

3. YATOM, J.—An outbreak of conjunctivitis in man, associated with the virus of Newcastle diseases. *Harefuah*, N.3, February 1, 1946.
4. SHIMKIN, N. I. (a)—The epidemiology of eye diseases in Palestine. *Hebrew Harefuah A. Med. Jl.*, Vol. I, No. 4-5, April, 1945. (b) La Maladie des yeux Haifa, Palestine. *Ann. d'Ocul.*, December, 1924. (c) Blindness among Jews in Palestine, and its causes. Congress International, Cairo, Egypt, 1928.

HISTORY OF OPHTHALMOLOGY THROUGH THE AGES*†

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TODAY, as the result of war, we are living in one of those crises of history which cause a great social upheaval in human society. Steady peaceful progress is replaced by a sudden jerk forward and, as a result, we must adapt ourselves to the new environment.

The future position of our profession in its relationship to the State is being examined by our legislative authorities, and so it behoves us (the present holders of our birthright) to be certain that the public, and we ourselves, have our views clearly set out.

That great statesman, Winston Churchill, recently remarked, "The longer you can look back the further you can look forward." And so to-day I propose to trace the history of ophthalmology from the earliest times, race you through the middle ages and so up to the present day. I will endeavour to pick out the chief actors and emphasise the part they played in unravelling the history of about 4,200 years.

The uncertainties of unrecorded history make it impossible to say where the dawn of civilisation began, but the earliest mention of any medical matter is found in an ancient work on law. About 2250 B.C. Hammurabi—a king of Babylon-Assyria—promulgated a collection of laws. A considerable number of sections of these laws relate to ophthalmology—or rather to ophthalmic negligence or malpractice—*e.g.*, one such law states that:—

(196). If a man destroy the eye of another man, they shall destroy his eye. (In the case of a freeman he shall pay one manna of silver and, in the case of a slave he shall pay one half his price.)

Another states:—

(215). If a physician open an abscess in a man's eye with a

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bronze lancet and save that man's eye, he shall receive ten shekels of silver—if the eye is destroyed they shall cut off his fingers—if a slave's eye is destroyed he shall pay one half the price of the slave.

This age is obviously the bronze age as bronze instruments were being used.

The practice of medicine and surgery of these times was almost wholly in the hands of priests and was mixed with the greatest superstition and magic. Apparently no patient was treated without the appropriate magic incantation being duly recited.

The scene now changes from Babylon 2250 B.C. to Egypt 1650 B.C. A priceless document was found between the legs of a common mummy at Thebes and purchased by the Egyptologist Ebers from an Arab.

This Papyrus Ebers, as it was called, consisted of 110 pages or columns and describes all the diseases and remedies that were known to the Egyptians of that time. Of these 110 columns, eight are devoted exclusively to diseases of the eye and treatment is advised for such troubles as pain in eye, tear in eye, pus in eye, blood in eye, turning of eye, dimness of sight, etc. Common medicaments employed were: onions, leeks and beans, castor oil, pomegranate, copper salts, oxymel of squill, hemlock and opium.

In these days of ancient Egypt all learning of the times was imparted in the temple school and so, priests were doctors, and doctors priests. Anatomical knowledge was generally poor which is somewhat extraordinary when one remembers that an essential portion of the religion of the time was embalming of all bodies, both rich and poor.

These Egyptian doctors did, however, practise inspection, palpation, percussion and auscultation if even in a rudimentary way; while some of their public health laws were excellent.

In Homeric times there were many gods of healing but Aesculapius was greatest of all. Many Aescupalian temples were built which were half temple and half hospital. They were served by priests who gave medical and surgical instruction. Possibly the subtle art of suggestion, to patients previously rendered highly liable to suggestion, by want of food and drugs, was often practised by them.

In 460 B.C., in the golden age of Greece, Hippocrates was born and had as contemporaries many great and immortal men such as Socrates and Thucydides. To Hippocrates, who is usually referred to as the Father of Medicine, we ascribe the oath which bears his name and the many writings which are said to be his. It is almost certain that the oath was in use before his time, and also that all these writings were not those of Hippocrates the Great. Nevertheless, the title "The Hippocratic Art" is well justified because

Hippocrates completed the separation of scientific medicine from temple practice and magic. He introduced into medicine the science of observation and inductive reasoning. Finally he taught that "The physician is a servant, not a teacher of Nature"—do enough but never too much.

What Hippocrates failed to understand was that there were various sorts of disease—his crude pathology made treatment a question of influencing his four cardinal humours (blood, mucous, yellow bile and black bile). This was attempted by restrictions in diet, hot foot baths, irritant gargles, cupping, venesection, the cauterising of blood vessels in the neighbourhood, multiple incisions down to bone and even trephining of skull.

In the treatment of ocular affections the acute variety were treated by venesection and cupping, with local counter-irritation, at some remote distance, to draw the humours away from the eye. The chronic affections were treated mainly with local application of milk of women, and gall of goats, but various preparations of copper, iron and lead were also used.

Greek medicine was practised not only in Greece but extended also to Alexandria and Rome—this period extends from the time of Hippocrates to the end of the fruitful era of the Roman Empire (about 800 years).

The Alexandrian school introduced collyria for treatment of eye diseases. The collyrium was a solid medication (not a liquid) containing multiple secret ingredients made up in a cake, the basis being gum. Seals or stamps used to imprint inventor's name, ingredients, etc., on the collyrium have been recovered in large numbers. A fragment of cake was dissolved in water, oil, milk of women, urine, bile or saliva before use.

The disease which was such a scourge to eyes was trachoma—it has been described as, as old as the Nile and the desert, and certainly caused tremendous suffering and much blindness.

Three famous men's work was accomplished in this period of Greek medicine—Celsus, Pliny, Galen. Celsus of the Alexandrian School wrote "De Medica" in A.D. 29. It is mainly a compilation but written in excellent Latin. Out of a historical void he gives a detailed description of couching for cataract. The name cataract was adopted later by Constantinus Africanus—the Greek name was "hypochoyima" and the Latin "suffusio." The names all express the humoral implication—in "suffusio corrupt" the humour was supposed to collect in a space between the pupil and the lens—thus obstructing visual spirits. When suffusio was fully formed it could be displaced into a part of the eye rather than in front of the lens by means of an operation. Operation consisted of entering a sharp strong needle into the eye and gently working the suffusio away from the pupil.

Roman writers of this period were interested in the problem of why the pupil is black. Pliny made the observation that the eyes of nocturnal animals were brilliant in the dark; but the fact that no animal radiates light it has not received was not appreciated for many years to come.

Galen (A.D. 131-201).—Next to Hippocrates this old Roman master of medicine has been called the greatest of all physicians. Unfortunately his books on optics and diseases of the eye have been lost in the tide of time. He did, however, add to the knowledge of the anatomy of the eye. He declared Nature created nothing defective and nothing in vain. He describes the eye as the most divine of organs and admires the wisdom of the creator who took such care of brain and retina. Like Hippocrates he thought the crystalline body (lens) to be the essential organ of vision (and his ideas on cataract were the same as Celsus). He believed the function of the retina was to perceive the alterations which occur in the crystalline body and to communicate them. He used hyoscyamus to dilate the pupils for cosmetic purposes.

It is interesting to note that in this era Julius Caesar raised the status of physicians who were permanent residents in Rome by granting them citizenship. These physicians were mainly Greeks or slaves as the better class Roman only took up legal or administrative posts.

The Arabian Period (A.D. 850-1375).—About 630 A.D. there appeared the Prophet Mahomed. By 1050 the Turks under the banner of Allah began a reign of conquest and Christian persecution in the then known world of the Eastern Mediterranean. One unfortunate result of this was the burning of the famous library at Alexandria; this has created a gap in these ancient writings which can never be refilled. The Arabians did, however, translate some Greek writings into Syriac and later into Arabic. Unfortunately they revered the authority of tradition and did not learn the crowning wisdom that fact is greater than dogma. And so, alas, many mistakes were perpetrated in these translations.

The crusades against the banner of Islam (1096-1272) had one advantage that as a result of travel some Eastern learning began to filter West.

Before decay overtook the Arabian Renaissance the torch had been handed on to Western Europe by the translations into Latin from the Arabic version of the Greek masters. Also, at this time we have the work of an Arabian genius Alhazen whose "Optics" were the earliest basis of our present science.

Interlocking with the Arabian era there began a period of systematised intellectual effort in the schools of Salerno and Montpellier.

The famous monk Constantinius Africanus translated Arabic

writings into Latin and thus began a movement which gathered speed with years. Later Benevenutus Grassus wrote a book giving a good summary of Greek and Arabic teaching. It is important historically as it is the only book of its kind which was translated into many different languages.

In this era there appeared an interesting treatise on the hygiene of the eye by one, Peter the Spaniard, who later became Pope John XXI.

The conception of contagiousity of ophthalmia was offered by John Yperman.

It is hard to say exactly when the genius of man discovered the fact that glasses relieve the ocular defects of nature. In the days of the Roman Empire short sight diminished the market value of a slave. The old Roman patrician's only means of overcoming his presbyopia was to make a slave read to him.

The observation that segments of spheres can be used as magnifying glasses was not original to Roger Bacon but this English monk, physicist, mathematician and philosopher was the first person to recognise clearly the use of lenses for old people, and for those with weak sight. In 1268 Roger Bacon in his "Opus Magnus" treats on the science of optics in general and lenses in particular. He recommends the use of a plain convex lens, with the thickness smaller than the radius, as an aid for seeing for the old. Such lenses were to be used resting on the page to magnify the text.

Bacon had shortly afterwards to flee before Papal wrath but before doing so he probably passed his ideas on (indirectly) to Alexander de Spina—a Dominican monk at Pisa. The latter is generally accepted as the inventor of spectacles.

The existence of rock glass was known from the earliest times but the evolution of spectacles parallels the evolution of civilisation.

There is no doubt that rock crystals were probably used by pre-historic man to make tools and as a burning glass. Placed opposite the sun's rays the crystal is a most useful contrivance to produce heat and as a remedial agent for cauterising the human body. The ancient Egyptians, Greeks and Romans knew well the art of polishing rock crystals.

There is a common belief that glass making and spectacles came from China but this is not so. There are records of Confucius (B.C. 551-479) and earlier Chinese writers containing various stories to which claims are attached. It is more probable that glass making and spectacles were introduced into China via India by trading Israelites coming from highly advanced nations settled along the Mediterranean.

Pliny, the historian (A.D. 23-79) credits the discovery of glass making to the Phoenicians who rested their cooking pots on blocks

of natron (subcarbonate of soda). The heat of their fire fused this alkali with the sand of the shore to produce glass.

Amongst the earliest existing examples of glass is a small lion's head of opaque blue glass of very fine colour. The example is in the British Museum and is of Egyptian origin dating to about 2500 B.C. Records of Assyrians in the Near East about that time give a detailed process for making glass and also the actual materials used.

The glass of these early periods was used for decorative purposes or objects of art—remains of window panes were found in the ruins of Pompeii as were also some convex lenses with very short focal lengths.

It has long been established that primitive tribes devised light protective goggles before contact with civilisation. The Eskimos have long used wooden goggles hollowed out to fit over the eyes, and held in place with string or a leather thong tied round the head. Small horizontal slits served to admit the minimum of light while the back of the wood was blackened with smoke, black paint or graphite.

For centuries, masks were devised for treating squints, forcing the faulty eye to assume a normal position in looking through a small aperture. Coloured glasses were made in the latter half of the 16th century, chiefly green, blue or smoked glasses, or amber lenses, etc.

The invention of printing in 1440 established spectacle making as an industry, as many persons now found it necessary to correct their visual errors.

The similarity of spectacle frames about this time indicates a common source of origin. In 1465 the Spectacle Makers' Guild took part in a review before the French King.

The earliest known lenses were for the correction of presbyopia, but they were first used as a hand glass. It was only later that methods were devised to support the lenses before the eyes.

It is interesting to note that men of dignity and learning were always portrayed wearing spectacles. Amongst the Chinese, frames, even without lenses, were a badge of superior social status and learning. Also the tortoise was a sacred reptile to the Chinese and, therefore, tortoise-shell rims were thought to be conducive to good fortune and long life.

The next lenses developed were for the correction of hypermetropia. It was not until the 16th century that myopic lenses came into use. Little is known as to how the power of the lenses was designated during this period, but probably the age of the wearer was the basis of classification.

The 17th century marks the beginning of a new era in progress in the optical field. In 1623 Daza de Valdes, a notary of the Inquisi-

tion at Seville, mentioned cataract lenses. In 1608 Galileo Galilei constructed his telescope on the model of Hans Lippershey of Holland, and discovered four satellites of Jupiter, demonstrating the fact that they revolved round the planet. This gave a new impetus to the lens grinding profession. During this century Newton conducted his famous experiments on the composition of light. He was the first to decompose light by prisms and recombine it again. This definite knowledge paved the way for further experiments in optical lenses and apparatus.

About the same time as the telescope was being constructed the microscope was also coming into use. A Dutchman called Leeuwenhoek was studying his "little animals" as he called them, and in 1673 first published his observation to the newly formed Royal Society in London. It is interesting to note that England was still at war with Holland at this time, and until 1674, but the historian records that the nations had been at war without being angry. Now Leeuwenhoek has been given the title of "Father of Bacteriology and Protozoology" and he was undoubtedly the first to see and describe his "little animals," but he made no attempt to carry his findings any further. The super-excellence of his lenses which he taught himself to grind, polish and mount, together with the exceptional keenness of his eye, put him at least a century ahead of all other microscopists. Surely there must have been a want of an inquisitive genius in the following age?

The theories enunciated by Galen persisted for centuries but about the year 1500 Leonardo da Vinci, the famous Italian painter who produced the "Mona Lisa," was the first to discover that the retina, and not the lens, was the essential organ of vision. He also realised the principle of the "camera obscura" as applied to the eye.

During the 16th and 17th centuries the facts of physiological optics began to be slowly accepted and one Robert Hooké first measured the minimum visual angle (the basis of our present day test types).

Clinical progress had, however, not made much headway and it was not till the beginning of the 19th century that Brisseau convinced the Academie Royal des Sciences that cataract was really an opaque lens.

It is said that Susruta of India in 3000 B.C. had described the true pathology of cataract, stating it was due to derangement of intra-ocular fluids. It is also said that this surgeon practised anti-septic surgery—fumigating his room prior to operation and insisting that hands, nails, hair and beard were kept clean.

In 1748 Daviel (France) first published his planned operation of extracting the opaque lens from the eye through the anterior chamber. It took about 100 years for this operation to be accepted as

far superior to the old operation of couching with all its resulting complications.

Daviel's principle of extracting the opaque lens from its capsule is still employed up to the present time but, of course, the technique has been much improved. To-day the intra-capsular extraction of the lens (*i.e.*, removing the lens complete with capsule) is rapidly gaining ground. It was invented by De la Faye in 1753 but it was only after 1890 when Herbert of Bombay, and Mulroney and Smith in the Punjab (all members of the Indian Medical Service) published their results that it began to be accepted.

With the intra-capsular extraction of the lens good results are brilliant but the operation is more difficult to perform and, if accidents do occur the resulting consequences are more serious.

The last great ophthalmologist to the pre-scientific era was William Mackenzie of Glasgow whose text-book on ophthalmology was the book of the day, translations being used both in Germany and France. He is credited with the earliest recognition of the fact that increased intra-ocular pressure was the essential factor in glaucoma. But the fact was noted by Richard Banister in the 17th century.

I now come to the three factors which so greatly contributed to revolutionising medicine in general, and surgery in particular.

1. Bacteriology by Pasteur. Leeuwenhoek observed yeast cells but did not appreciate that these structures were living organisms—Pasteur confirmed that putrefaction and fermentation have their origin in germs.

2. Anti-septic surgery introduced by Lister in 1869.

3. Anaesthesia. The ancients tried vinegar, mandragora and other plants, as well as ice and snow, to try to render surgery painless. In 1846 ether was first used as a general anaesthetic by Long in America, and shortly afterwards Simpson of Edinburgh introduced chloroform.

Cocaine was first used in ophthalmology in 1884 by Carl Koeller of Vienna but it had been used some years previously for nose and throat work.

Today it is difficult for us to imagine what surgery was like prior to these days. Now operations could be performed painlessly and, especially with delicate operations as on the eye, without the patient moving at the critical moment. Also, the first battle had been won against that dreadful enemy of the surgeon—sepsis.

In spite of these three major discoveries the ophthalmic surgeon had still one great nightmare (which is present even to this day), *i.e.*, sympathetic ophthalmia—an inflammatory reaction in an injured eye spreading to the non-injured eye, with resulting

loss of vision. In 1818 Wardrop noted the fact that veterinary surgeons destroy the injured eye of a horse, with lime or with a nail, so that the good eye may be saved. To-day we can prevent sympathetic ophthalmia occurring but we are unable to cure it when once it is established.

The application of the principle of the magnet in removing metallic foreign bodies from injured eyes has preserved sight in an untold number of cases. In 1842 Nicholas Meyer first removed a foreign body from inside an eye by applying a magnet to the scleral wound. Later Dickson of London and McKeown of Belfast further improved upon his technique. In 1875 Hirschberg invented the powerful electromagnet which is used to-day.

The outstanding invention of the ophthalmoscope by Herman von Helmholtz was destined to make ophthalmology the most exact of all clinical sciences. In 1851 he published his paper describing the apparatus which enabled him to do what for centuries had baffled his predecessors—view the inside of the living eye. Apparently Charles Babbage in England had done the same thing a few years previously but unfortunately had failed to publish the fact.

The great ophthalmologist of this day was Albrecht Von Graefe of Berlin (1828-1870). In this age of "clinical intuition" he took full advantage of this new ophthalmoscope by examining the interior of the eye and describing the normal and pathological pictures which were revealed to him thereby. Von Graefe laid the foundation of a scientific and practical clinical ophthalmology. It is, however, with glaucoma that his name is most frequently associated.

The term glaucoma goes back to Hippocratic time and was generally accepted to mean a greenish or bluish appearance of the eye. It was then supposed to be an affection of the lens as opposed to cataract which was a perverted humour in front of the lens. The term was probably applied loosely to all forms of blindness, other than cataract, in which the pupil changed colour.

The essential feature of glaucoma—a rise in the intra-ocular pressure—was only generally appreciated about 1840, but Von Graefe was the first man to measure clinically the ocular tension, to describe the cupping of the optic disc and the pathological changes in the visual fields.

Von Graefe noted that corneal staphyloma regressed when an iridectomy was performed, and in 1857 he described his classical operation of a broad iridectomy to relieve the congestion in cases of acute glaucoma. His pathological conceptions may not have been quite correct but his operation was to be the means of preserving much vision and the saving of untold suffering.

Since his day various operations have been devised to establish

extra-ocular drainage in order to relieve increased intra-ocular pressure, notably Lagrange's sclerectomy, Elliot's trephine and Holth's iridencleisis.

The drugs which are used to-day in the conservative treatment of glaucoma—those producing an artificial contraction of the pupil—were not discovered until 1862. In this year the miotic effect of calabar bean was noted—later eserine (1864) and pilocarpine (1874).

The fact that extracts of hyoscyamus and belladonna produce artificial dilation of the pupil had been known for centuries but it was only in 1831 that Mein isolated atropine alkaloid—(homatropine 1879).

Von Graefe is given the credit of establishing the proper clinical use of these two groups of drugs.

In this wonderful scientific age many countries produced men equal to the occasion. Sir William Bowman (Britain) was not only a distinguished ophthalmologist and scientist but he has been described as the greatest of all anatomists. De Schweinitz (U.S.A.), Fuchs (Vienna), De Wecker (France), and Donders in Holland, are names that will certainly remain in history, as will also Credé for his method of preventing ophthalmia neonatorum, and Hutchinson for his classical description of inherited syphilis.

The twentieth century opens with advantage being taken of the improvement in the microscope, which afforded greater accuracy in histological studies. In 1904 Sir John Parsons gave the world a complete monograph on "The Pathology of the Eye." The year 1911 marked the climax of 150 years' struggle to find a satisfactory clinical method of illumination of the anterior part of the living eye—Alvar Gullstrand of Uppsala, Sweden, had produced his "Slit-lamp microscope" so that one could now view the anterior structures of the eye with a high binocular magnification.

The greatest triumph of this century in ophthalmology has been a method of treating retinal detachment. Gonin, of Lausanne, published his method of closing the retinal rents and searing the loose membrane back into position by means of thermal and chemical irritants applied to punctures in the sclera. His technique has since been improved upon by Larsson, Safar and Weve, who used diathermy, and Vogt who used electrolysis.

Previous to Gonin's time all these eyes went completely blind while to-day in over 50 per cent. of cases the sight is preserved.

For over 100 years attempts had been made to regain the transparency of an opaque cornea by means of grafting. In 1922 Tudor Thomas, of Cardiff, after a long series of experiments, succeeded, the secret of his success being that he applied grafts from animals of the same species.

The intellectual supremacy of man is a result of appreciating and interpreting complex visual patterns. In many modern achieve-

ments it is frequently some optical device that contributes to the final result—without optical instruments, clinical and scientific laboratories, motion picture studios and observatories, etc., would be almost helpless.

Prior to the 18th century the use of glasses was unnecessary to the majority of individuals as the ability to read or write was the possession of the learned few, and the costliness of the glasses made them prohibitive to the average individual.

Astigmatism was demonstrated by Young in 1801, and in 1827 Airy designed suitable cylindrical lenses.

A trial case of lenses was arranged in 1843 while test types were devised by Jaeger in 1854.

For a long period the art of fine optical glass making was shrouded in secrecy and passed along from father to son.

The main constituent of optical glass is sand or silica. Sand makes up 12 per cent. of the earth's crust yet only a few known deposits will furnish a quality suitable for optical glass. In general this glass contains about 70 per cent. sand, 11-13 per cent. calcium oxide of lime, 14-16 per cent. sodium oxide or soda with a small percentage of potassium, borax, antimony and arsenic to aid in improving quality. The raw materials are united by fusion or melting at relatively high temperatures in special crucibles made of burnt clay. In order to obtain the high standard of optical glass to which we are accustomed to-day an accurate control over the entire manufacturing process must be maintained.

It is over 50 years since the first attempt was made to make a contact lens, *i.e.*, a lens which fits between the lids in actual contact with the eyeball. The idea is to abolish a faulty corneal refracting surface by substituting an accurate one. In certain cases with high or difficult refractive errors the visual improvement to the patient is tremendous. The great difficulty, however, is for the patient to tolerate a glass in contact with the eye for any length of time but by the modern method of obtaining an accurately fitting glass this tolerance time factor is being extended.

The last decade has seen our pharmacopea re-written by the introduction of the sulphonamides and penicillin. The former made possible a great advance in the treatment of trachoma, and in the cure of ophthalmia neonatorum. Penicillin has demonstrated its wonderful power in external eye infections, and ocular wounds, but up to date has been disappointing in deep intra-ocular infections. It is too early, however, to arrive at definite conclusions.

To-day the members of the Staff of this Hospital are helping to plan a new Health Service for the nation in general and for our own Medical School in particular.

Our prayer is that we may be enabled to "think clearly" as it is only by clear thinking that real progress can be achieved.

The practice of medicine has now become so complex it is essential that all branches combine to pool their knowledge in order to obtain the best results.

With this end in view it has been decided that there should be established in Belfast a large out-patient or diagnostic block attached to the main hospital which will be common to all units. Here a free interchange of knowledge between various departments will be readily available.

When it comes to rendering special in-patient treatment and further research each unit will have its own pavilion or hospital within the colony where this work can be carried out.

This should ensure more adequate material and better facilities for the teaching of, not only undergraduates, but also post-graduates.

But when our new organisation is completed will we be in Utopia? That depends as always on us as individuals.

In the highly scientific age of the last century perhaps the machine has had more attention than the man—perhaps disease has had more attention than the patient. Let us remember that the microscope does not observe nor do our books think.

The reputation of a medical school will depend not so much on its hospital and laboratories as upon the character and ability of both its students and teachers.

REFERENCES

1. SHASTID, T. H.—History of ophthalmology. American Encyclopaedia of ophthalmology.
2. SORSEBY.—Short history of ophthalmology.
3. DOBELL.—Anthony Vonleeuwenthoek and his little animals.
4. CHANCE.—Ophthalmology.
5. JAMES, R. R.—The history of ophthalmology in England prior to the year 1800.
6. MANN, I.—The history of contact lenses. *Trans. Ophthal. Soc. U.K.*, Vol. VLIII (pt. 1).
7. DUKE-ELDER.—Text-book of Ophthalmology.
8. RAUKSIN.—History of Chinese spectacles. *Chinese Med. J.*
9. BLEW, C. L.—Military surgeon (1941).
10. TREACHER COLLINS.—History and traditions of the Moorfields Eye Hospital.
11. RAMSAY, A. MAITLAND.—Wm. Mackenzie.
12. DALRYMPLE-CHAMPNEYS (SIR WELDON).—An examination of doctors in the State from ancient times to the present day, etc. *Proc. Roy. Soc. Med.*
13. BLEW, C. L.—Origin and history of ophthalmic lenses and spectacles. *Eye, Ear, Nose and Throat*. Mon. 1943.
14. BERLINER, M. L.—Biomicroscopy.
15. TREVELYAN, C. M.—English social history.
16. CRAVEN, E. S.—Lenses and prisms; methods of manufacturing. American Encyclopaedia, Vol. X, p. 7219, 1917.
17. HILL, E.—Eyeglasses and spectacles, history of. *Ibid.*, Vol. VII, p. 4894, 1915.