THE LARYNGOSCOPE.

VOL. XVI. ST. LOUIS, MO., FEBRUARY, 1906. No. 2.

ORIGINAL COMMUNICATIONS.

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THE OTO-PROJECTOSCOPE.*

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Some five years ago, it occurred to me that if the principle of the simple otoscope could be so elaborated and mechanically perfected as to project the picture of the membrana tympani and the fundus of the external auditory canal, on the screen, as effectively as the simple otoscope presents such a picture to the retina of the eye, it would be of inestimable practical value for clinical demonstrations, and for permanently recording and describing the morphology of this field in otology.

In proceeding with my investigations along these lines, the first serious obstacle met with was the question of the source and intensity of light. In this connection, it may be of interest to briefly record the development of the otoscope. The main principle in the construction of every form of otoscope is a light-reflecting surface placed at an angle to throw gathered rays of light parallel to the axis of the auditory canal, and cause these rays to be reflected through a central aperture in the mirror to the eye of the observer at the proximal end of the otoscopic tube.

In the simple Brunton otoscope, the light is gathered in a metal cone at a right angle to such a tube and placed directly over a flat mirror, the reflecting surface of which is toward the ear and fixed at an angle of 45 degrees. The source of light in such a simple apparatus is daylight or, at best, a bright beam of sunlight.

* Read before the Tenth Annual Meeting of the American Academy of Ophthalmology and Oto-Laryngology, held at Buffalo, September 14, 15 and 16, 1905.

Another development in the construction of the otoscope was presented by Weber-Liel in combining the principle of the Brunton otoscope with that of the microscope. In this the simple lens at the proximal end of the otoscopic tube was replaced by a microscopic eye-piece of proper focal distance, so that a decidedly magnified image of the membrana tympani and the fundus of the ear could be obtained.

A new feature was offered by Myles, who inserted a small low-candlepower electric lamp and reflector in place of the open, funnel-shaped, light-collecting section of the otoscopic tube.

In my first experiments to develop a projected image, I soon realized that neither focussed sunlight nor any form of incandescent electric bulb offered sufficient light to reflect a bright image on the screen. I was therefore convinced early in this research that a more

Fig. 1. Brunton's Otoscope.

intense and bulky light resource was required and consequently portability could not be included as one of the features of such an apparatus.

The problem to be developed, then, was that of combining the otoscope with some form of projection apparatus in which the arc lamp with its high candle-power and concentrated form of light could be used. A 2,000-candle-power right-angle, hand-feed arc-lamp was finally selected as the most satisfactory source of light of sufficient intensity available for this work, and it was also found to be the only light capable of being properly focussed and concentrated into a beam small enough to pass through the central aperture of the reflecting mirror to the fundus of the auditory canal.

The elimination of the intense heat generated by concentrating so powerful a beam of light into the auditory canal, one which was unbearable to the ear of the patient, confronted us. This was overcome by interposing an alum tank of sufficient capacity between the lenses of the projection apparatus and the otoscope. By means of this accessory, the powerful beam of light which reaches the ear can now be projected for a prolonged sitting without any discomfort whatever to the patient.

Perhaps the most difficult optical feature to be considered was the establishment of the proper adjustment and focal distances of the lenses used in obtaining our projected image. The first of the series of lenses are those of the projection apparatus, and consist of a combined plano-convex system of five-inch diameter lenses, (c)

Fig. 2. Myles' Electric Otoscope.

placed between the arc-lamp and the alum tank (g). This lens system (c) is located in the large end or base (B) of the elongated cone (h) of the otoscope. By means of these lenses the light of the arc-lamp is concentrated and parallelized on the polished plate-glass mirror (j) and projected through the tube (i) and the adjustable ear speculum (k) to the fundus of the canal and tympanum. The central aperture in the mirror (j) admits of passage of the reflected rays from the tympanum to the projection lenses (l), and from this point the image (x) is thrown on the screen (D). The lenses (l) are of the photographic projection system of from four to six inches focus, and admit of a considerable adjustment of the image by means of rack and pinion (m). The ear specula (k),

are of different sizes, each of which may be readily substituted and fixed into position in the cylinder (i). The right-angled piece of the otoscope (C) containing mirror and projection lenses can be swung to either right or left side of the apparatus and securely fixed by milled screws (n). All of the metal parts of the otoscope are made of spun brass of 1-16 inch thickness, the interior of all tubular parts are carefully blackened, and each section of the apparatus can be taken apart for cleaning and readjustment.

The projection cabinet (A) is made of carefully seasoned quarter-sawed oak, and the entire interior of this cabinet is thoroughly lined with sheet asbestos. The arc-lamp is secured to an adjustable and movable platform so that it may be focused the full range of the length of the projection cabinet. The dimensions of this cabinet are 18 inches long, 10 inches wide, and 14 inches high. Thorough ventilation and outlet for the heat generated by the electric lamp is secured by the circular openings (b) around the base of the cabinet, and by the asbestos chimney (e). The cover of the cabinet (d) is of asbestos board. A small door (f) is hinged in one side of the cabinet, fitted with a ruby-glass window to observe the proper adjustment of the carbons of the arc-lamp.

In the accompanying illustrations, the relative positions of the projection cabinet (A), the otoscope attachments (B and C), the screen (D), and the patient (E), will be seen.

To add to the practical value of this apparatus, an epidiascope of simplified form (F) has been constructed, which may be readily attached to the projection apparatus (A) by removing the otoscopic attachment (B and C). With this accessory and an additional series of projection lenses (o), any picture or object in black-and-white or in colors, instruments, pathological specimens, bone specimens, or in fact any object required for demonstrations, may be thrown on the screen in original color and contour. The results obtained by this simple form of epidiascope are equally as effective and the projections of as equally good a definition as those obtainable by even the most expensive and complicated form of projection apparatus. Objects to the size of a median section of the human head may be thus projected. In a recent demonstration I was enabled to show the technique of passing the Eustachian catheter on such a head-section to my entire class of over one hundred students.

A word or two as to the practical value of this apparatus. Those of us who are teachers in otology realize how difficult it is to demonstrate the fundus of the auditory canal, the membrana tympani,

Fig. 3. Projection Cabinet A with Oroscope B—C.
 b, Perforated base for ventilation. c, Lens system in B. d, Asbestos cover. e, Asbestos chimney. f, Door with ruby glass window.
 g, Alum tank in B. h, Cone, connecting B and C.

or the tympanic cavity in their pathological variations. These areas are visible to only one observer at a time by the usual methods of examination by aid of speculum and reflected light. Even when the attention of a group of students is called to pathological points and lesions in these localities and they examine the patient, one after the other, the teacher is unable to determine whether the features which he is endeavoring to point out have been appreciated by the student observers.

Fig. 4. Author's Ootoscope.

c, Lens System. g, Alum tank. h, Cone. i, Speculum cylinder. j, Reflecting mirror. k, Ear speculum. l, Projection lens system. m, Focusing screw. n, Screw to fix speculum.

The oto-projectoscope overcomes this difficulty by throwing a picture of the fundus of the canal, the membrana tympani, or the cavum tympanum on the screen, where its details may be elaborated by the demonstrator and the entire group of students may see the image simultaneously. The picture is unusually bright and shows every line of the illuminated areas distinctly. The small radiating blood-vessels, the natural lustre of the membrana tympani, the triangular light-spot, pus, perforations in the membrana tympani, pulsation of fluid within the tympanic cavity, granulations, polypi, and other equally important pathological features have been clearly demonstrated with this apparatus.

Fig. 5. Oto-Projectoscope Complete.

A. Projection cabinet and are light. B. Metal cylinder and cone containing lens system and alum tank. C. Otoscopic attachment with projection lenses and ear speculum. D. Flat, white card-board screen, mounted on movable and adjustable iron stand.

E. Position of patient, with otoscope adjusted in auditory canal.

The image thrown on the small, adjustable white paste-board screen is about four c. m. in diameter at its most brilliant focal point, about three feet from the projection lens.

Not only is the Oto-projectoscope available for demonstrations in otology, but the nasal and pharyngeal cavities may also be included in this consideration. It is simply necessary to substitute a nasal speculum or mouth piece for the ear speculum in the tube (i) and change the adjustment of the projection lenses (1) in order to obtain most satisfactory views of the nares and pharyngeal cavities.

Until now, no successful photographic reproductions of clinical pictures of these areas have been obtained. I have already succeeded in photographing the pictures thrown on the screen and am per-

Fig. 6. Epidiascope.

F, Epidiascope cabinet. A, Projection cabinet. o, Epidiascope projection lenses.

fecting and elaborating this feature in a forthcoming paper. I hope to be able to prove that this will be an invaluable means of securing permanent records in photographic form of the pathology of the middle ear and membrana tympani.

In the past year there has been considerable agitation along the lines of photo-therapy. Some of our French colleagues have recently reported the satisfactory treatment of tinnitus aurium by means of light-therapy. If there is a future for this form of therapeutics in the treatment of ear diseases or symptoms, it may be most effectively accomplished by the oto-projectoscope, because there is no other source of light so intense as that generated in this apparatus, and no

other appliance by means of which so intense a light, properly cooled, can be made to penetrate the tympanic cavity.

Trans-illumination has been the subject of much investigation and discussion as an aid to diagnosis of the anomalies and pathology of the accessory sinuses, and there have been many electric devices suggested to aid us in these observations. I have constructed a small mouth tube which may be substituted for the ear speculum, and by means of which the most intense and satisfactory trans-illumination of the sinuses may be obtained. It is especially to be emphasized that the light from the Oto-projectoscope is cool, and offers this additional advantage over any other form of electric light used for trans-illumination.

The simple epidiascope attachment adds another resource to the teacher in otology. By its means, all specimens, normal and pathological, large and small, osteological and soft parts, drawings, charts, text book illustrations, and every other available objective and tangible resource of the teacher can be utilized for class instruction. It is a pleasure to see how sharply defined the outlines of an osteological preparation of the temporal bone with its ossicles, semi-circular canals, and cochlea can be projected on the screen and viewed by an entire class at a distance of twenty feet.

In conclusion, I wish to express my deep obligation to Rev. Henry J. De Laak, S. J., professor of physics at St. Louis University, for his most valuable co-operation in conducting the numerous trials and experiments necessary to perfect this apparatus. I am especially indebted to him for the epidiascope idea in its simplified form and for the privileges accorded me in his laboratory for developing this apparatus.

My thanks are also due to Mr. William A. Phillips, electrician, Ozark Bldg., St. Louis, for mechanically perfecting and constructing this apparatus.

Mr. Phillips is authorized to construct duplicates of the Oto-projectoscope model described in this paper.

In a future paper I expect to produce more data and practical evidence of the possibilities of the Oto-projectoscope.

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