CLINCAL NOTE

A NEW MONOCULAR EAR MICROSCOPE

By L. BLACKMORE and C. S. HALLPIKE (London)*

MAGNIFYING devices for the examination of the tympanum have been a common feature of the otologist's armamentarium for many years.

They range from the simple convex lens of the Siegle speculum to Lüscher's Ear Microscope (Lüscher, 1927). The latter has, perhaps the best claim to be regarded as a precision instrument. It provides a high magnification, $\times 10$ and $\times 20$, which makes it possible to observe various very minute features of the tympanum. In other ways, however, this high magnification is a disadvantage. The field of view is small, adequate fixation of the head is difficult to attain, and operative procedures are impossible. An instrument of greater general utility is the aural magnifier described by Eckert-Möbius (1924) and constructed by Zeiss. This is illustrated in Figs. 1 and 2. It is of robust construction and light

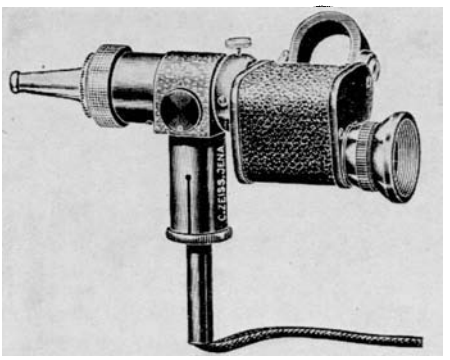


FIG. 1.

enough to hold in the hand. It, too, has certain disadvantages. The magnification is rather high ($\times 9$—$\times 21$), the field is restricted to a part only of the tympanic membrane and the illumination is uneven. Furthermore, the illuminating light beam makes use, as shown, of a considerable proportion of the object glass of the viewing system and the resultant light-scatter impairs the quality of the image. Again no facilities are provided for operative procedures. In the design of the instrument now to be described, it has been our aim to eliminate these and other defects. Our principal objectives are specified as follows:

(1) That the standards of optical definition and evenness of illumination should be very high.

(2) That the field of view should include the entire tympanic membrane.

(3) That the depth of field should be such as to include the entire tympanic

* Published by permission of the Admiralty and the Medical Research Council.

https://doi.org/10.1017/S0022215100048386 Published online by Cambridge University Press

membrane from the anterior deep part to the posterior superficial part of its periphery.

(4) That ample space should be left between the base of the aural speculum and the optical system to permit the introduction of instruments for intra-tympanic manipulations.

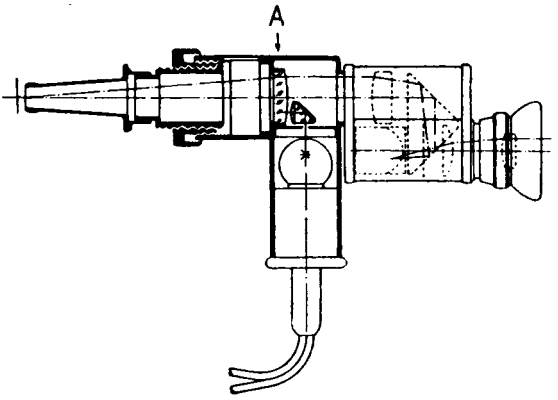


FIG. 2.

(5) That the magnification should be the maximum that can be usefully employed for such manipulations, and is also optically compatible with the conditions of field of view and depth of field indicated above under (2) and (3). In practice this magnification is found to have a value of approximately $\times 6$.

(6) That the instrument should be robust yet sufficiently small, light and well balanced to be held easily in one hand.

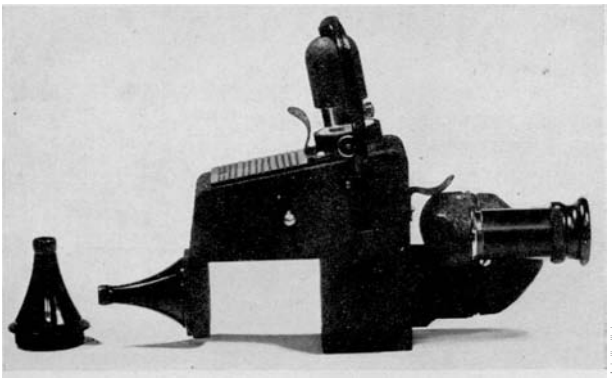


FIG. 3.

A complete working model was designed, constructed and tested in use. Thereafter, the final prototype of the production model was made by Keeler Optical Products Ltd., who have incorporated certain valuable features, particularly an astigmatic concave mirror and specially mounted pre-centred lamps. The instrument in its manufactured form is shown in Fig. 3. Its weight is 14 oz. and its overall length, including the speculum, $7\frac{1}{2}$ in. (19 cm.).

https://doi.org/10.1017/S0022215100048386 Published online by Cambridge University Press

In Fig. 4 the instrument is shown in use, while the optical system is given in Fig. 5.

Illumination System.—This is of conventional type and incorporates several novel features which have proved of decisive importance in solving certain difficult optical problems which arise:

1. High intensity of illumination.
2. Evenness of illumination with absence of glare and stray light.
3. High quality definition.

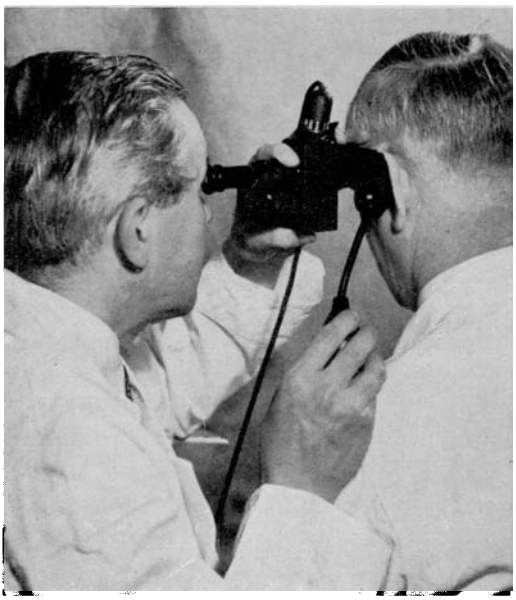


FIG. 4.

The system consists of a high wattage lamp (1) and a field condenser (2) of focal length $\frac{3}{4}$ in. (19 mm.), with associated iris diaphragm (3) as indicated in Fig. 5.

The Lamp.—This presents a number of special features. It is of single pole type. Rating: 11 volts 12 watts, miniature bayonet cap, made by Siemens, pattern No. 5L/235. The filament is coiled and forms the periphery of a half-circle of radius approximately $1\frac{1}{2}$ mm. The spherical globe, some 18 mm. in diameter, is silvered over its posterior half. This produces an image of the filament in the plane of the real filament which completes the circle of the effective light source. This is shown at (5) in Fig. 5. There is thus obtained an annular radiant with considerable conservation of light. An image of this radiant, magnified $\times 4$, is focused by means of the field condenser by way of the plain mirror (4) upon the perforated concave mirror (6). The image of the radiant is disposed, as shown, around the central perforation. This concave mirror deflects the light beam along the viewing optical axis, through the speculum and on to the membrane. The mirror also forms a well-defined image of the light filled aperture of

https://doi.org/10.1017/S0022215100048386 Published online by Cambridge University Press

the iris diaphragm in the plane of the tympanic membrane, thus ensuring an evenly illuminated field. The diameter of the light beam is controlled by the iris diaphragm to fall within the aperture of the speculum, and in this way the ill-effect on definition of light scatter from the walls of the speculum is avoided. The position of the concave mirror along the illuminating optical axis is arranged to provide ample space in front of it for the introduction of instruments through the speculum.

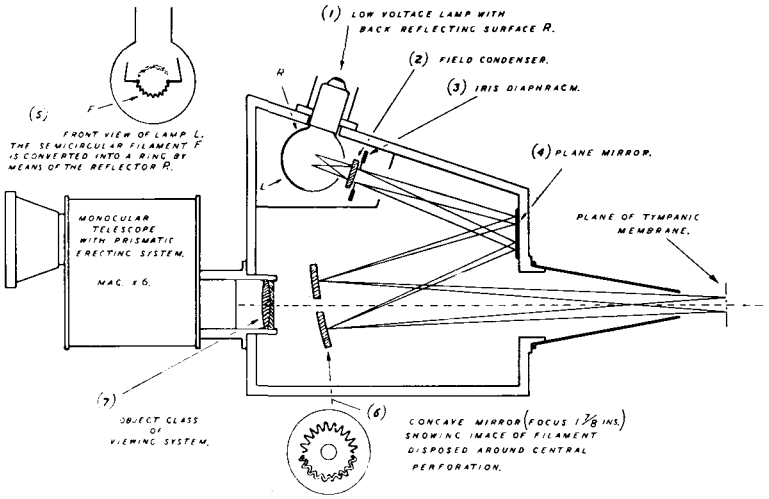


FIG. 5.

The Viewing System.—Here the chief requirements are depth of field and good definition. Depth of field is needed for two reasons; firstly, to include all parts of the obliquely set tympanic membrane and secondly, to render the focusing of the system insensitive to small movements of either the patient or the instrument as held in the examiner's hand. The image of the membrane is erected by means of a Porro prismatic erecting system, and viewed with a focusing eye-piece giving a magnification of approximately 6x. The optical quality of the image is very high; this depends upon (1) the good optical qualities of the viewing system and (2) the avoidance of glare and light scatter. This is achieved, as described, in two ways. Firstly, by the avoidance of light reflections from the sides of the speculum by means of the iris diaphragm; secondly, by the use of an annular radiant, the image of which is focused around without impinging upon the central viewing aperture of the concave mirror (6). The necessary depth of field is obtained by stopping down the objective glass and Brücke lens of the viewing system (7), each of approximately 5 in. focal length, to $\frac{3}{16}$ in. by means of the central perforation of the concave mirror (6), giving an F. number of approximately 26. The smallness of this aperture also has the additional advantage of minimizing flare and allowing a reasonable tolerance on the size of the lamp filament. The considerable depth of field and other advantages which thereby result are, however, obtained at the cost of a light loss which needs to be compensated by the high efficiency of the illuminating system already described.

https://doi.org/10.1017/S0022215100048386 Published online by Cambridge University Press

The Specula.—The shape of the specula is shown in Fig. 3. The lumen is of circular cross section with a wide aperture base. A range of sizes is provided having the following internal diameters at the narrow extremity:

2·5, 3·5, 4·5, 5·5 and 8·0 mm.

Internal diameter at the base is 23 mm.

At their extremities the specula carry a small external annulus which increases comfort and facilitates the sealing of the meatus when carrying out tests of mobility of the membrane. For this purpose a glass window, mounted in an air-tight stopper, is used to occlude the base of the speculum, and movements of the membrane are then induced by means of a small rubber bulb, as with the familiar Siegle's speculum.

In use the instrument has proved of considerable value. It is robust and easy to handle for the examiner and comfortable for the subject. With it, very minute observations can be made. Small fluid collections can be detected and aspirated, while the reflex contractions of the tympanic muscles, invisible with a Siegle speculum, are readily discerned.

Acknowledgments

For the construction of the working model of the instrument we are indebted to the staff of the Otological Research Unit, Medical Research Council, National Hospital, Queen Square, London, W.C.1. It is also desired to acknowledge the help given by the Superintendent and Staffs of the Admiralty Gunnery Establishment and the Admiralty Research Laboratory during the early stages of the development of this equipment.

REFERENCES

LÜSCHER, E. (1927) *Z. Hals-Nas.-u. Ohrenheilk.* **17**, 403.

ECKERT-MÖBIUS, A. (1924) *Verh. Ges. dtsch Hals- Nas.- u. Ohrenärze,* Breslau, Sitzungsberichte, 109.

https://doi.org/10.1017/S0022215100048386 Published online by Cambridge University Press