff. (G.) Caustic.

Ätzwasser. (G.) Caustic water.

Aub, Joseph. This well-known ophthalmologist was born and educated in Cincinnati, receiving his professional degree at the Medical College of Ohio in 1866. He then pursued the exclusive study of ophthalmology at Vienna, London and Berlin. Returning to America, he was for some time assistant to Herman Knapp, at the New York Ophthalmic and Aural Institute. In 1872, settling in his native

city, he began the practice of ophthalmology on his own account. An excellent scholar, a skilful operator, and gifted with the faculty of making numerous and steadfast friends, he was very successful from the very beginning of his work. For seventeen years he was ophthalmologist to the Cincinnati Hospital, and, for 5 years was Professor of Ophthalmology in the Cincinnati Medical College. His chief fault was over-application to his practice. As a result of his almost unremitting labors, he became ill and, when it was altogether too late to be of benefit, he journeyed to the South, seeking there the health that could never be his again. Becoming convinced of the uselessness of further endeavors in this direction, he returned to Cincinnati, where he died soon after, in May, 1888.—(T. H. S.)

Aubert's binocular corneal microscope. The inventor presented this instrument at Heidelberg in 1891. It yields an upright picture by double inversion of the image. It produces an enlargement of twenty diameters of the object when it is ten and a half centimeters from the eye. The field is quite large. Concentrated daylight may be used for the illumination.

Aufätzen. (G.) To open by a corrosive.

Aufbähen. (G.) Poulticing; to puff up; to inflate; to swell.

Aufblicken. (G.) To look upwards.

Aufbrechung. (G.) An opening, eruption.

Aufbreiten. (G.) To spread.

Auffangeglas. (G.), n. In optics, the objective of a microscope or telescope.

Auffeuchtung. (G.) Moistening.

Aufgetrieben. (G.) Turgescent.

Aufhebemuskel. (G.), n. A levator muscle.

Auflösbar. (G.), adj. Soluble.

Auflösung. (G.), n. Solution.

Auflösung der linse. (G.) Solution or absorption of the crystalline lens, as in soft cataract.

Auflösung des glaskörpers. (G.) Synchesis, or fluid vitreous.

Aufspritzen. (G.), tr.v. To syringe.

Auftrinken. (G.), tr.v. To absorb.

Aufwärtskehrung der augenlider. (G.) Eversion of the eyelids.

Augapfel. (G.), n. The eyeball.

Augapfelausrottung. (G.) Removal of the eyeball.

Augapfelbinde. (G.) Fascia of the eyeball.

Augapfelbindehaut. (G.) The ocular conjunctiva.

Augapfelbrand. (G.) Sloughing or gangrene of the eyeball.

Augapfeleiterung. (G.) Suppuration of the eyeball.

Augapfelentzündung. (G.) Inflammation of the eyeball.
Augapfelfläche. (G.) The surface of the eyeball.
Augapfelhalter. (G.) Ophthalmostat, or instrument for fixing the eyeball.
Augapfelhäutchen. (G.) An ocular membrane.
Augapfelkrampf. (G.) Nystagmus.
Augapfelmuskellähmung. (G.) Paralysis of the external muscles of the eyeball.
Augapfelschmerz. (G.) A pain in the eyeball.
Augapfelschrumpfung. (G.) Atrophy or shrinking of the eyeball.
Augapfelstarrkrampf. (G.) Tetanic contraction of the ocular muscles.
Augapfelvarikosität. (G.) Varicose condition of the veins of the eyeball.
Augapfelveränderung. (G.) A change in the eyeball.
Augapfelvorderfläche. (G.) The anterior surface of the eyeball.
Augapfelvorfall. (G.) Protrusion of the eyeball.
Augapfelwand. (G.) Wall of the eyeball.
Augapfelwassersucht. (G.) Dropsy of the eyeball.
Augapfelzucken. (G.) Nystagmus.
Augapfelzuckung. (G.) Nystagmus.
Auge. (G.) The eye.
Auge des Neugeborenen. (G.) The eye of the new-born.
Auge, Fotäles. (G.) Foetal eye. See **Embryology of the eye.**
Auge, Reduziertes schematisches. (G.) Schematic reduction of the eye.
Augen. (G.) The eyes.
Augenabscess. (G.) Panophthalmitis purulenta.
Augenabstandsmesser. (G.) This device permits the position of the pupil and interpupillary measurements to be made in asymmetrical faces and, especially, is it valuable in indicating the proper kind of nose-bridge. Hertel (Uber ein neuen Apparat zur Bestimmung des Abstandes der Gläsermitten für die Fern—und Nähebrille.—*v. Graefe's Arch. für Ophthalm.* LXIV. 176-183. 1906. Beschreibung in der *Zentralzeitung für Optik und Mechanik.* XXVIII. 61 ff. u. 74ff. 1907.) more fully describes the use and necessity for this instrument.
Augenachse. (G.) The axis of the eye.
Augenader. (G.) Ophthalmic vein.
Augenaderhaut. (G.) Choroid.
Augenaderlass. (G.) Abstraction of blood from the eye.
Augenähnlich. (G.) Resembling an eye.

Augenaponeurose. (G.) Palpebral fascia.
Augenarterie. (G.) Ophthalmic artery.
Augenarznei. (G.) Remedy for the eye.
Augenarzt. (G.) Ophthalmologist; oculist.
Augenärztlich. (G.) Ophthalmiatric.
Augenausfluss. (G.) A discharge from the eyes.
Augenausrottung. (G.) Removal of the eye.
Augenausschälung. (G.) Enucleation of the eye.
Augenaxe. (G.) The axis of the eye.
Augenbad. (G.) Ophthalmic bath or eye-douche.
Augenbader. (G.) A basin used for bathing or washing the eyes.
Augenbalsam. (G.) Balsamum ophthalmicum; eye balsam.
Augenband. (G.) Tarsal ligament.
Augenbeben. (G.) Nystagmus.
Augenbecher. (G.) An optic cup.
Augenbecken. (G.) The socket of the eyeball.
Augenbersten. (G.) Rupture of the eyeball.
Augenbeschreibung. (G.) Ophthalmology.
Augenbeschützer. (G.) An eye-protector.
Augenbetrug. (G.) An optical illusion.
Augenbewegend. (G.) Oculo-motor.
Augenbewegender. (G.) The third cranial (motor oculi) nerve.
Augenbeweglichkeit. (G.) Mobility of the eyeball.
Augenbewegung. (G.) Ocular movement.
Augenbewegungen. (G.) Movement or motion of the eyes.
Augenbewegungen, Accommodative. (G.) Accommodative ocular movements.
Augenbewegungen, Associirte oder conjugirte. (G.) Associated or conjugate ocular movements.
Augenbewegungen, Dissociirte. (G.) Dissociated ocular movements.
Augenbewegungen, Einseitige. (G.) Unilateral ocular movements.
Augenbewegungen Nervenbahnen. (G.) Eye-movements in the nerve tracts.
Augenbezirk. (G.) The ophthalmic region.
Augenbildung. (G.) Blepharoplasty.
Augenbinde. (G.) A bandage for retaining a dressing on, to cover or to prevent the use of the eye.
Augenbindehaut. (G.) Ocular conjunctiva.
Augenbinden. (G.) Eye-bandaging.
Augenbinzeln. (G.) Nictitation, blinking.
Augenblase. (G.) A vesicle developed from the lateral wall of the forebrain, forming the posterior portion of the eyeball.

Augenblase, Primäre. (G.) Primary optic vesicle.
Augenblase, Secundäre. (G.) Secondary optic vesicle.
Augenblasen. (G.) In ocular embryology, the primitive optic vesicle.
Augenblasengrube. (G.) In embryology, the optic cup.
Augenblasenspalte. (G.) Fœtal ocular fissure.
Augenblasenstiel. (G.) A protuberance in the brain of the embryo, at the extremity of which the optic vesicle is situated. See **Embryology of the eye.**
Augenblasenwurm. (G.) The cysticercus cellulosa which has invaded the eye.
Augenblende. (G.) A blinker, blind, an eye-flap.
Augenblennorrhöe. (G.) Gonorrheal ophthalmia.
Augenblennorrhöe der Neugeborenen. (G.) Ophthalmia neonatorum.
Augenblick. (G.) A wink of the eye; twinkling of the eye; moment; instantly; instantaneously.
Augenblicke. (G.) Lucid intervals.
Augenblöde. (G.) Amblyopia.
Augenblödigkeit. (G.) Weakness of the eyes.
Augenblutadern. (G.) The ophthalmic veins.
Augenblutschwamm. (G.) A fungous (malignant) growth of the eye.
Augenblutunterlaufung. (G.) Hemophthalmia; suffusion or ecchymosis of the eye.
Augenbogen. (G.) The iris.
Augenbraue. (G.) The eyebrow.
Augenbrauenbogen. (G.) Superciliary ridges (q. v.).
Augenbrauengegond. (G.) The superciliary region.
Augenbrauenhaar. (G.) The hair of the eyebrow.
Augenbrauenhaut. (G.) The skin of the eyebrow.
Augenbrauenmuskel. (G.) See **Corrugator supercilii.**
Augenbrauenverlust. (G.) The loss of the hair of the eyebrow.
Augenbrauenwulst. (G.) The superciliary ridge.
Augenbrauenzache. (G.) Those fibres of the occipito-frontalis muscle that run towards and are attached near the inner canthus and at the side of the nose.
Augenbraumuskel. (G.) The corrugator muscle.
Augenbraunbogen. (G.) The arch of the eyebrows.
Augenbraune. (G.) The eyebrow.
Augenbraunenausfall. (G.) Falling out of the eyebrows.
Augenbraunenbogen. (G.) See **Superciliary ridges.**
Augenbraunenbogenloch. (G.) The supra-orbital foramen.
Augenbraunenmuskel. (G.) The corrugator supercilii muscle.
Augenbraunennery. (G.) The supra-orbital nerve.

Augenbraunenrunzler. (G.) A name for the corrugator supercilii muscle.

Augenbraunen-verschönerungsmittel. (G.) An ancient application for beautifying the eye by darkening the edges of the lids and lashes.

Augenbraungegend. (G.) The superciliary region.

Augenbraunhaare. (G.) The eyebrows.

Augenbreite. (G.) The space between the eyes.

Augenbrennen. (G.) Pain or discomfort in the eyes.

Augenbruch. (G.) Exophthalmus.

Augenbürste. (G.) A brush for scarifying the lids and palbepral conjunctiva.

Augenbutter. (G.) The secretion (normal or increased) of the Meibomian glands.

Augenbutterdrüsen. (G.) Meibomian glands.

Augencatarrh. (G.) Catarrhal conjunctivitis.

Augendach. (G.) The roof of the orbit.

Augendecke. (G.) Nictitating membrane, or third eye-lid.

Augendeckel. (G.) An eye-protector; an eyelid.

Augendeckelhaare. (G.) The eyelashes.

Augendiät. Augendiätetik. (G.) Ocular hygiene; dietetics with reference to the eye.

Augendistanz. (G.) The distance between the eyes.

Augendouche. (G.) Fomenting the eyes with water.

Augendrehpunkt. (G.) The point of rotation of the eyeball.

Augendruck. (G.) The tension of the eyeball.

Augendrücken. (G.) Pain in the eyes, from undue pressure.

Augendrüse. (G.) Lachrymal gland.

Augendrüsen. (G.) The Meibomian glands.

Augendrüsenentzündung. (G.) Inflammation of the lachrymal glands.

Augendunkelheit. (G.) A diminution or loss of vision.

Augenduscher. (G.) Eye douche.

Augeneinstülpung. (G.), n. In the embryology of the eye, ectodermic involution.

Augeneisen. (G.) Actual cautery; a cautery iron for use on the eye or its appendages.

Augeneiterung. (G.) Suppuration of the eyeball or its appendages.

Augenentzündung. (G.) Any inflammation of the eye.

Augenentzündung, Ägyptische. (G.) Egyptian ophthalmia.

Augenentzündung der Neugeborenen. (G.) Ophthalmia neonatorum.

Augenentzündung, Trockene. (G.) Xerophthalmy.

Augenerkrankung. (G.) Ocular affection.
Augenermüdung. (G.) Asthenopia, ocular fatigue.
Augenessenz. (G.) An eye essence. Römerhausen's collyrium.
Augenfällig. (G.) Manifest; readily seen.
Augenfarbe. (G.) The color of the eye; glaucoma of the eye.
Augenfeld. (G.) The field of vision.
Augenfell. (G.) A corneal opacity; a pterygium.
Augenfeuchtigkeit. (G.) A term sometimes applied to the aqueous or vitreous humor.
Augenfistel. (G.) A lachrymal or corneal fistula.
Augenfläche. (G.) An orbital or ocular surface.
Augenflecke. (G.) A pigmented spot on or opacity of the eye.
Augenflecken, Weisser. (G.) Leucoma, nebula, the white spot in the eye.
Augenflimmern. (G.) The swimming of objects before the eyes.
Augenflügel. (G.) The lesser wings of the sphenoid bone.
Augenfluss. (G.) Any form of discharge from the eye.
Augenflüssig. (G.) Having a discharge, especially of water, from the eyes.
Augenflüssigkeit. (G.) Vitreous.
Augenfortsatz. (G.) An orbital process.
Augenfunken. (G.) Flashes of light, or sparks, in or about the eye; phosphenes.
Augenganglie. (G.) Optic ganglion.
Augengebiet. (G.) The region of the eye.
Augengefässe. (G.) The ocular blood-vessels.
Augengegend. (G.) The region or neighborhood of the eye.
Augengeist. (G.) A name sometimes given to Pagenstecher's spiritus ophthalmicus, i. e., Spt. melissæ, 100; Spt. lavandulæ, 25; Spt. camphor., 3.; Spt. etheris nitros., 2.; 01. rosæ, gtt. 1. This mixture is used as a collyrium when diluted with 5 or more parts of water.
Augengeschwulst. (G.) Protrusion of the eyeball.
Augengeschwür. (G.) An ulcer on the cornea or sclera.
Augengespenster. (G.) An optical illusion.
Augengewölk. (G.) A pterygium; also, an opacity of the cornea.
Augengicht. (G.) Gout in the eye.
Augenglas. (G.) The eye-piece of a telescope or microscope.
Augengläser. (G.) Eye-glasses; spectacles.
Augenglasschleifer. (G.) An optician.
Augengriffel. (G.) The elevator of the upper lid.
Augengrube. (G.) The orbit; also, the depression above the eyes in some animals.

Augengrund. (G.) Fundus oculi.

Augenhalter. (G.) Ophthalmostat, or instrument for fixing or steadying the eyeball during an examination or operation.

Augenhaut. (G.) Any of the coverings of the eyeball.

Augenhautbraune. (G.) The choroid.

Augenhäutchen. (G.) Opacity of the cornea.

Augenheber. (G.) Levator palpebræ superioris.

Augenheftnadel. (G.) A fixation needle for the eye.

Augenheilanstalt. (G.) An eye-hospital.

Augenheilkunde. (G.) Ophthalmology.

Augenheillehre. (G.) Ophthalmology.

Augenheilmittel. (G.) A remedy for the eye.

Augenheilwasser. (G.) An eye-lotion.

Augenheraustreten. (G.) Exophthalmia.

Augenhintergrund. (G.) Fundus oculi.

Augenhintergrund, Normal. (G.) The normal fundus of the eyes.

Augenhintergrundsuntersuchung. (G.) An examination of the fundus oculi.

Augenhöhfläche. (G.) The orbital surface of the ones forming the orbital cavities.

Augenhöhle. (G.) The orbit.

Augenhöhlen. (G.) The orbits.

Augenhöhlenarterie. (G.) The arteries of the orbit.

Augenhöhlenast. (G.) The orbital branch.

Augenhöhlenblutadern. (G.) The orbital veins.

Augenhöhlenbogen. (G.) Superciliary ridges.

Augenhöhlendach. (G.) The roof of the orbit.

Augenhöhlendecke. (G.) The roof of the orbit.

Augenhöhlenentzündung. (G.) Orbital cellulitis.

Augenhöhlenfissur. (G.) Sphenoidal fissure.

Augenhöhlenfläche. (G.) The inner surface of the bones that enclose the orbit.

Augenhöhlenflügel. (G.) The lesser, or orbital, wings of the sphenoid bone. A segment of the anterior cerebral lobes rests upon their upper surface, while the lower surface forms the posterior part of the orbital roof. At their base is the foramen opticum. A projection from each near the sella turcica forms the anterior clinoid process.

Augenhöhlenfortsatz. (G.) An orbital process.

Augenhöhlengegend. (G.) The orbital region.

Augenhöhlengeschwulst. (G.) An orbital tumor.

Augenhöhlenhaut. (G.) The orbital periosteum or aponeurosis.

Augenhöhleninhalt. (G.) The contents of the orbit.
Augenhöhlenkamm. (G.) Orbital crest.
Augenhöhlenkrebs. (G.) Cancer of the orbit.
Augenhöhlenlappen. (G.) The orbital lobes.
Augenhöhlenloch. (G.) The orbital foramen.
Augenhöhlennerv. (G.) Orbital nerve.
Augenhöhlenöffnung. (G.) Orbital fossa.
Augenhöhlenrand. (G.) The margin of the orbit.
Augenhöhlenschlagader. (G.) Orbital artery.
Augenhöhlenspalte. (G.) Sphenoidal fissure.
Augenhöhlenteil. (G.) The orbital portion.
Augenhöhlenwagenbreitenindex. (G.) The orbito-malar index.
Augenhöhlenwand. (G.) The wall of the orbit.
Augenhöhlenwandung. (G.) The orbital wall.
Augenhöhlenwassersucht. (G.) Dropsy of the orbit. Hydrophthalmia.
Augenhöhlenwinkel. (G.) Orbital angle.
Augenhornhaut. (G.) The cornea.
Augenindex. (G.) Orbital index.
Augeninnere. (G.) Viscera of the eyeball.
Augenjucken. (G.) Itching of the eyes or eyelids.
Augenkamm. (G.) The orbital arch.
Augenkammer. (G.) One of the chambers of the eye. The anterior chamber.
Augenkammer, Cordere. (G.) The anterior chamber of the eye.
Augenkammer, Hintere. (G.) The posterior chamber of the eye.
Augenkammern. (G.) The chambers of the eye.
Augenkammerwasser. (G.) Aqueous humor.
Augenkapsel. (G.) The capsule of the eye.
Augenkatarrh. (G.) Catarrhal conjunctivitis.
Augenkitzel. (G.) Tickling of the eye.
Augenklappe. (G.) Eyelid.
Augenklapperand. (G.) Margin of the eyelid.
Augenklinik. (G.) An eye clinic or infirmary.
Augenknochen. (G.) The cheek bones.
Augenknorpel. (G.) The tarsal cartilage.
Augenknoten. (G.) Ophthalmic ganglion.
Augenkrampf. (G.) Nystagmus.
Augenkrank. (G.) Suffering from eye-disease.
Augenkranke. (G.) A sufferer from eye-disease.
Augenkrankenanstalt. (G.) An eye infirmary, or hospital.
Augenkrankenzimmer. (G.) A room, generally in a clinic or hospital, set apart for the treatment of eye diseases.

Augenkrankheit. (G.) Disease of the eyes.
Augenkrankheitslehre. (G.) Treatise on eye diseases. Ophthalmology.
Augenkrätze. (G.) Gonorrheal ophthalmia.
Augenkratzen. (G.) Scarification of the conjunctiva.
Augenkratzer. (G.) Instrument for scarifying the conjunctiva.
Augenkrebs. (G.) Cancer of the eye.
Augenkreis. (G.) The orbit; the orbital ring.
Augenkugel. (G.) The eyeball.
Augenlähmung. (G.) Blepharoplegia.
Augenlefzen. (G.) The eyelids.
Augenlehre. (G.) Ophthalmology; ophthalmic science.
Augenleiden. (G.) Disease of the eyes.
Augenleise. (G.) The orbit.
Augenleiste. (G.) The orbit.
Augenleistenfortsatz. (G.) An orbital process.
Augenleuchten. (G.) Luminosity of the eye.
Augenlicht. (G.) Eyesight; vision.
Augenlid. (G.) An eyelid.
Augenlidanschwellung. (G.) A swelling of the eyelid.
Augenlidaponeurose. (G.) Palpebral fascia.
Augenlidarterien. (G.) Arteries of the eyelid.
Augenlidaufhalter. (G.) Levator palpebræ.
Augenlidaussenfläche. (G.) The outer surface of the eyelid.
Augenlidband. (G.) A tarsal ligament.
Augenlidbändchen. (G.) A band, ligament.
Augenlidbildung. (G.) Restoration of the eyelid. Blepharoplasty.
Augenlidbindehaut. (G.) The palpebral conjunctiva.
Augenlidbinzeln. (G.) Nictitation, blinking.
Augenlidblutadern. (G.) The palpebral veins.
Augenlidbrand. (G.) Sloughing or gangrene of the eyelid.
Augenlidcarbunkel. (G.) Carbuncle of the eyelid.
Augenlidcolobom. (G.) Defect of the lid tissues. Coloboma of the lid.
Augenliddrüse. (G.) A gland of the eyelid; a Meibomian gland.
Augenliddrüsen. (G.) The Meibomian glands.
Augenliddrüsenentzündung. (G.) Inflammation of the palpebral glands.
Augenliddrüsengeschwulste. (G.) A Meibomian cyst or tumor.
Augenlideinwärtskehrung. (G.) Entropion.
Augenlidentzündung. (G.) Inflammation of the eyelid.

Augenlider. (G.) The eyelids.
Augenliderarterien. (G.) Arteries of the eyelid.
Augenliderauswärtskehrung. (G.) Eversion of the lid. Ectropion.
Augenliderbalggeschwulst. (G.) Cystic tumor of the lid.
Augenliderbänder. (G.) Papebral, or tarsal, ligaments.
Augenliderbeule. (G.) A furuncle or boil of the eyelid.
Augenliderbindehaut. (G.) The palpebral conjunctiva.
Augenliderbindehautentzündung. (G.) Inflammation of the lining of the lids. Palpebral conjunctivitis.
Augenliderblinzeln. (G.) Nictitation; blinking.
Augenliderbrand. (G.) Carbuncle or gangrene of the eyelid.
Augenlidercallosität. (G.) Thickening and infiltration, with subsequent hardening, of the eyelids.
Augenlidercarbunkel. (G.) Carbuncle of the eyelid.
Augenliderdrüsen. (G.) Meibomian glands.
Augenliderdrüsenblennorrhöe. (G.) Inflammation of and discharge from the Meibomian glands.
Augenliderdrüsenentzündung (G.) Inflammation of and discharge from the Meibomian glands.
Augenlidereinwärtskehrung. (G.) Inversion of the eyelid. Entropion.
Augenliderentzündung. (G.) Inflammation of the eyelids. Blepharitis.
Augenlider Erkrankungen. (G.) Diseases of the eyelids.
Augenliderexulceration. (G.) Marginal blepharitis.
Augenliderflechte. (G.) Excoriation of the intermarginal portion of the lids, produced by long-continued lachrymation and discharge from the inflamed conjunctiva.
Augenlidergeschwulst. (G.) Tumor or swelling of the eyelids.
Augenlidergeschwür. (G.) Ulceration of the eyelids.
Augenliderhaare. (G.) The eyelashes.
Augenliderhalter. (G.) An ophthalmostat, or instrument used to hold the eyelids at rest during an examination of or operation on the eyeball.
Augenliderhautentzündung. (G.) Inflammation of the skin of the lid.
Augenliderhirsekorn. (G.) Meibomian tumor. Chalazion.
Augenliderknorpel. (G.) Tarsal cartilage.
Augenliderknorpelverschrumpfung. (G.) Atrophy or wrinkling of the tarsal cartilage.
Augenliderkrampf. (G.) Spasm of the eyelids. Blepharospasm.
Augenliderkrankheiten. (G.) Diseases of the eyelids.
Augenliderkrätze. (G.) Blepharitis ulcerosa.

Augenliderkratzer. (G.) An instrument for scarifying the palpebral conjunctiva, or other tissues of the eyelid.

Augenliderkrebs. (G.) Cancer of the eyelid.

Augenliderlähmung. (G.) Paralysis of the muscles of the eyelids. Blepharoplegia.

Augenliderläusesucht. (G.) Pediculososis of the eyelashes, the parasites (lice) depositing their eggs at and being attached to the base of the cilia.

Augenlidernerv. (G.) A nerve supplied to the eyelid.

Augenliderrand. (G.) Border of the eyelid.

Augenliderräude. (G.) Irritation and excoriation of the intermarginal portion of the lids, due to chronic continual lachrymation and discharge from an inflamed conjunctiva.

Augenliderrauhigkeit. (G.) Granular lids. Trachoma.

Augenliderrödem. (G.) Edema of the eyelids.

Augenliderrose. (G.) Erysipelas of the eyelids.

Augenliderschaffung. (G.) Relaxed condition of the eyelids.

Augenliderschleimfluss. (G.) A profuse muco-purulent discharge from the eyelids.

Augenliderschwiele. (G.) A thickening of the lid skin, sometimes congenital, producing a whitish, indurated, and horny elevation of the surface, with more or less obliteration of the natural lines of the skin and impairment of the sense of touch.

Augenliderspalte. (G.) Palpebral fissure.

Augenlidersteinkrankheit. (G.) A disease associated with chalk deposits (lithiasis) in the tissues of the eyelids.

Augenlidertriefen. (G.) Inflammation of the palpebral or the Meibomian glands.

Augenlidertripper. (G.) Gonorrheal ophthalmia.

Augenliderumkehrung. (G.) Eversion of the eyelid. Ectropion.

Augenliderumlegung. (G.) Eversion of the eyelid. Ectropion.

Augenliderumstülpung. (G.) Eversion of the eyelid. Ectropion.

Augenlidervenen. (G.) The veins of the eyelid.

Augenliderverknorpelung. (G.) Thickening and infiltration, with subsequent hardening, of the eyelids. Sclerosis of the lids.

Augenliderverkürzung. (G.) Retraction of the lids, so that they cannot be closed over the eyeball. This condition is generally due to paralysis of the orbicularis muscle and a lesion of the facial nerve.

Augenlidervorfall. (G.) Ptosis; paralysis of the levator muscles of the eyelid. Blepharoptosis.

Augenliderwassergeschwulst. (G.) Edema of the eyelid.

Augenliderwassersucht. (G.) Edema of the eyelid.

Augenliderwindgeschwulst. (G.) Emphysema of the eyelids.
Augenliderzellgewebsentzündung. (G.) Inflammation of the palpebral tissues.
Augenliderzusammenwachsung. (G.) Marginal symblepharon.
Augenlidfistel. (G.) Fistula of the eyelid.
Augenlidfläche. (G.) The surface of the eyelid.
Augenlidflechte. (G.) Eczema of the eyelid.
Augenlidfluss. (G.) A discharge from the eyelids.
Augenlidfollikel. (G.) A palpebral follicle.
Augenlidgeschwulst. (G.) Tumor of the eyelid.
Augenlidgriffel. (G.) Instrument for separating and holding apart the eyelids. A lid speculum.
Augenlidhaare. (G.) Eyelashes.
Augenlidhaken. (G.) An eyelid retractor or hook.
Augenlidhalter. (G.) A lid speculum.
Augenlidhaut. (G.) The skin of the eyelid.
Augenlidhautentzündung. (G.) Inflammation of the skin of the eyelid.
Augenlidhebemuskel. (G.) Levator palpebræ.
Augenlidheber. (G.) The levator palpebræ superioris muscle.
Augenlidinnenfläche. (G.) The inner surface of the eyelid.
Augenlidkante. (G.) The margin of the eyelid.
Augenlidkarbunkel. (G.) A carbuncle of the eyelid.
Augenlidklemme. (G.) An eyelid clamp.
Augenlidknorpel. (G.) Tarsal cartilage.
Augenlidknorpelband. (G.) Tarsal ligament.
Augenlidknorpelentartung. (G.) Degeneration of the tarsal cartilage.
Augenlidknorpelentzündung. (G.) Inflammation of the tarsal cartilage.
Augenlidknorpelgeschwulst. (G.) A tumor of the tarsal cartilage.
Augenlidkrampf. (G.) Blepharospasm.
Augenlidkrätz. (G.) Psorophthalmia.
Augenlidkrätzer. (G.) A brush for scarifying the palpebral conjunctiva and lids.
Augenlidkrebs. (G.) Cancer of the eyelid.
Augenlidlähmung. (G.) Paralysis affecting the eyelid. Blepharoplegia.
Augenlidlinse. (G.) The crystalline lens.
Augenlidlös. (G.) Afflicted with absence or defect in one or more eyelids. Ablepharus.

Augenlidlosigkeit. (G.) Absence of one or more eyelids. Ablepharia.
Augenlidmuskel. (G.) A muscle of the eyelid.
Augenlidmuskellähmung. (G.) Paralysis of the muscle of the eyelid.
Augenlidmuskulatur. (G.) Muscular apparatus of the eyelid.
Augenlidnakt. (G.) Suture of the eyelid.
Augenlidnerv. (G.) A nerve supplied to the eyelid.
Augenlidoberfläche. (G.) The surface of the eyelid.
Augenlidödem. (G.) Edema of an eyelid. Blepharœdema.
Augenlidplatten. (G.) The tarsal plates or cartilages.
Augenlidrand. (G.) The border of an eyelid.
Augenlidrandentzündung. (G.) Blepharitis.
Augenlidränderentzündung. (G.) Blepharitis marginalis.
Augenlidrandmuskel. (G.) The ciliary portion of the orbicularis palpebrarum.
Augenlidrandverwachsung. (G.) The adhesion of palpebral margins.
Augenlidringmuskel Palpebrarum. (G.) Orbicularis palpebrarum.
Augenlidrinne. (G.) The primary groove of the eyelid.
Augenlidrose. (G.) Erysipelas of the eyelid.
Augenlidrunzler. (G.) The corrugator supercilii muscle.
Augenlidschlag. (G.) Paralysis of a lid muscle. Blepharoplegia.
Augenlidschlagadern. (G.) Palpebral arteries.
Augenlidschliesser. (G.) The orbicularis palpebrarum muscle.
Augenlidschliessmuskel. (G.) Sphincter, constrictor.
Augenlidschluss. (G.) Closure of eyelids.
Augenlidschut. (G.) The protection afforded by eyelids.
Augenlidschwellung. (G.) Swelling of the eyelids.
Augenlidschwiele. (G.) Thickening of the eyelid.
Augenlidspalt. (G.) Coloboma of the eyelid.
Augenlidspalte. (G.) A palpebral fissure.
Augenlidspaltenenge. (G.) Blepharophimosis; congenital narrowness of opening between the eyelids.
Augenlidspaltenverengung. (G.) Contraction of the eye fissure.
Augenlidstellung. (G.) Position of the eyelid.
Augenlidtalgdrüsenentzündung. (G.) Adenoblepharitis.
Augenlidtripper. (G.) Gonorrheal ophthalmia.
Augenlidumkehrung. (G.) Inversion of the eyelid. Ectropion.
Augenlidunstülpung. (G.) Inversion, retroversion, reversal.
Augenlidverdickung. (G.) Infiltration or thickening of the eyelid. Pachyblepharosis.
Augenlidverkrümmung. (G.) Distortion of the eyelid.
Augenlidverlängerung. (G.) Blepharoplastic operation.

Augenlidverwachsung. (G.) Adhesion of the eyelids. Symblepharon.

Augenlidverwachung. (G.) Symblepharon.

Augenlidvorfall. (G.) Ptosis, or drooping of the eyelid. Blepharoptosis.

Augenlidwarzen. (G.) A small soft tumor, often pendulous, of areolar or granular structure, occurring on the eyelids and elsewhere.

Augenlidwinkel. (G.) Canthus.

Augenlidzellgewebsentzündung. (G.) Inflammation of the palpebral cellular tissue.

Augenlidzerfressen. (G.) Ulceration or erosion of the lids, especially at their angles.

Augenlied. (G.) Obsolete form of Augenlid, the eyelid.

Augenliedvenen. (G.) Veins of the eyelid. Palpebral veins.

Augenlinse. (G.) Crystalline lens.

Augenloch. (G.) The pupil.

Augenlöffel. (G.) A cataract spoon.

Augenlos. (G.) Without an eye. Eyeless.

Augenlosigkeit. (G.) Blindness, or the lack of an eye.

Augenlust. (G.) Delight of the eye.

Augenmahl. (G.) A mole on the eye or eyelid.

Augenmangel. (G.) Absence of the eye. Anophthalmia.

Augenmass. (G.) Eyesight.

Augenmattigkeit. (G.) Asthenopia.

Augenmäuslein. (G.) The ocular muscles.

Augenmerk. (G.) The visual point. Fixation point.

Augenmesser. (G.) A knife for operating on the eyes. Also, an ophthalmometer.

Augenmissbildung. (G.) Malformation of the eye.

Augenmittel. (G.) A remedy used in the treatment of eye diseases.

Augenmittellehre. (G.) Ophthalmic therapeutics.

Augenmuskel. (G.) Abductor oculi, a muscle of the eye, ocular muscle.

Augenmuskeläusserer. (G.) The abducent nerve.

Augenmuskel Äusserer gerader. (G.) The external rectus muscle.

Augenmuskelcentren. (G.) Cerebral centres for the ocular muscles.

Augenmuskel, Innerer gerader. (G.) The internal rectus muscle.

Augenmuskelkegel. (G.) A cone formed by the ocular muscles originating around the optic foramen.

Augenmuskelkerne. (G.) Cerebral centres for the eye muscles.

Augenmuskelkrampf. (G.) Nystagmus.

Augenmuskellähmung. (G.) Paralysis of an ocular muscle.
Augenmuskellähmung bei Arteriosklerose. (G.) Arteriosclerosis in paralysis of the eye muscle.
the eye muscle.
Augenmuskellähmung bei Hemiplegia alternans. (G.) Paralysis in alternate hemiplegia of the eye muscle.
Augenmuskellahmung, Congenitale. (G.) Congenital paralysis of
Augenmuskellähmung, Kernläsionen. (G.) Nuclear lesions in paralysis of the eye muscle.
Augenmuskellähmung, Kopfhaltung. (G.) Position of the head in eye-muscle paralysis.
Augenmuskellähmung, Periodische. (G.) Periodical paralysis of the muscle of the eye.
Augenmuskellähmungen. (G.) Paralysis of the eye muscles.
Augenmuskellähmungen, Angeborene. (G.) Congenital paralysis of an ocular muscle.
Augenmuskellähmungen bei Tabes. (G.) Eye-muscle paralysis in tabes.
Augenmuskellähmungen, Centrale oder cerebrale. (G.) Central or cerebral eye-muscle paralysis.
Augenmuskellähmungen, Conjugirte. (G.) Conjugate eye-muscle paralysis.
Augenmuskellähmungen, Fasiculäre. (G.) Fasicular eye-muscle paralysis.
Augenmuskellähmungen, Hyterische. (G.) Hysterical eye-muscle paralysis.
Augenmuskellähmungen, Latente. (G.) Latent paralysis of an eye muscle.
Augenmuskellähmungen, Peripherische. (G.) Peripheral paralysis of the muscle of the eye.
Augenmuskellähmungenschwindelgefühl. (G.) The sensation of dizziness in eye-muscle paralysis.
Augenmuskellähmungensymptome. (G.) The symptoms in eye-muscle paralysis.
Augenmuskeln. (G.) The ocular muscles.
Augenmuskelnentzündung. (G.) Inflammation of the eye muscles. Ocular myositis.
Augenmuskelnerv, Oberer. (G.) The trochlear nerve.
Augenmuskelnkerne. (G.) The nucleus of the muscles of the eye.
Augenmuskelnnerven. (G.) The nerve supply of the ocular muscles.
Augenmuskelnphysiologie. (G.) Physiology of the eye muscles.

Augenmuskelnschlagadern. (G.) The arteries supplied to the ocular muscles.
Augenmuskel, Oberer gerader. (G.) The superior rectus muscle.
Augenmuskel, Oberer schiefer. (G.) The superior oblique muscle.
Augenmuskel, Unterer gerader. (G.) The inferior rectus muscle.
Augenmuskel, Unterer schiefer. (G.) The inferior oblique muscle.
Augennadel. (G.) A needle used in operating on the eye, especially on cataract.
Augennagel. (G.) Pterygium.
Augennasenfurche. (G.) The oculo-nasal groove running in the embryo from the eye to the olfactory pit.
Augennebel. (G.) Opacity of the cornea. Leucoma.
Augennerv. (G.) An ocular nerve; any nerve supplied to the eye or its appendages.
Augennervenknoten. (G.) Ciliary ganglion.
Augennicht. AUGENNICHTS. (G.) Zinc oxide; used as an application to the eyes.
Augenpein. (G.) Pain in the eye.
Augenpest. (G.) Contagious conjunctivitis. Epidemic ophthalmia.
Augenpflege. (G.) Hygiene or care of the eyes.
Augenphantom. (G.) A mask for demonstrating or practising operations on the eye.
Augenphthise. (G.) Atrophy of the eyeball.
Augenpigment. (G.) The coloring matter of the ocular tissues.
Augenpincette. (G.) A forceps for grasping the eye or parts of it.
Augenpol. (G.) The ocular pole.
Augenpulsader. (G.) The ophthalmic artery.
Augenpulver. (G.) Powder used in treating the eye, or its diseases.
Augenpunkt. (G.) The visual or fixation point.
Augenreiz. (G.) An irritant of the eye; tickling of the eye.
Augenreizung. (G.) Irritation of the eye.
Augenring. (G.) The pupil.
Augenringmuskel. (G.) Orbicularis palpebrarum.
Augenrinnen. (G.) Tearing or watering of the eye. Epiphora.
Augenrollmuskel. (G.) The trochlear muscle of the eye.
Augenrose. (G.) Erysipelas of the eye or its appendages.
Augenröthe. (G.) Xerophthalmia.
Augensalbe. (G.) An eye-salve.
Augensalbeblei. (G.) Lead ointment for the eye.
Augensalbebor. (G.) Boracic ointment for the eye.
Augensalbe, Gelbe präzipitat. (G.) Precipitate (yellow) eye ointment.
Augensalbeichthyol. (G.) Ichthyol ointment for the eye.

Augensalbekupfer. (G.) Copper ointment for the eye.
Augensalben. (G.) Eye ointments.
Augensalberesorzin. (G.) Resorcin ointment for the eye.
Augensalbesalizyl. (G.) Salicylic ointment for the eye.
Augensalbe unguentumdiachyli. (G.) Diachylon ointment for the eye.
Augensalbe weisse präzipitat. (G.) Precipitate white ointment for the eye.
Augensalbezink. (G.) Zinc ointment for the eye.
Augensalbe, Zusammengesetzte. (G.) Unguentum ophthalmicum comp.
Augenscalpell. (G.) A scalpel used upon the eye.
Augenschau. (G.) Ophthalmoscopy.
Augenscheeren. (G.) Scissors used upon the eye.
Augenschere. (G.) Eye-scissors.
Augenschirm. (G.) A screen or shade for the eyes.
Augenschlagader. (G.) Ophthalmic artery.
Augenschleim. (G.) Mucous discharge from the eye.
Augenschleimfluss. (G.) Discharge from the eye.
Augenschleimhaut. (G.) Conjunctiva; ocular mucus membrane.
Augenschliesser. (G.) Orbicularis palpebrarum.
Augenschmalz. (G.) Ocular discharge.
Augenschmerz. (G.) Pain in the eyes.
Augenschminke. (G.) A cosmetic for coloring the eyebrows.
Augenschnupfen. (G.) Catarrhal discharge from the lids or eyes.
Augenschnupftabak. (G.) A pulverized (snuff-like) application for the eyes.
Augenschröpfen. (G.) Scarification of the palpebral conjunctiva.
Augenschröpfer. (G.) An instrument for scarifying the conjunctival surface of the eyelids.
Augenschutz. (G.) Protection of the eye.
Augenschützer. (G.) An eye-shade or shield.
Augenschwäche. (G.) Asthenopia.
Augenschwamm. (G.) A sponge for use upon the eyes; more commonly a fungus growth of the eye.
Augenschwarz. (G.) The black pigment, melanin ($C_{26}H_{13}N$), in the chorioid and the skin of brunettes and negroes in particular. It is found pathologically in the blood, where it constitutes the condition known as melanemia and melanosis. The pigment is insoluble in water, alcohol, ether, chloroform, or carbon disulphide, but is dissolved by solution of potassium hydrate. It is probably a transformation product of hematin.

Augenschwiele. (G.) Pachyblepharon.

Augenschwindel. (G.) An asthenopic symptom-complex of headache with vertigo and impairment of vision.

Augenschwinden. (G.) Atrophy of the eyeball; a phthisis bulbi.

Augenschwund. (G.) Atrophy of the eyeball.

Augenscirrhus. (G.) Scirrhus cancer of the eye.

Augenseife. (G.) An eye soap.

Augenseuche. (G.) Contagious eye-disease affecting the eyes of the lower animals.

Augensichel. (G.) A name proposed by Kraus for the blepharometrum of Buzzi.

Augensieb. (G.) An eye shade or protector made of black haircloth, and used by the Tartars.

Augenspalt. (G.) Coloboma of the eyelid.

Augenspalte. (G.) Ocular fissure.

Augenspalte, Untere. (G.) Spheno-maxillary fissure.

Augensperre. (G.) Obliteration or closure of the pupil.

Augenspiegel. (G.) An ophthalmoscope.

Augenspiegelbefund. (G.) The result of ophthalmoscopic examination.

Augenspiegelbild. (G.) The ocular fundus appearances as seen with the ophthalmoscope.

Augenspiegel, Binoculärer. (G.) A binocular ophthalmoscope.

Augenspiegeldemonstrations. (G.) Demonstrations of the ophthalmoscope.

Augenspiegel, Elektrischer. (G.) An electric ophthalmoscope.

Augenspiegelergebnis or Spiegelbefund. (G.) The result of examination by the ophthalmoscope.

Augenspiegeluntersuchung. (G.) An ophthalmoscopic examination.

Augenspies. (G.) An ophthalmostat, for steadying the eyeball during an examination.

Augenspritze. (G.) An eye-syringe.

Augensprosse. (G.) The optic vesicle.

Augenstaar. (G.) Cataract.

Augenstaarkrampf. (G.) Spasm of the eye.

Augenstäupe. (G.) Ophthalmia epizootica.

Augenstechen. (G.) Pricking or shooting pains in the eyes; reclination of cataract.

Augenstein. (G.) A name given both to a dacryolith and lapis-divinus (q. v.).

Augenstellung. (G.) Position of the eye.

Augenstern. (G.) The pupil.

Augensternerweiterung. (G.) Dilatation of the pupil.
Augensternhaut. (G.) Pupillary membrane.
Augensternverengerung. (G.) Contraction of the pupil.
Augenstich. (G.) Paracentesis oculi.
Augelstiel. (G.) Optic peduncle.
Augenstreupulver. (G.) Dusting powder for the eye.
Augensymptome. (G.) Eye symptoms.
Augentabak. (G.) An eye-snuff, or powder for applying to the eye.
Augentalg. (G.) Secretion on or from the lid margins.
Augentäuschung. (G.) An optical illusion.
Augenthränen. (G.) Epiphora.
Augentriefen. (G.) An irritating discharge from the eyes.
Augentriefen an den Lidecken. (G.) A morbid discharge from the corner of the eye.
Augentriefen des hohen Alters. (G.) A discharge from the eyes of old people.
Augentriefig. (G.) Blear-eyed.
Augentripper. (G.) Gonorrheal ophthalmia; purulent conjunctivitis. Blennophthalmia.
Augentrockenheit. (G.) Xerophthalmia.
Augentropfen. (G.) Eye-drops or lotion.
Augentropfglas. (G.) A bottle with pipette for eye-drops.
Augentropfwasser. (G.) Collyrium, eye-drops.
Augentrost. (G.) Euphrasia officinalis. The plant eyebright.
Augenübel. (G.) Ophthalmia.
Augenüberanstrengung. (G.) Overstraining of the eye.
Augenumkehrung. (G.) Ectropion.
Augenumstülpung. (G.) Eversion of the eyelids.
Augenvene. (G.) Ophthalmic vein.
Augenverband. (G.) Eye bandaging; eye dressing, eye bandage.
Augenverbände. (G.) Eye bandages.
Augenverbrennung. (G.) A burn of the eye.
Augenverdrehen. (G.) Rolling and turning up of the eyes.
Augenverdunkelung. (G.) Amaurosis, or amblyopia.
Augenvereiterung. (G.) Suppuration of the eye.
Augenvergrösserung. (G.) Enlargement of the eyeball.
Augenverknöcherung. (G.) Ossification of any part of the ocular tissues.
Augenverletzung. (G.) Injury to the eye or its appendages.
Augenverletzungen. (G.) Eye injuries.
Augenverletzungen, Begutachtung. (G.) A formal opinion in eye injury.
Augenverletzungen, Prophylaxe. (G.) Prophlaxis in eye injury.

Augenvorfall. (G.) Protrusion of the eyeball. Exophthalmia.
Augenwännchen. (G.) A cup or other vessel for bathing the eyes.
Augenwanne. (G.) Bath for the eye.
Augenwaschwasser. (G.) An eye lotion.
Augenwasser. (G.) A liquid collyrium, or eye-water.
Augenwässer. Eye waters. These were and are called collyria, a collyrium originally meaning "dough" or "cake," i. e. a medicament formed by the kneading together of several substances, which, when dissolved in water, were dropped into the eye, and used for irrigating, as eye-washes, eye-waters, eye-douches, and as compresses.
Augenwasserartige. (G.) Aqueous humour.
Augenwasserfluss. (G.) Ocular discharge.
Augenwassersucht. (G.) Hydrophthalmia.
Augenweh. (G.) Pain in the eyes.
Augenweiss. (G.) The sclera or white of the eye.
Augenweite. (G.) The visual distance.
Augenwelle. (G.) The optic axis.
Augenwimmer. (G.) An eyelash.
Augenwimper. (G.) Eyelashes.
Augenwimperdrüsen. (G.) Meibomian glands.
Augenwimperlöcherchen. (G.) The follicle into which the eyelash is set.
Augenwimpern. (G.) Eyelashes.
Augenwimpernausfallen. (G.) Falling out of the eyelashes.
Augenwimpernpunkte. (G.) Puncta ciliaria.
Augenwimpernverlust. (G.) Loss of eyelashes.
Augenwimperränder. (G.) The margins of the eyelids.
Augenwindung. (G.) Frontal convolution.
Augenwink. (G.) A wink.
Augenwinkel. (G.) Canthus or angle of the lids.
Augenwinkelabscess. (G.) Abscess at one of the ocular canthi.
Augenwinkelarterie. (G.) Angular artery.
Augenwinkelbänder. (G.) The tarsal ligaments.
Augenwinkelblutader. (G.) Angular vein.
Augenwinkelentzündung. (G.) Inflammation at one of the ocular canthi.
Augenwinkelfrass. (G.) Ulceration or erosion of the eyelids, especially at the canthi.
Augenwinkelgeschwulst. (G.) A tumor at an ocular canthus.
Augenwinkelgeschwür. (G.) An abscess of the lachrymal sac. Aegilops.

Augenwinkelpulsader. (G.) Angular artery.
Augenwinkelschlagader. (G.) Angular artery.
Augenwinkelschnitt. (G.) Canthotomy.
Augenwinkelunreinigkeit. (G.) The whitish discharge (sebume) found at the angles of the eyes after sleep.
Augenwinkelvereiterung. (G.) Lachrymal abscess.
Augenwinkelzache. (G.) Those fibres of the occipito-frontalis muscle that run towards and are attached near the inner canthus and at the side of the nose.
Augenwinken. (G.) Winking of the eyelids or eyes.
Augenwolk. (G.) Nebula corneæ.
Augenwölkchen. (G.) A pterygium; an opacity of the cornea.
Augenwölklein. (G.) A pterygium; an opacity of the cornea.
Augenwunde. (G.) Wound of the eye.
Augenwurzel. (G.) Dandelion or valerian root.
Augenzahn. (G.) Canine or eye-tooth.
Augenzergliederung. (G.) An obsolete term for an anatomical dissection of the eye; also enucleation.
Augenzeugnis. (G.) Ocular proof.
Augenzirkel. (G.) The iris.
Augenzittern. (G.) Nystagmus.
Augenzucken. (G.) Nystagmus.
Augenzuckung. (G.) Nystagmus.
Augenzwiebel. (G.) Eyeball.
Augenzwischenraum. (G.) The space between the eyes.
Auginos. (L.), m.n. An old name for hyoscyamus.
Auglein. (G.) A little eye.
Augsburg eye balsam. A mixture containing 3 parts of red oxide of mercury, 2 each of extract of belladonna and tincture of opium, with 28 of some fatty excipient.
Auramine, Oculo-toxic symptoms from. Auramine is a synonym of yellow pyoktanin. Patients to whom this aniline derivative was administered developed yellow vision [xanthopsia (q. v.)], which in several instances lasted half an hour. Blue vision never occurred.
Aurantia. A stain used in histology, and not uncommonly in conjunction with eosin. See **Histology of the eye.**
Aura, Ophthalmic. Any ocular symptom that precedes a disease or paroxysm, as in migraine or epilepsy. A scintillating scotoma, for example, sometimes ushers in attacks of "sick headache."
Aureola. (a) In *astronomy,* the ring of light seen around the moon in total eclipses of the sun. (b) In *meteorology,* a kind of halo sur-

rounding a shadow cast upon a cloud or fog-bank or dew covered grass; often observed by aeronauts on the upper surface of clouds. Also called "glory."

Aureole. A luminous emanation or cloud surrounding a figure or an object; an aureola.

Auric chloride. See **Gold chloride.**

Auri et sodii chloridum. GOLD AND SODIUM CHLORIDE. In Germany this remedy (probably only a mixture of the two chlorides) is occasionally used as an eyewash.

℞

Sodii boratis	0.5 (g. vii)
Aquæ destillatæ	20.0 (f℥v, mviij)
Auri et sodii chlor.	0.03 (gr. $^{23}/_{50}$).

To be instilled twice daily in cases of simple conjunctivitis.

Ausädern. (G.) To dissect or draw out the veins.

Ausarbeitung. (G.) Elaboration.

Ausart. (G.) To degenerate; degeneration, degeneracy.

Ausarten. (G.) To degenerate.

Ausartung. (G.) Degeneration.

Ausätzen. (G.) To cauterize, or destroy by caustics.

Ausätzung. (G.) Cauterization.

Ausbaden. (G.) To bathe out; to bathe enough.

Ausbähen. (G.) To dry up, to dry.

Ausbauchen. (G.) To swell, or to bulge out.

Ausbauchung. (G.) Swelling or bulging out; protuberance.

Ausbeizen. (G.) To remove by corrosives or caustics; to eat out.

Ausbilden. (G.) To form, to develop.

Ausbildung. (G.) Development, formation.

Ausbluten. (G.) To cease bleeding.

Ausbrauchen. (G.) To use up, to consume.

Ausbreitung. (G.) Spread, extension, diffusion.

Ausbrennen. (G.) To apply actual cautery; to destroy by cautery; to cauterize.

Ausbruch. (G.) Eruption.

Ausbuchten. (G.) To form a sinus; diverticulum or pouch.

Ausbuchtung. (G.) Excavation, sinus, diverticulum, pouch, bulging.

Auscultation, Ocular. This method of examination is mainly employed in connection with pulsating exophthalmos (q. v.). A rushing sound is heard, with the stethoscope or ear alone, over the closed eyelid, at the temple, on the forehead, and frequently over the entire corresponding half of the skull, the *bruit* being synchronous with the arterial pulse. At first it seems to be a distinctly

intermittent sound, but close attention usually reveals even during the supposed pauses a continual buzzing or hissing. There is occasionally, mingled with this buzzing, a whistling tone, which is heard at irregular intervals, and which is probably caused by temporary acceleration of the pulse. The noises may be diminished or stopped entirely by compression of the common carotids on each side.

As a result of aneurysm of the basal cerebral artery-vessels, arterial murmurs can also be demonstrated. They further occur, though rarely, in cases of pressure on the basal vessels by tumors, and even in highly vascular cerebral tumors themselves. The early appearance of the vascular murmurs would probably indicate aneurysm rather than tumor; however, it must be remembered that anemic noises caused by circulatory anomalies in the carotids may, by conduction, be heard in the head—a fact that should be considered in the auscultatory diagnosis of these diseases.

Ausdampfen. (G.), intr.v. To evaporate.

Ausdauer. (G.) Perseverance; holding out.

Ausdauern. (G.) To endure, to hold out.

Ausdehnbar. (G.) Dilatable, distensile, elastic.

Ausdehnbarkeit. (G.) Dilatability, extensibility.

Ausdehnen. (G.) To dilate, distend, stretch.

Ausdehnswerkzeug. (G.) A dilating apparatus.

Ausdehnung. (G.), n. Extension, expansion.

Ausdehnungsfähigkeit. (G.) Dilatability, extensibility.

Ausdehnungskraft. (G.) Elasticity, dilatability.

Ausdehnungsvermögen. (G.) Faculty, ability, capability, power, capacity.

Ausdehnungswerkzeug. (G.) A dilating apparatus, a dilator.

Ausdrängen. (G.) To squeeze or press out.

Ausdruck. (G.) Expression.

Ausdrücken. (G.) To express, to squeeze or force out.

Ausdrucksmittel. (G.) Means of expression.

Ausdulden. (G.) To endure suffering; to suffer to the end; to suffer without consideration.

Ausdünstung. (G.) Perspiration, transpiration.

Ausdünstungsmesser. (G.) A hygrometer.

Auseinanderfahren. (G.), intr. v. To diverge, as of light rays.

Auseinanderlaufend. (G.) Divergent.

Auseinanderweichen. (G.) To separate.

Auseitern. (G.) To suppurate, to cease suppurating.

Ausfall. (G.) A falling out, prolapse.

Ausfallen. (G.) To fall out.

Ausfliessen. (G.) To flow out, to run.
Ausfluss. (G.) A discharge, flowing or running out.
Ausflussmenge. (G.) The amount discharged.
Ausflussstrahl. (G.) A jet, stream.
Ausforschen. (G.) To explore, to investigate.
Ausforschung. (G.) Exploration, investigation.
Ausfrieren. (G.) Congelation; to congeal.
Ausführen. (G.) To evacuate, to purge.
Ausführend. (G.) Evacuant, excretory, purgative.
Ausführlich. (G.) Detailed, circumstantial.
Ausführung. (G.) Evacuation, excretion.
Ausführungsgang. (G.) The excretory duct.
Ausführungsmittel. (G.) A purgative.
Ausgang. (G.) Outlet, termination.
Ausgangstheil. (G.) Emunctory, region of outlet.
Ausgären. (G.) To ferment, to cease fermenting.
Ausgebreitet. (G.) Diffuse, scattered.
Ausgebuchete. (G.) Excavated, pouched, sinous.
Ausgedehnt. (G.) Dilated, diffused, widely spread, extensive.
Ausgefressen. (G.) Eroded, corroded.
Ausgehöhlt. (G.) Excavated, hollowed out.
Ausgeprägt. (G.) Well developed.
Ausgepresst. (G.) Squeezed out, expressed.
Ausgesprochen. (G.) Pronounced, marked, decided.
Ausgetragen. (G.) Mature.
Ausgetreten. (G.) Extravasated.
Ausgiessung. (H.) Effusion.
Ausgleichswiderstand. (G.) Compensating resistance.
Ausgleichung. (G.) Compensation.
Ausgleichungsströmung. (G.) Compensatory current.
Ausguss. (G.) Effusion.
Aushalten. (G.) To hold out, to bear, to sustain, to endure.
Aushauchung. (G.) Exhalation, expiration.
Ausheilen. (G.) To cure completely, to heal up.
Ausheilung. (G.) A complete cure.
Aushilfsmittel. (G.) House remedies, a temporary or make-shift remedy or appliance.
Aushöhlung. (G.) Excavation, hollow.
Ausjammern. (G.) Ceased to lament, through lamenting.
Auskeimen. (G.) To germinate, to cease germinating.
Auskernen. (G.) To enucleate.
Auskernung. (G.), n. Enucleation.

Ausklaren. (G.) To clear up, to make clear.
Auskleiden. (G.) To cover, to line.
Auskleidung. (G.) A covering, lining, lining membrane.
Auskränken. (G.) To cease grieving.
Auskratzen. (G.) To scrape or scoop out, to curette.
Auskratzen bei Trachom. (G.) To scrape out, or curetting in trachoma.
Auskratzung. (G.) Erasement, scraping out, curetting.
Auskultation. (G.) Auscultation.
Auskultationsbefund. (G.) The result of auscultation.
Auskultationserscheinung. (G.) Auscultation phenomenon.
Auskultationslehre. (G.) The science of auscultation.
Ausleeren. (G.) To empty.
Ausleerungsmittel. (G.) A purgative.
Ausleiden. (G.) To cease to suffer.
Auslösung. (G.) Setting free, disarticulation, enucleate, to loosen.
Auslüften. (G.) To air, to ventilate.
Auslüftung. (G.) Airing, ventilation.
Ausmeisseln. (G.) To gouge, or chisel out.
Ausnehmung. (G.), n. Extraction.
Auspinseln. (G.) To brush out, to brush in the inside.
Ausplätzen. (G.) To rupture, to burst.
Auspressen. (G.) To squeeze out, to express.
Ausprung. (G.) Scab, crusta lacta.
Ausqualmen. (G.) To cease smoking.
Ausquetschen. (G.) To squeeze out, to crush out.
Ausräumen. (G.) To empty.
Ausräumung der Orbita. (G.) Evisceration of the orbit.
Ausrenken. (G.) To dislocate.
Ausrotten. (G.) To eradicate, to extirpate.
Ausrupfen der Haare. (G.) Epilation.
Aussacken. (G.) To become sacculated, to bulge.
Aussackung. (G.) Sacculation, bulging, diverticulation.
Aussäuern. (G.) To remove or extract acidity.
Aussaugen. (G.) Exsuction.
Ausschaben. (G.) To scrape out.
Ausschabung. (G.) A scraping out.
Ausschälbar. (G.) Capable of enucleation or resection.
Ausschälen. (G.) To enucleate, to extirpate, to resect.
Ausschälung des Auges. (G.) Enucleation of the eyeball.
Ausscheiden. (G.) To secrete, to excrete, to eliminate, to extract.
Ausscheidung. (G.) Secretion, excretion, disassimilation.

Ausschlag. (G.) Eruption, breaking-out, efforescence, exanthem rash.
Ausschlauchen. (G.) To cleanse with a rubber tube irrigator.
Ausschliessen. (G.) To exclude.
Ausschliesslich. (G.) Exclusive, exclusively.
Ausschliessung. (G.) Exclusion.
Ausschneiden. (G.) To exercise, to cut out, to extirpate.
Ausschneiden des Auges. (G.) Excision of the eyeball.
Ausschnitt. (G.) A notch.
Ausschwären. (G.) To remove by suppuration.
Ausschwitzen. (G.) To exude.
Aussehen. (G.) Appearance, looks.
Ausseihen. (G.) To filtrate, to filter, to strain.
Aussen. (G.) External, outside.
Aussenblutung. (G.) External hemorrhage.
Aussenfalte. (G.) The external fold.
Aussenfläche. (G.) External surface.
Aussenscheide. (G.) External sheath.
Aussenschicht. (G.) External layer.
Aussenseite. (G.) Exterior, outside.
Aussentemperatur. (G.) External temperature.
Aussenwinkel. (G.), n. External canthus or angle.
Äussere. (G.) External, exterior, outer, outward.
Äusserer Augenmuskelnerv. (G.) The sixth cranial nerve.
Äusserlich. (G.) Exterior, external, outward.
Äusserste. (G.) Outmost, extremely.
Aussetzen. (G.) To intermit, to pause, to stop.
Aussetzend. (G.) Intermittent, intermitting.
Aussetzung. (G.) Exposure, intermission.
Aussonderend. (G.) Secretory, excretory.
Aussondern. (G.) To secrete, to excrete, to eliminate.
Aussonderung. (G.) The act of secretion, excretion, elimination.
Ausspanner. (G.) The extensor muscle, or tensor muscle.
Ausspannung. (G.) Distension, relaxation.
Aussparung der Macula. (G.) Dilated or free opening of the macula.
Ausspritzen. (G.) To wash or cleanse by syringing, to syringe, to inject.
Ausspritzend. (G.) Ejaculatory.
Ausspritzung. (G.) Ejaculation, spirting out.
Ausspritzungsgang. (G.) Ejaculatory duct or canal.
Ausspritzungskanal. (G.) The syringing of a canal or channel.
Ausstossung. (G.) Elimination.
Ausstrahlen. (G.) To radiate.

Ausstrahlung. (G.) Radiation.
Ausstrecken. (G.) To stretch, to distend, to extend.
Ausstrecker. (G.) The tensor or extensor muscle.
Ausstreckmuskel. (G.) The tensor or extensor muscle.
Ausstreckung. (G.) Extension, stretching, distension.
Ausstülpen. (G.) To cause to protrude, to bulge, to extrovert.
Ausstülpung. (G.) Protrusion, diverticulum, extroversion.
Austamponieren. (G.) To place a tampon.
Austastung. (G.) The act of palpation.
Austernschalen-Keratitis. (G.) Oyster-opener's keratitis. Oyster-shucker's keratitis.
Austernvergiftung. (G.) Poisoning by oysters.
Austilgen. (G.) To obliterate, to extirpate, to destroy.
Austilgung. (G.) Obliteration, extirpation, destruction.
Austreten. (G.) To protrude, to extravasate.
Austretung. (G.) Extravasation, protrusion.
Austritt. (G.) Extravasation, protrusion.
Austrittsstelle. (G.) Place or point of exit.
Austrocknen. (G.) To dry up, to exsiccate, to become dry.
Austrocknend. (G.) Exsiccant, desiccant, parching.
Austrocknung. (G.) Exsiccation, desiccation.
Austupfen. (G.) To cleanse, to remove by sponging or mopping.
Ausüben. (G.) To practice.
Ausübung. (G.) Practice, exercise.
Auswängen. (G.) To force out.
Auswärts. (G.) Outwards.
Auswärtsdrehen. (G.) To supinate, to turn outwards.
Auswärtsdreher. (G.) The supinator muscle.
Auswärtsdrehung. (G.) Supination.
Auswärtsgehen. (G.), n. Eversion.
Auswärtskehrung. (G.) Eversion.
Auswärtsroller. (G.) A rotator outwards.
Auswärtsrollung. (G.) A rotating outwards.
Auswärtsschielen. (G.) Divergent strabismus.
Auswärtswendung. (G.) Extroversion, a turning outwards.
Auswärtszieher. (G.) The abductor muscle.
Auswärtszieher des Augapfels. (G.) The external rectus muscle of the eye.
Auswaschen. (G.) To wash out, to irrigate, to cleanse.
Ausweichung. (G.) Migration.
Ausweiden. (G.), tr.v. To eviscerate.
Ausweidung. (G.), n. Evisceration or exenteration.

Ausweidung der Augenhöhle. (G.) Exenteration of the orbital contents.

Ausweidung des Augapfels. (G.) Evisceration of the eyeball.

Ausweiten. (G.) To dilate.

Auswendig. (G.) Outside, external, outward.

Auswischen. (G.) To wipe out, to sponge out.

Auswuchs. (G.) Excrescence, apophysis.

Auswurfstoff. (G.) Excretion, ejected matter.

Auszehren. (G.) To consume, to waste slowly.

Auszehrung. (G.) Consumption, tuberculosis, phthisis.

Auszehrungskrankheit. (G.) A wasting disease, consumption.

Auszeihung. (G.) Extraction.

Auszeihungsversuch. (G.) Attempted extraction.

Ausziehen. (G.), tr.v. To extract.

Auszug. (G.) Extract, decoction, essence, infusion.

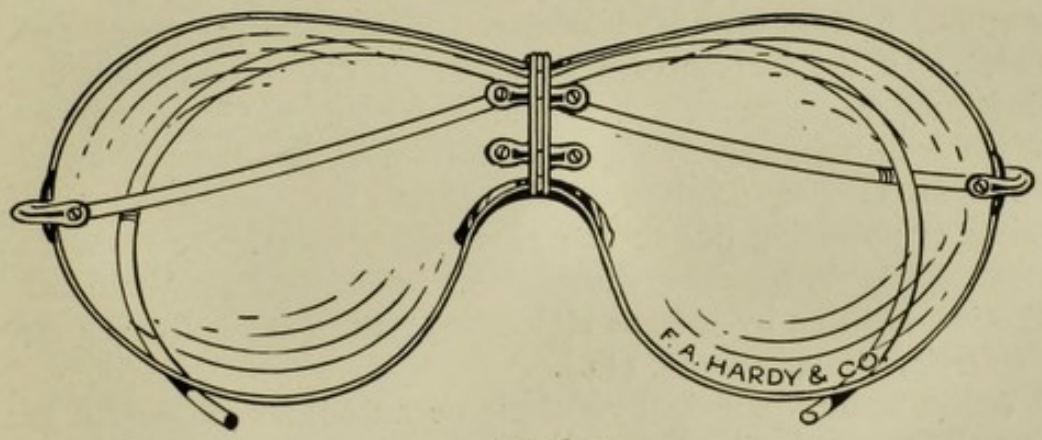
Autoclave. A form of sterilizer. See **Hospitals, Equipment of.**

Autocytotoxins. Cytotoxins produced in the body of the individual whose organs secreted them.

Auto-enucleation of the eye. See **Automutilation, Ocular.** Also, **Avulsio bulbi.**

Autofundoscope. An ophthalmoscope for the self-examination of the fundus oculi. See **Auto-ophthalmoscope.**

Autoglas. A trade name for an eye protector made to conform to the shape of the face and nose, so that dust and wind are excluded.



Autoglas.

This type of goggles is made entirely of glass, except for a hinged center-piece and the temples. The hinged center-piece, in connection with four different curves of the margins of the lenses, allows exact adjustment to the contour of the individual facial requirements. It is ground with an inner curve of 6 dioptres and may

be ordered either plane or with the wearer's refractive error corrected. It appears on the market in various tints: white, light amber, dark amber and smoke. It is not only of use for motorists, but may with advantage be used by patients requiring complete protection from wind, dust, sunlight, etc. (C. F. Hubbard.)

Autogonie. (G.) Spontaneous generation.

Autointoxication. A self-poisoning (occasionally giving rise to eye symptoms) in consequence of the absorption of noxious products of a defective or disturbed metabolism. The character, the composition of the numerous poisons that must be incriminated with producing some of the ocular disorders herein specified remain for the present unknown or at least undefined; hence no specific (with the exception of a few of the bacterial toxemias), antitoxic treatment can, in the obscurity of our present-day knowledge, be instituted. The source, on the other hand, and the manifestations of these toxins are very well understood, hence a large and successful field remains for causal and symptomatic therapy.

de Schweinitz and Fife (*Ophthalmic Year-Book,* 1909, p. 184) contend that although there is no ocular disease known to be due to intestinal auto-intoxication, and laboratory examinations have thus far failed to isolate any definite toxin to which diseases of the eye can be attributed, it is nevertheless desirable that such examinations be made. A side light is thrown upon this subject by the coincident occurrence of uveal disease with skin lesions.

The toxins may either be generated within the body (endogenous toxemia) or they may be introduced from without (exogenous toxemia). In the former case we speak of auto-intoxication and include under this name a group of symptom-complexes attributable in the main to a variety of gastro-intestinal, hepatic and metabolic, or constitutional, disorders. The exogenous toxemias include all forms of poisoning due to unorganized bodies (alcohol, tobacco and other alkaloids, metallic poisons, etc.) introduced from without, and also intoxication by poisons elaborated within the body by parasites (bacteria, tænia, amœba, etc.).

Three factors principally determine auto-intoxications of gastro-intestinal origin, viz.:

1. Stagnation of the contents of the stomach and bowel.
2. Perversion, qualitative or quantitative, of the gastro-intestinal secretions.
3. Invasion of the gastro-intestinal tract by abnormal putrefactive bacteria or the unchecked overgrowth of normal species of the intestinal flora.

As a rule several of these factors are combined and the existence of the one directly or indirectly determines the incidence of the others.

Autointoxication from stagnation of the gastro-intestinal contents is quite entirely due to inability on the part of the gastro-intestinal wall to propel the contents of the digestive canal onward within the normal time. This inability may be due to antony of the gastric or intestinal musculature or to mechanical causes as, e. g., narrowing of the intestinal lumen, malposition or sacculation of parts of the tract, or to both these factors combined. In the case of the stomach we witness the appearance of motor insufficiency, gastric ectasy, gastric atony; in the case of the intestine of intestinal stenosis of various kinds and, broadly speaking, of chronic constipation.

An immense amount of thought, ingenuity and labor have been expended in devising methods for determining the exact condition of the gastric walls—for recognizing and differentiating ectasy and atony and simple dilatation and megalogastria. However valuable and interesting such refinements in diagnosis may be, they furnish little information in regard to the proper treatment of all these conditions (popularly known as dyspepsia, indigestion, biliousness) that may not be briefly expressed in the following sentences:

The three main indications for treatment are (1) to improve the motor power of the stomach, (2) to prevent further dilatation, (3) to adequately nourish the patient despite his stomach trouble in order to maintain the best possible general nutrition.

The diet, then, should be of such a character that it imposes the minimum of labor on the stomach walls, that it contains none of the articles that can readily undergo acid or gaseous fermentation when they stagnate in the stomach. The state of the gastric secretion must at the same time be carefully taken into consideration, so that the composition of the food must also vary according to the presence or absence of sufficient or over-abundant hydrochloric acid and peptic ferments.

If the secretion of hydrochloric acid is normal or increased, there is no objection to the use of meats or other albuminous foods, inasmuch as these are properly digested in the stomach; at the same time, especially in the presence of hyperchlorhydria, the ingestion of amylaceous foods should be reduced; for the digestion of the latter is always impeded in the presence of much hydrochloric acid in the sense that amylolysis is interfered with and they undergo abnormal decomposition when they remain in the stomach in an undigested state for an abnormally long time. If on the other hand

the secretion of gastric juice is reduced, no meats at all should be given, but only eggs, milk and mushy amylaceous foods, i. e., gruels, made of milk with wheat flour, rice, barley, tapioca or sago, milk-toast, vegetable purées, fruit, butter, cream and olive oil and bread-stuffs.

Large meals should always be avoided and all the above articles should be given in small quantities at frequent intervals. From a practical standpoint it is best to experiment a little in each case, i. e., to determine at frequent intervals by actual removal of the stomach contents after a mixed meal which foods of the different kinds are retained and which evacuated within the normal time limits. In combination with such a motility test a study of the gastric secretion can be advantageously made and the selection of the diet regulated accordingly.

All articles of food that are coarse in texture, that contain indigestible parts like tendons, skin, connective tissue in the case of meats, stems, husks, pips, seeds in the case of vegetables, should be forbidden. Carbonated beverages that distend the stomach; alcoholic liquors of all kinds, solutions of albumoses and peptones, very salt and very sweet foods are all forbidden because they all draw water into the stomach and hence overburden the organ. For the same reason the total liquid intake should be reduced. Too dry a diet should, however, be avoided as the propulsion of semi-liquid and mushy foods is easier in motor insufficiency than the propulsion of a "dry" stomach contents. Too great a liquid restriction as advised by some may even lead to dehydration of the tissues and in extreme cases to tetany.

Sometimes rectal administration of liquids is of aid to supply enough fluid; this measure in combination with complete food abstinence for a period of days, with or without rectal feeding, is in severe cases often of signal value. Rest after meals is always indicated; and these patients should be told to lie down for half an hour after each feeding, preferably on the right side, as this facilitates the movement of the food through the pylorus. The evening meal should never be eaten too near bed-time as digestion is less active during sleep and stagnation is favored in this way.

Lavage of the stomach is probably the most valuable remedy we possess, provided it is carried out persistently. By removing undigested residue from the stomach after the time for its physiological removal is passed, stagnation is effectively prevented; moreover the digestion of the next meal is not disarranged by the presence of foul, decomposing material in the stomach; hence nutrition is

not so seriously interfered with if lavage is performed than if it is omitted. In advanced cases the following plan is the best: Several hours before retiring, i. e., late in the afternoon, the stomach should be washed out; in this way any residue that may have remained behind from breakfast or luncheon is removed and the evening meal is introduced into a clean stomach. The latter should be digestible within three hours and should be composed of material that can undergo such rapid digestion. In case food particles, nevertheless, are still found in the stomach in the morning, then morning lavage must be instituted; or if the patient suffers much distress during the night, then washing of the stomach before retiring may become necessary besides. In general a daily lavage late in the afternoon is all that is required. The technique of lavage need not be described in this place. The addition of various drugs to the wash waters, as, e. g., boric acid, resorcin, salicylic acid, hydrochloric acid or bicarbonate of soda as the exigencies of the case may demand, needs only be mentioned; their main sphere of usefulness is to prevent fermentation and to stimulate the gastric walls to increased activity—and it is highly problematical whether they really accomplish this and whether plain water is not equally effective. Douching and spraying the stomach walls with water or with medicated solutions is of subordinate value as compared to lavage. Electricity applied in various ways, in my experience, is of no value whatsoever. Properly performed massage, and certain simple hydrotherapeutic measures are often highly efficient.

Drugs have only a very subordinate place in the treatment of motor insufficiency; we are dealing here largely with a mechanical difficulty and hence the most effective means are mechanical in character; hence surgery, too, may occasionally be useful, especially, of course, in pyloric occlusions producing stagnation of the stomach contents; here and there drainage of the stomach by gastro-enterostomy, mechanical reduction of the size of the stomach, correction of malpositions of the organ may be indicated.—(A. C. C.)

Automarginoplasty. A procedure by which disfigurement is avoided and a defect in the lid edge (due to injury or operation) is remedied by filling in the latter by means of tissues from the damaged lid itself. Kuhnt, for example, accomplishes (*Zeitschrift für Augenheilkunde,* March 25, 1911) this by shifting a portion of the tarsus into the defect. When the deficiency is, as it usually is, caused by the excision of a malignant growth care in the primary operation is called for. The tumor of the lid, fixed in a clamp, is circumcised in the skin, the lateral cuts slanting towards the healthy skin. Then the

clasp is turned and the diseased part excised from the conjunctival surface by an incision parallel with the border and two incisions at right angles to this. The lateral incisions are extended 1 cm. towards the retrotarsal fold, through the conjunctiva and tarsus, and this piece is dissected from the muscle and skin. After removal of the clasp the marginoplasty is made by lifting this movable remains of the tarsus and uniting it by sutures to the lateral portions of the lid border. One needle of a double-armed thread is introduced into the conjunctiva about 1 mm. from the lid border and a vertical incision made through the whole thickness of the lid; the other needle 1 mm. from the horizontal and vertical incisions through the conjunctiva and remainder of tarsus and a corresponding point of the orbicularis and skin, but so that this is pierced from about 1½ to 2 mm. from the incision. After the sutures are tied the new portion of the lid border is in faultless position. Sometimes a fine suture in the intermarginal seam may be advantageous.

The first dressing remains for three or four days. Definite recovery occurs after six to eight days. After a few weeks a linear tattooing may be made at the region of the anterior edge of the new part, to represent the cilia. Normal conditions of the skin and conjunctiva are necessary, as scars or shrinking processes prevent the lifting of the remaining tarsus.

Automatic sight. A "sight" connected in such a manner with the elevating gear of the gun, that when it is directed on the water-line of a target at any range the gun will have the proper quadrant elevation for that range.

Automatie. (G.) Automatism.

Automobile drivers, Vision of. Before the Paris Ophthalmological Society, Sauvineau cited the cases of a man wearing 16 D. lenses which gave him 15-100 vision, and a boy with congenital cataract, who were driving automobiles. Kalt told of another driver whose vision with his strong lenses was in one eye 1-20 doubtful, and in the other 1-6. In order to make its action unanimous the Society contented itself with calling attention to the risk of accident due to the poor vision of chauffeurs, and that risk would be reduced by requiring binocular vision with a normal field, and normal motility of the eyes, and visual acuteness with correcting glasses of not less than ½ in one eye and ¼ in the other. Lantsherre states that the automobile club of Belgium requires at its school normal vision in one eye, and at least ½ in the other.

Automobile glasses. CAR-DRIVERS' GOGGLES. These are made of cork and mica, celluloid and concave glass, plain and tinted, for the pro-

tection of the eyes from wind and dust, that would otherwise injure the delicate corneal and other ocular tissues. They fit snugly about the orbit and are found in great variety at the optician's.

Probably the best protective, made wholly of glass, is that found in the market under the trade name of "autoglas." It completely shuts off injurious currents of dust-laden air, does not interfere with the proper ventilation of the eye, can be had in all tints of color, and may be ground with the patient's proper correction.

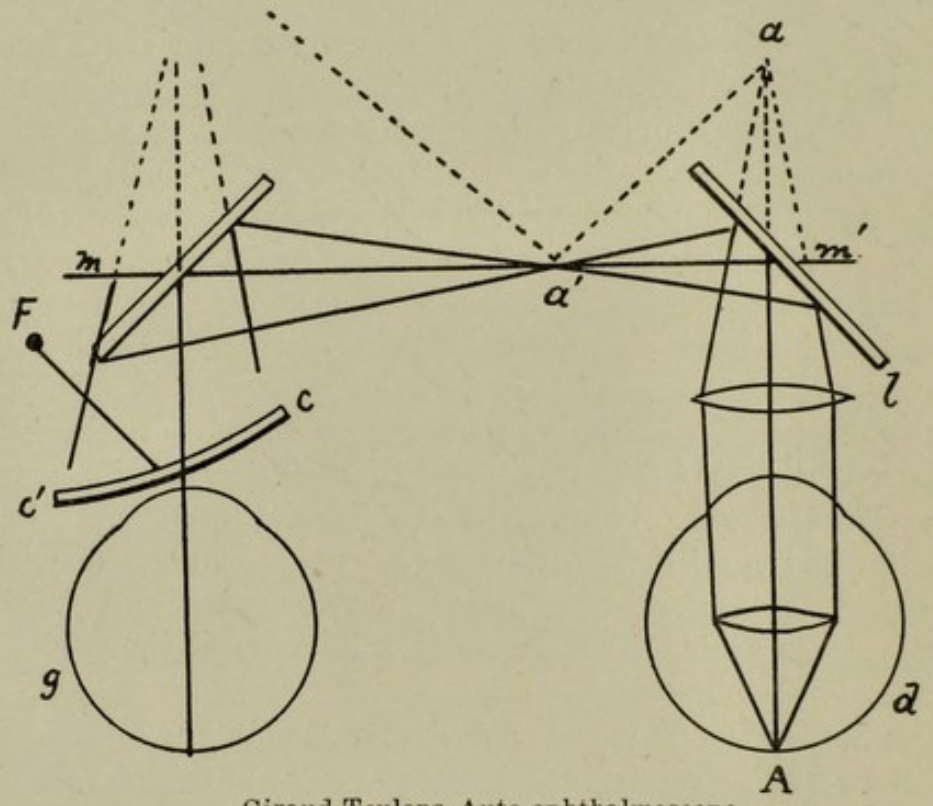
Automutilation, Ocular. Axenfeld has recently gathered the literature concerning self-enucleation by insane persons and has published it, in addition to many of his own observations. According to Axenfeld's experimental investigations, the injury may be brought about very quickly; he himself needed barely a minute to do a non-operative avulsion on a cadaver. Berlin, Dehn and Rothenpieler are of the opinion that lunatics maim themselves by pinching and cutting through muscles, tendons and the optic nerve with their finger-nails. Axenfeld, on the other hand, has demonstrated that this injury may be brought about by simply tearing out the globe with the fingers without help from the nails. The fingers, as they force an entry into the orbit, press the muscles back toward the apex of the orbital cavity, and the resulting tension severs the connection between the muscles and their tendons. The force needed to accomplish this lesion may even rupture the eyeball as a result of the strong compression. In dragging and forcing the eye out of the orbit with the fingers, the walls of the orbit furnish leverage.

Noyes has reported a case of self-enucleation by the fingers. Gifford has given a full account of these cases of self-mutilation (enucleation of the globe) which are usually attempted by insane persons who, not infrequently, succeed in gouging out one or both eyes.

In Henderson's case a young woman inflicted repeated burns with some caustic, possibly carbolic acid, upon the lids and conjunctiva, causing a serious symblepharon. Badal states that the most frequent of such occurrences is self-enucleation with the finger, especially in females. Doret observed pieces of matches voluntarily introduced into the conjunctival sac beneath the lids by a woman, who then claimed that the inflammation was due to ammonia used in washing floors. Vasioutinski states that self-mutilations of the eyes by conscripts in Russia affect the conjunctiva, cornea and lens. He finds that a special form of brownish-yellow spots upon the cornea is caused by silver nitrate.

In a case observed by Lafon, an insane patient attempted self-enucleation of the eyeballs by pressing his thumbs forcibly against the globes. Irido-cyclitis occurred, resulting in total blindness.

Auto-ophthalmoscope. An instrument devised for the purpose of examining one's own fundus. Various forms have been invented, but the first successful one was constructed by Coccius; since then Heymann, Giraud-Teulon, Zehender, Gould and others have described different instruments. One of the simplest and best is that of Giraud-Teulon. Its action is explained by the accompanying diagram.

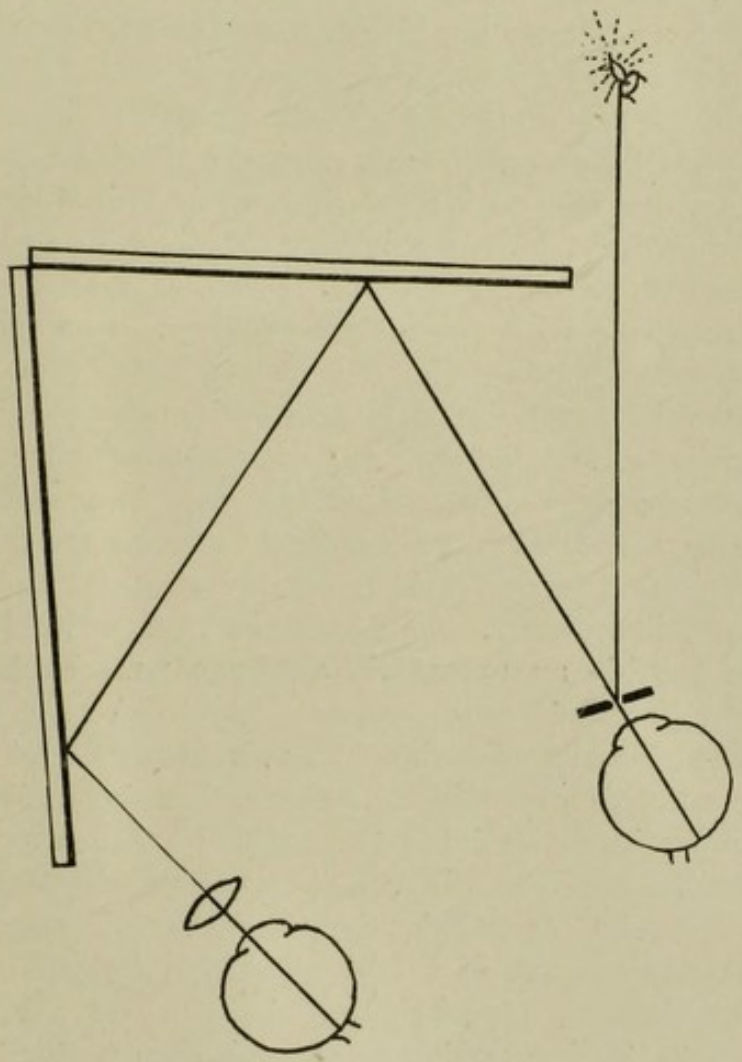


Giraud-Teulons Auto-ophthalmoscope.

The instrument consists of two plane mirrors, m m′, inclined to one another at an angle of 90°, and placed in front of the observer. A concave mirror (c c′) is held obliquely before the left eye (g), so that the rays from a flame (F) are reflected on to m, and thence on to m′, which will reflect them into the right eye (d). A double-convex lens, l, is placed between d and m′, by which an inverted aerial image of A is formed, which is situated in reality at a′ between the two mirrors, but which will appear to g to be situated beyond the mirror, m, at a″. In fact the rays emanating from d, instead of passing straight on, are bent twice at a right angle, and brought back to g, without having undergone any change in their relative positions.

Another method is described by R. Wessley *(Centralbl. f. prakt.*

Augenheilk., October, 1897.) for which is needed only an angular looking glass, which may be readily improvised by taking two small pieces of mirror glass placed at an angle. Such a glass reflects objects twice, giving doubly-reflected images, one within 120 to 90 degrees, the other within 90 to 72 degrees. The head is brought within the angles of the glass and the right eye looks at the image of the left, and *vice versa*. As the head cannot be brought much



Wessley's Auto-ophthalmoscope.

nearer than reading distance to the glass, the angle of the glass should be about 95 to 75 degrees. (See figure.)

A candle flame is then brought near the glass and the eye to be observed is shadowed, while the other eye is lighted. Before the latter an ophthalmoscope is held so that the light from its mirror is reflected to the glass and into the pupil of the other eye, which is seen in the looking glass to be lighted, and is fixed by the observing eye. Then a convex lens is placed before the examined eye when it

is readily observed that the fundus is clearly seen in the mirror, about the same area as one can ordinarily observe in another person. It is easy to change the angle of the reflecting mirror to bring any part of the eye-ground into the middle of the ophthalmoscopic picture. To see the optic nerve head when the eyes are parallel, the angle of the glass should be 84 degrees. The upper or lower portion of the fundus may be seen by altering the glass to or from the perpendicular

George M. Gould (*Jour. Am. Med. Assoc.,* 1898) describes an autofundoscope (q. v.), a simple bit of mechanism intended slowly and accurately to revolve a pin-hole through, and placed about two millimeters from the center of a black rubber disc. The method essentially is a very old one of moving a pin-perforated card held in the hand, before the eye, and observing an illuminated blank space through the perforation. In this way, however, one sees only faint movable, and indefinite images of the retinal vessels, which disappear and reappear with provoking rapidity. One may place the instrument, without the tube, five or ten feet from a brilliantly illuminated white cardboard, and thus obtain a very fair and steady image of the macular region and the entire perimacular vascular system. A little patience and considerable care is needed to hold the eye very steady, at the right angle, and to rotate the disc at exactly the requisite rapidity and uniformity to bring out the image most perfectly and immovably. Gould thinks that it would have been possible to provide an automatic clockwork mechanism much superior to the described crude device. (A. B. R.)

Autoperimetry. The examination of one's own field of vision, inasmuch as one must constantly control fixation, demands great attention, especially in determining the limits of the color zones. This is, for example, important in the study of scintillating scotoma in one's own eye. An opportunity for the observation of this migrainous symptom in the eye of a patient before the passing off of the attack is wholly a matter of chance.

Autophakoscopy. Seeing the image of one's own ocular interior or of one's own crystalline lens. Mitchell (*Ophthalmic Record,* VII, pp. 219, 220), who has investigated this phenomenon, says that there is a golden tinge to the luminous disc employed in Darier's experiment that is absent in the more successful one made by him. He saw the outlines of all floating bodies in the vitreous; they could not have been more perfectly defined if placed under the microscope. The striæ in the crystalline lens and the movement of drops of mucus and tears across the surface of the cornea are not seen by this experiment; it is only possible to watch the movement of *muscæ voli-*

tantes. Just why this is so he is unable to explain. To designate this procedure as autophakoscopy is evidently a misnomer, since the stria in the crystalline lens is not seen; this body being one part of the eye that escapes our scrutiny when practising this method. But for the want of a better name he decided to publish the account under the old title.

Autophakoscopy by the Mitchell method may be practised with any lens, provided it is held before the eye in the same position as when used for visual purposes. A globule of water or colorless liquid albolene, adhering to the outer surface of the lens, is the essential part of the apparatus used in the production of this peculiar phenomenon, and it is through this globule that the reflections from the interior of the eye are visible.

Autophakoscopy, however practised, does not seem to possess any features that tend to make it of value to the ophthalmologist in clinical work.

Autoplastik. (G.) Autoplasty.

Autoplasty. n. The restoration of a part by tissues taken from the same organ or organism.

Autoptic, adj. Seen with one's own eyes; relating to or based on autopsy or personal observation: as autoptic evidence. Also written autopsic.

Autoscope. An instrument invented by Coccius for the self-examination of the eye. See **Auto-ophthalmoscope.**

Autoskiascopy. This is a procedure announced by Jackson by means of which one's own refraction may be skiascopically determined, i. e., the refraction of one eye measured by means of a mirror with the other. In this procedure the refractive state of a portion only of the background, situated on the temporal side, is examined. There is less practical value, according to Elsching, in this plan than in autophthalmoscopy (q. v.).

Autosuggestion.. This is a term, originated by Page, for that peculiar mental, or semi-hypnotic condition, in which the will is subordinated to suggestion by others or, more properly, by the environment of the patient. It is generally associated with or is closely allied to hysteria. Schmeichler and others have furnished reports of cases where the eye symptoms had this origin.

Autotoxin. Any metabolic product of an organism which acts upon that organism in any unfavorable or poisonous manner. Clinically, auto-intoxication may result from the formation of abnormal products, or the failure of elimination of substances which normally are excreted without damage to the organism.—(E. E. I.)

Auxometer. An instrument for measuring the magnifying power of lenses.

Available accommodation. This represents that proportion of the amplitude of accommodation available for near-work, and generally is equal to two-thirds of the total range. For example, if at 50 years of age the near-point be at 16 inches, the total accommodation will be 2.5 diopters. Two-thirds of this amount will be 1.67—the amount of available accommodation.

Avanzamento. (It.), n. Advancement, i. e., an operation by which an ocular muscle is detached from its insertion and attached at a point removed from its origin.

Avanzamento della capsula di Tenone. (It.) Advancement (q. v.) of Tenon's capsule.

Avanzamento dell'elevatore della palpebra. (It.) Advancement of the levator of the eyelid.

Avanzamento di un muscolo dell'occhio. (It.) Advancement of an ocular muscle.

Avempace. Also known as Abu Bekr Mohammed ibn Badjeh. This distinguished Spanish-Arabian philosopher, poet and physician was born about A. D. 1138. He lived successively in Saragossa, Seville, Granada and Fez. In the last-named city he became vizier to the Almorawides. Tradition relates that he was poisoned by, or at the instigation of, jealous physicians. His most important writings are those on pharmacology, in which he mentions a number of remedies for diseases of the eye.—(T. H. S.)

Avenzoar. He was, in addition, known as Abu Merwan ibn Zohr, or Zuhr; also called Abimeron and Abumeron. This most distinguished representative of Spanish-Arabian medicine, and the most illustrious member of a highly distinguished Jewish family, was born at Pentaflor, near Seville, in the latter part of the 11th century. His father and his grandfather were famous philosophers and physicians. Avenzoar himself, however, restricted his studies, or, at all events, his professional work, almost exclusively to medicine. He was especially famous as a clinician, and was, it is scarcely necessary to add, a keen observer and a profoundly original thinker. His master in the healing art was plainly Galen, but him the great Arabian, unlike most of the other physicians of the middle ages, did not follow slavishly.

His most important book is *al-Teisir* (Alleviation by means of Remedies). In this book he takes an unusually hopeful view of many diseases, and even (in decided opposition to Galen) declares that amaurosis is curable. Concerning the cataract operation, however,

he is decidedly pessimistic, naively observing: "Extraction is impossible, reclination permissible only." The ophthalmic portions of his work are not, on the whole, of very great value.

He left a famous son and grandson, named, respectively, Abu Bekr Muhammed b. Abd Al-Malik Ibn Zuhr and Abu Muhammed Abdallah b. Abu Bekr Muh. Ibn Zuhr. Each of these descendants surpassed his ancestor as an ophthalmologist.

He died A. D. 1162.—(T. H. S.)

Avenzohar. A celebrated Jewish ophthalmologist who flourished in Spain at the end of the eleventh century. See **Avenzoar.**

Averroes. Also known as IBN ROSH, or IBN RUSD, and called "THE MOHAMMEDAN SPINOZA." This distinguished contemporary, pupil, and friend of Avenzoar was born at Cordova, Spain, A. D. 1126. His father and his grandfather were judges, and he himself became a Cadi. As a judge he had a wide reputation. In 1196 he was appointed governor of Andalusia. Soon, however, he was accused by his enemies of heresy, and condemned to exclusion from the community of true believers. The place of his banishment was a Jewish colony near Cordova, called an-Nisada. He was soon recalled, however, and sent to Morocco, where he was bitterly persecuted till his death.

He was a very industrious man, and is said to have spent, in all his adult life, only two nights without working—that of his wedding-day and that of the day which followed his father's death. He wrote on a vast variety of subjects—philosophy, philology, astronomy, law, and medicine. His chief medical work is generally called by its mediaeval Latin title, *Colliget* (Kitab al Kullijat, anglicé: The General Principles of Medicine).

The Colliget soon took rank as a high authority, second, in fact, only to the *Canon* of Avicenna. In a word, it is a whole system, or encyclopedia, of medicine, rather impractical, however, and thoroughly saturated with philosophy.

As an ophthalmologist Averroes is greatly inferior to a number of other Arabians—notably Ammar and Ali ben Isa. He is nevertheless important for the history of optics, inasmuch as he wholly departed from the purely theoretical views of the nature of vision which had been laid down by the ancients and, for the most part, by mediaeval writers as well. Thus, for example, he finally overthrew the old-time doctrine that, in the act of vision, emanations pass out from the eye to the object which the mind desires to in-

vestigate, and return with information concerning it. See, for further information on this point, **Alhazen.**—(T. H. S.)

Aveuglement. (F.) Blindness.

Avicenna. In Arabic, Abu Ali al-Husain b. Abdallah b. al-Husain b. Ali as-Saih ar-rais Ibn Sina. This greatest of all Arabian physicians (for this reason generally called by the Arabs simply The Prince or The Chief) was born at Khorassan A. D. 980. At the age of ten he knew (it is asserted) the Koran by heart, and the greatest difficulty which his teachers met in connection with the instruction of this wonderful pupil was to keep him supplied with subjects. At the age of 17 he was called in consultation in the case of the Emir, Nuch ben Mansur, and acquitted himself most creditably.

The death of his father—a high official at Bokhara—having left him rich, Avicenna began a life of dignified and successful wandering. He passed from court to court in the various capacities of physician, astronomer, author, teacher, and, finally, vizier—a dignity which he reached in Hamadan.

Charged with treason, he was imprisoned. He escaped, however, and fled to Ispahan. Being here entertained with great cordiality, he remained for 14 years.

He was all his life a great student and a wicked man. In his 58th year he died, as a result, it is said, of excessive study and dissipation. Some still unkinder writers aver that he perished because, when sick, he took his own medicine. He was a very prolific and a very interesting writer. His works, declared to amount in number to 105, were in prose and in verse, and treated of law, astronomy, philosophy, mathematics, statesmanship, and medicine.

Avicenna was not an original medical writer, but was an excellent compiler. His medical *Magnum Opus,* Kanun (Canon), was only a sort of combined codification and amplification of Galen, Paullus, and others of the Greeks. The literary form, however, was so delightful that the book at once took rank above the *Kingly Book* of Ali Abbas and even the *Hawi* of Rhazes. It became the Canon indeed, not only for its own immediate time and place, but for Western lands also through half a thousand years.

Though chiefly a general practitioner, Avicenna also deserves high praise as an accurate and logical ophthalmologist. His writings on the eye are comprised in the third division of the third book of The Canon. As an ophthalmologist, however, Avicenna wrote, it would seem, from an inextensive personal experience in the treatment of eye-diseases. He has also been severely criticised for paying

too little attention to the most important subjects—for example, trachoma and cataract.*—(T. H. S.)

Avulsio bulbi. (L.) By this term is meant the tearing out of the eyeball, with complete or almost complete severing of the surrounding softer tissues, conjunctiva, muscles, Tenon's capsule, and the optic nerve. This traumatism is seen most frequently as the result of brawls and in people who, mentally unbalanced, have done an automutilation (q. v.). On the other hand, it is sometimes encountered in other injuries, by forceps delivery and by dull or sharp objects which force their way between the eyeball and the bony orbit, in bullet wounds at the temple, and as the result of sudden compression of the orbit behind the eyeball, as, for instance, where a person is run over.

Avulsion. A traumatic or operative tearing away of a part, or organ, as, for example, the eyeball from its socket, or the iris from its intraocular attachments.

Avulsion of the bulb. Rupture of the nerves, tendons of the ocular muscles and other contents of the orbit that hold the globe in place, so that the eyeball is torn from its socket.

Avulsion of the retina. Dragging of the retina from the ora serrata, generally as the result of injury, has been reported in cases of retinal detachment. Hesse reports a case in which it occurred without trauma, but in detached retina associated with very high myopia.

Axanthopsia. Violet-blindness or blue-blindness. According to the theory of Helmholtz and Young blue- or violet-blindness is due to the blue-substance of the retina being equal to the green- or red-substance. In Holmgren's case of unilateral violet-blindness the red half of the spectrum was separated from the green by a colorless zone in the midst of the yellow. See **Akyanopsia.**

Axe anatomique de l'oeil. (F.) The antero-posterior diameter of the eye.

Axe du cristallin. (F.) That antero-posterior axis of the eye which passes through the centre of the crystalline lens.

Axencylinder. (G.) Axis cylinder.

Axencylinderfortsatz. (G.) Axis-cylinder process.

Axencylinderscheide. (G.) Sheath of axis cylinder.

Axendrehung. (G.) Torsion, rotation about a centre, causing twisting of a ligament or pedicle.

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* The ophthalmic part of Avicenna's writings is most accessible to modern readers in the excellent German translation: *Die Augenheilkunde des Ibn Sina, aus dem Arabischen übersetzt und erläutert* von J. Hirschberg und J. Lippert, Leipzig, 1902.

Axenebene. (G.) The axial plane.

Axenfaden. (G.) Central filament.

Axenfaser. (G.) Axis cylinder.

Axenfeld's lachrymal sac dilator or retractor. This is one of the first as well as one of the most useful instruments for separating the edges of the wound in the operation for excision of the lachrymal sac. It is operated by a screw attached to movable arms. See **Lachrymal apparatus, Operations on.**

Axenhypermetropie. (G.) Axial hypermetropia.

Axenkanal. (G.) Central canal.

Axenkörper. (G.) Axis corpuscle.

Axenmyopie. (G.) Myopia due to too great length of the axis of the eye.

Axenskelet. (G.) Axial skeleton.

Axenstab. (G.) Notochord.

Axenstrang. (G.) Axis cord.

Axe optique. (F.) Optic axis.

Axes of the orbits. These axial lines diverge greatly and make rather an acute angle when extended until they meet behind, at the chiasma. Dwight (*System of Diseases of the Eye,* Vol. I) estimates this angle at from 42° to 45°. He further says that they run downward as well as outward in their course from the apex to the base, forming an angle of from 15 to 20 degrees with the horizon. It has been thought that greater divergence is found in shorter skulls, but this is not certain. The roof of the orbit is in the main more nearly horizontal from before backward than the floor. It is not a straight line, but a sinuous one curving upward in the middle. The cavity is more or less overhung by the superior border. The degree of overhang is very uncertain. There is next to none in the Roman skull, and a great deal in others. It is deepest at the outer angle, but it is not unlikely that it is most marked in skulls with large frontal sinuses.

Axial. Pertaining to or of the nature of an axis; situated in the axis. *Axial magnification,* in optics, the ratio of infinitely small conjugate line-segments of the principal axes in an optical system. It is inversely proportional to the square of the abscissa on the axes. Also called *depth-magnification. Axial plane,* in *optics,* the plane containing (1) the principal axis of a lens or mirror, or (2) the plane which is coincident with the axis of a cylindric lens. In *crystallography,* a plane containing (1) two of the crystallographic axes, or (2) the optic axes in the case of a biaxial crystal. *Axial point,* in *optics,* a point located upon the axis of a lens or mirror.—(C. F. P.)

Axial ametropia. This refractive condition results when, in consequence of a shortening (hyperopia) or lengthening (myopia) of the antero-posterior diameter of the eye, the light rays do not cross one another properly and are not easily focussed on the macula.

Axial cataract. Any form of cataract that occurs in the axis of the lens-system, e. g., anterior capsular cataract, posterior capsular cataract, central cataract, or cortical cataract. See **Cataract.**

Axial hypermetropia. That form of hypermetropia due to an abnormally short antero-posterior diameter of the eye. See **Hypermetropia;** also **Refraction of the eye,** and **Physiological optics.**

Axial myopia. This form of ametropia depends upon a lengthening of the antero-posterior diameter of the eyeball, but, unlike the great majority of cases of axial hyperopia, is an acquired, not a congenital, condition. It usually shows itself during the school years. See **Refraction and accommodation of the eye.**

Axial neuritis. Inflammation of and changes in the central bundles of optic nerve fibres, such as are observed, for example, in alcohol-tobacco amblyopia.

Axialstare. (G.) Any form of cataract that occurs in the axis of the lens-system, e. g., anterior capsular cataract, posterior capsular cataract, central cataract, or cortical cataract. See **Cataract.**

Axial torsion of the optic nerve. Some investigators, for example Vossius and Strahl, believe that during foetal life the optic nerve and the eyeball gradually revolve about the long axis of the former from below outward, and that this torsion may amount to as much as ninety degrees. Of course this movement would considerably alter the ante-partum relations of the ocular organs within the orbit.

Axillar. (G.) Axillary.

Axiometer. This device for determining the axis of cylinders is based on the principle that when a luminous streak is reflected by a cylindrical surface, the reflected image will have a different degree of obliquity from that of the luminous streak except in two positions, viz., when the streak is parallel to the axis of the cylinder and when it is at right angles to it, the apparent angle of the image and that of the object will coincide, Cooper has devised a box containing a lamp by means of which a luminous streak may be reflected on the spectacles of a patient who is directed to look at the streak; as the luminous streak is rotated two images will appear as crossed lines, and the rotation is continued until the two lines are parallel or come together. This position is read off on a graduated arc on the front

of the box and gives the precise axis of the cylindrical lens. Glasses may be tested on or off the face; in the latter case they are to be set in a holder provided for the purpose.

Axioplasm. The stroma of recticular substance connecting the fibrillæ of the axis-cylinders. Also called neuroplasm.

Axis. In *analytical geometry,* any fixed line of reference used to determine the position of a point or series of points (line or surface) in space. *Axis of a beam of light,* in optics, the middle ray of the beam; also called the chief ray. *Axis of a cone,* a straight line drawn from the apex to the center of the base. *Axis of a crystal,* one of three or four imaginary lines assumed for convenience to define the position of the planes of the crystal, and to exhibit its symmetry. *Axis of a curve,* a right line dividing a curve into two symmetrical parts, so as to bisect every chord perpendicular to it (See **Axis of symmetry**). *Axis of a cylinder,* a straight line drawn from the center of the one end to that of the other. *Axis of a cylindric lens,* the straight line which is the rectangular intersection of the lens' plane surface with the radial plane whose rotation generates the cylindrical surface. *Axis of a lens,* a straight line drawn through the optical center of the lens, and perpendicularly to both its surfaces. *Axis of a sphere,* any straight line drawn through the center and terminated both ways by the surface of the sphere. *Axis of a spherical, concave or convex mirror,* a straight line which passes through the geometrical and optical centers of the mirror. *Axis of a telescope,* a straight line passing through the centers of all the lenses in the tube. *Axis of an ellipsoid,* its maximum and minimum diameters and the diameters and the diameter perpendicular to these. *Axis of refraction,* a straight line drawn perpendicular to the surface of the refracting medium, through the point of incidence at which the refraction takes place. Some crystals have two axes of refraction (See **Optic axis,** below). *Axis of rotation,* the imaginary line about which all the parts of a rotating body turn. *Axis of symmetry,* a line on both or all sides of which the parts of a body or dimension (of line, curve or surface) are symmetrically disposed. *Axis of the eye,* a straight line passing through the center of the cornea, the nodal points, the center of rotation and the posterior pole of the eye. It contains the cardinal points of the entire dioptric system, the principal points, the nodal points and its principal foci. *Axis of vision.* (See **Visual axis,** below.) *Conjugate axis,* a minor axis said to be conjugate to the superior axis at right angles to it. The axis conjugate to the transverse axis. *Coordinate axes,* fixed lines on which or parallel to which an element (abscissa or ordinate) of the position of a point is measured. *Optic axis,* as applied to the *eye, lenses,* or *mirrors* (see above respectively).

Also the line in a doubly refracting crystal in the direction of which no double refraction occurs. Crystals belonging to the tetragonal and hexagonal systems have a single optic axis, coincident with their vertical crystallographical axis; hence they are said to be *uniaxial.* Crystals belonging to the orthorhombic, monoclinic, and triclinic systems have two optic axes, and hence are *biaxial. Principal axis of a lens,* the same as above, yet as distinguished from: *Secondary axis of a lens,* the straight line which connects a point on either side of the principal optic axis with the optical center of the lens. *Visual axis,* in *physiologic optics,* the straight line which connects the point of the object viewed with the *fovea centralis.* It does not coincide with the optic axis of the eye (See **Angle gamma**). Also called *visual line, line of fixation,* or *axis of vision.*—(C. F. P.)

Axis of cylindrical lenses, Notation for the. The relative position of the axis in cylindrical lenses is differently indicated in various countries. In Germany, an exactly horizontal or vertical axis is so indicated, (l. e., | or —); otherwise it is noted by giving the degrees or deviation of its upper end from the vertical. Thus, 25°t. or 25 n. means a cylinder whose axis deviates 25° temporal-ward, or 25° nasal-ward, from the vertical meridian. This notation has the advantage of pointing out at once whether the principal meridians of both eyes are symmetrically placed, or not.

In France and most other countries, the Javal method is employed, the figures on the ophthalmometer being taken as a basis. Javal placed the O point at the horizontal meridian; so that 25° cylinder "t" would, for the right eye, be written 115° and for the left eye 65°.

It is to be hoped that in the near future ophthalmologists the world over will agree upon some conventional method of axis notation. It matters little which is chosen as long as one is selected, so that we shall not have to resort to diagrams and other devices in a prescription or report to indicate just what we mean. So far, the efforts of both local and international societies, as well as of earnest individuals, to bring about the adoption of a common nomenclature seem to have been in vain.

Axis of rotation. Savage (*Ophthalmic Myology,* pp. 5, 6, 7) gives the following law for finding this: The axis of every possible rotation is in the movable equatorial plane, and is always fixed at right-angles to the plane through which the visual axis moves from the first to the second position.

To find the axis of any rotation, the rule given by Helmholtz needs no amending. At right-angles to the plane common to the first and

second positions of the visual axis, construct two planes in one of which shall lie the visual axis in the first position and in the other the visual axis in the second position. The plane common to the visual axis in the two positions may be named *a*, the plane passing through the visual axis in the first position may be named *b*, and the plane through this axis in the second position may be named *c*. The line of intersection of planes *b* and *c* is the axis about which the eye has rotated in passing from the one position to the other. Planes *b* and *c* being everywhere at right-angles to plane *a*, their line of intersection must also be perpendicular to plane *a*. A fourth plane, *d*, may now be constructed through the line of intersection of planes *b* and *c*, at right-angles to either plane *b* or plane *c*, and necessarily at right-angles to plane *a*. This plane *d* is the equatorial plane of the eye. If the rotation has been from the primary position to any secondary position, or from any secondary position back to the primary position, the axis of rotation is in both the equatorial plane which has moved with the eye, and also in the Listing plane, which, passing through the centers of rotation of the two eyes, is fixed vertically in the head and at right angles to the visual axis only when it is in the primary position. This can be true of only one eye at a time, for it is impossible for both eyes to be in the primary position at the same time. The primary position of an eye is that in which the visual axis is in the fixed horizontal plane of the head and, at the same time, parallel with the median plane of the head. In a normal state of the ocular muscles the two visual axes can never both be parallel with the median plane of the head; hence, the two equatorial planes cannot coincide, at the same time, with Listing's plane. Strictly speaking, the axes of rotation for the two eyes can be in Listing's plane only when moving in the horizontal plane. In all other rotations (vertical and oblique) either one or both axes is out of the Listing plane; but both are always in the equatorial plane. In rotation from one secondary position to another secondary position the axis is in the equatorial plane, but not in the Listing plane. There can be, therefore, no good reason for perpetuating the Listing plane.

Axis, Optic. This is a line around which the optic system of the eye may be considered as centered. Theoretically, the centers of curvature of the anterior and posterior surfaces of the cornea and lens should lie in this straight line, which does not pass through the fovea, however. Practically these points are decentered, usually in the vertical meridian.—(H. G.)

Axis, Optical. A line drawn from the centre of the eye-piece through the tube, objective and stage to the centre of the mirror of a microscope.

Axis, The, in refraction.

As Walter L. Pannell (*Ophthalmology,* October, 1912) very properly observes, any means aiding in the objective determination of the axis would seem in order, appreciating the increasing tendency among examiners to attach as much importance and weight to their own findings as to those secured by subjective assistance. Such being the case, the prescription is written only after due consideration of both findings, not of the subjective alone. Although, as Jackson points out, the test card examination is the last court of appeal, this seems to relate more particularly to the quantitive element of the correction than to the details of axis and so on.

That amount of assistance rendered by the examined eye, or, to be more specific, the average intelligence, does not always measure up to that degree of accuracy desired alike by the examined and examiner. In fact, the burden of attaining this very often rests with the refractionist. Hence the elaboration of objective means of examination as well as the invention of such optical instruments as will aid the individual under examination to give material assistance—scientific assistance through the instruments used.

The rules laid down for the determination of the axis with the retinoscope are to the effect, generally, that the band of light indicates the direction for the correcting cylinder. These rules may be qualified, meaning that the direction is so variable and elusive during the examination that as an index it is not entirely to be relied upon. A variation as much as thirty degrees may occur in the course of an examination, making it the problem to find the fixed position for the cylinder, which position alone is the correct one. When the eye is artificially made "spherical," the cylinder used, as already remarked, has a fixed position, and the shadow shows all the characteristics of a spherical one. Using the plane mirror, enough of the sphere is taken out of the correction so that at one meter a shadow of about .50 or .75 D. in a plus case moves "with" the mirror in a circular, vertical or horizontal direction. If the cylinder is altered or in a faulty position, of course the shadow becomes imperfect.

Some cases show, after the subjective test, that the position of the cylinder, when one eye alone is tested, is not the same as when the two eyes are in use together. For instance, the right eye may seem to require a cylinder at axis 90° when tested alone, the left at 75°, but uncovering both eyes together, the cylinders may be favor-

ably placed at 95° and 85° respectively; and in these latter positions, the shadow of each eye, both being uncovered, may seem a perfect spherical shadow, while with the cylinders at 90° and 75°, it is not so.

Not only is the foregoing contention conspicuously true of an uncertain number of cases—uncertain, because no observer has as yet carried to completion the examination of a sufficiently large number of instances to give us the true percentage—but it cannot be too much insisted upon that in looking from the distance to the near point a rotation of the globe may occur in one or both eyes, that will invariably cause asthenopic symptoms if the patient attempts to read with his high-grade cylinders, and not uncommonly some discomfort in lower degrees of astigmatism. In doing perfect refraction the eyes should be carefully tested separately and together not only at six meters but also at the near working distance, whatever the age or refraction of the patient. Failure to give the patient refractive comfort not infrequently hinges upon care in these particulars. See **Refraction and accommodation.**

Axis, Visual. The line drawn from the point of fixation (object) through the nodal point to the fovea centralis.

Axite. The end filaments of the axis-cylinder.

Axometer. An instrument used in adjusting the height of the bridge of a pair of spectacles, to bring the centers of the lenses in line horizontally with the centers of the pupils of the eyes.

Axonometer. An annular disk used in the ordinary trial frame to locate the position of one of the chief meridians of astigmatism.

Axoneuron. The intracranial nerve-cell of the neuron. Axoneurons are divided into endaxoneurons and rhizoneurons.

Axons of the retina. Long processes of the ganglion cells which pass into the nerve-fibre layer of the retina to the papilla and optic nerve.

Axoplasm of Schiefferdecker. This is a term applied to the interfibrillar matrix found, in small amounts, however, so far as the retina is concerned, along the axis-cylinder. See **Histology of the eye.**

Axungia ardeæ. (L.) Heron's fat; an ancient remedy once used for removing specks from the eyes.

Axungia balsamica. See **Benzoated lard.**

Axungia porci. See **Lard.**

Ayres' chalazion forceps. This is one of the earliest, simplest and best instruments for the removal of Meibomian cysts. It has a ring at the extremity of one arm, the terminal of the other arm of the forceps being a round plate which clasps the lid-skin against

Ayres' Chalazion Forceps.

and forces the tumor through the circle, where it is held in place to be operated on.

Azelainsäure. (G.) Azelaic acid.

Azimuth. An optico-astronomical term, which assumes that the horizontal plane of the eye is comparable to the actual horizon, and the vertical meridian to that form which degrees in longitude are reckoned, as from Greenwich. Plus azimuth is to the right from the centre of the cornea, when that is in the primary position, and minus azimuth to the left.—(L. H.)

Azoblau. (G.) Azo blue.

Azocarmin. (G.) Azo carmine.

Azofarbe. (G.) Azo color.

Azofarbstoff. (G.) Azo coloring matter.

Azoflavin. (G.) Yellow azo.

Azogelb. (G.) Yellow azo.

Azoroth. (G.) Red azo.

Azorubin. (G.) Red azo.

Azoschwarz. (G.) Azo black.

Azoverbindung. (G.) Azo compound.

Azoviolett. (G.) Azo violet.

F. A. SMITH

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