

## A new indirect ophthalmoscope prototype

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**SUMMARY** We have constructed a new indirect ophthalmoscope. This instrument has a T-shaped housing composed of an illuminating tube and a viewing tube. A fiberoptic light source provides illumination. The inverted aerial image of the fundus coincides with the plane of the viewing window of the housing. This unit can be easily connected to a television camera for television ophthalmoscopy or to an image intensifier for infrared ophthalmoscopy.

Conventional indirect ophthalmoscopes<sup>1-6</sup> comprise a head band, which carries a light-projection system, and viewing optics, usually a binocular eyepiece. The projection system forms a beam of light that is directed into the patient's eye through a hand-held condensing lens. The reflected light from the retina passes through the same condensing lens and forms an inverted aerial image seen by the observer in the viewing optics. Such instruments are widely used but have a number of disadvantages. The light projector and viewing optics are at times heavy. The head band is often awkward and uncomfortable. It takes a substantial amount of practice to learn to use such an instrument effectively. Careful co-ordination is needed to position correctly the hand-held lens and the observer's eyes. Because of the difficulty in eliminating stray light, inconvenient corneal reflexes may be produced.

We have constructed a new indirect ophthalmoscope. This instrument eliminates a number of previous shortcomings and can be easily adapted to other systems such as a television camera or an infrared image intensifier for infrared ophthalmoscopy.

### Design of instrument

The instrument has a T-shaped housing composed of a cylindrical tube (viewing tube) mounted to the wider end of a tapered tube (light source tube) (Figs. 1 and 2). The latter has at its narrow end a fiberoptic light guide that illuminates a planoconvex lens to form a parallel beam of light. A beam splitter is positioned in the light beam to reflect the incident light partly into a planoconvex lens of the viewing tube. This lens forms an image of the fiberoptic light source at the iris-pupillary plane of the patient's eye. The same lens

also forms an aerial image of the fundus in a plane at the opposite end of the viewing tube, close to the observer's eye. Thus the light projection system and the converging lens are combined in a single hand-held unit (Fig. 2). The viewing line of observer and the axis of the light beam are made substantially coincident by means of a beam splitter. The aerial image formed by the converging lens is viewed directly or through auxiliary optics such as a binocular eyepiece.

Because the aerial image falls at the viewing aperture of the instrument, it is possible to place graticules and other optical elements in or near the image plane for measuring or mapping features of the retina. A filter wheel is mounted at the entrance of the light source tube so that different filters and graticules can be moved into the path of the light. The light guide is longitudinally adjustable for focusing. If the lens is high powered and has a small aperture, light could be scattered from the lens mount or retaining ring, which would cause a halo around the observed image. To eliminate this the instrument has an adjustable aperture, so that the illuminating beam can be stepped down just to fill the lens.

On the output side of the light source tube is a polariser; another polariser is mounted in the viewing window at the end of the viewing tube close to the image plane. The polarisers are to eliminate unwanted reflections.

The instrument is held by the examiner, who uses the light source tube as a handle. When the light beam is focused at the pupillary plane of the patient's eye, an aerial image is formed at the image plane. This image can be viewed directly or by way of further optics, for example, a binocular optical system for stereoscopic viewing mounted on a spectacle frame. The position of the light source is adjustable towards

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and away from the lens, so that the effective focal length of the illumination system can be continuously varied, whereas the focal length for viewing remains unchanged. The instrument is normally set for viewing an eye with a 'standard' iris-retina distance. To view an object closer to the front of the eye, the viewing lens must be moved away from the eye. This would increase the diameter of the light beam at the iris, reducing the illumination within the eye and causing reflexes. By an adjustment of the light source towards the lens, the narrowest part of the beam can be moved to coincide with the pupil. Such focusing adjustment is also desirable to compensate for changes in the focal length of the lens when the instrument is used in different regions of the spectrum, for example, by means of filters in the filter wheel.

The dual-function lens is a plastic aspheric lens, but the optical layout enables a wide variety of lenses to be used. Because it is illuminated by parallel light, substitution of a lens of different power does not require any other changes in the focus close to the plane of the pupil and will illuminate a larger or smaller area of the fundus as the power of the lens is increased or decreased.

To enable several observers to view the image, a biprism (or the like) can be clipped or hinged to the instrument at the viewing window.

**Discussion**

This instrument is very easy to use. When the light beam is accurately placed in the patient's pupillary plane, the optical system will then be correctly aligned to produce the desired aerial image, which is easily seen by the examiner.

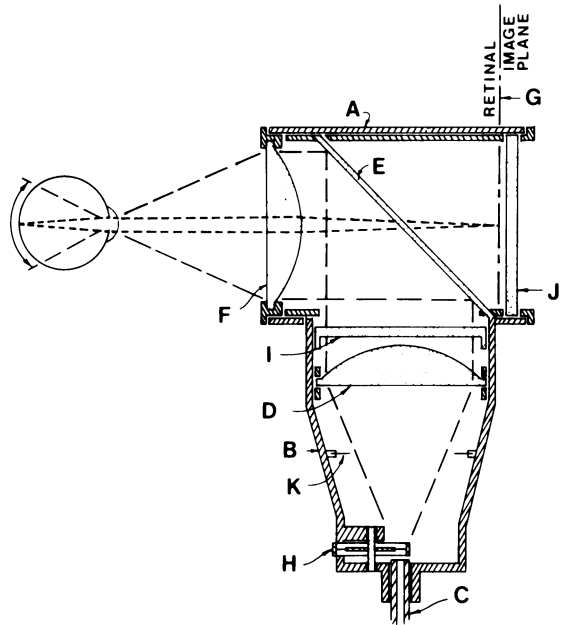
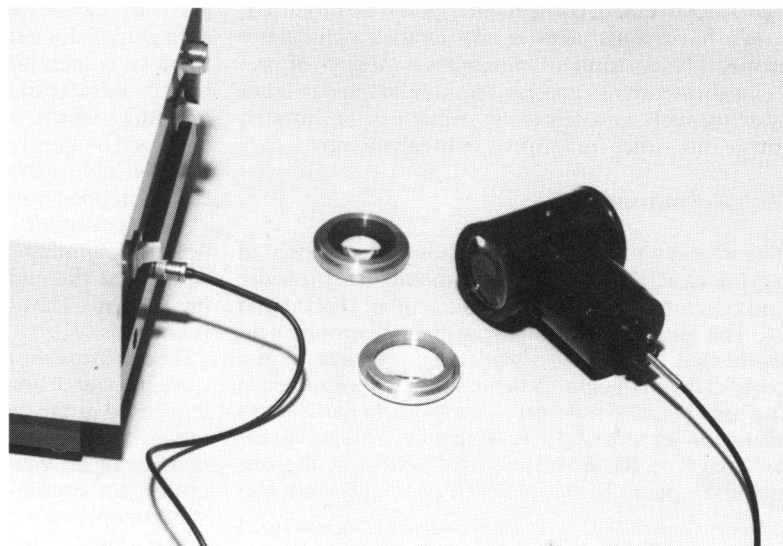


Fig. 1 Schematic diagram of the housing and the light path of the indirect ophthalmoscope. A: Viewing tube. B: Light source tube. C: Fiberoptic light guide. D: Collimating lens. E: Beam splitter. F: Dual-function condensing lens. G: Plane of aerial image of the fundus. H: Filter wheel. I and J: Light polarisers. K: Adjustable diaphragm. Arrow behind the diagrammatic eye demonstrates the field of illumination in the patient's eye.

Fig. 2 The indirect ophthalmoscope (right) is connected to a light source (left) with the fiberoptic guide. The lenses (middle) are 14 and 30D lenses that can be screwed to the ophthalmoscope as needed.



One of the advantages of the instrument is that it is not necessary for the user to wear the usual heavy light projector and viewing system on the head band, so that other components can be worn, for example, an image converter for viewing an image produced by infrared light. In another possible arrangement an image converter may be placed at the viewing window.

Fiberoptic light source is an ideal light source for the present instrument. The light output falls within a well-defined cone, which fills the aperture of the collimating lens, and the resulting parallel beam can be focused to give a small image at the patient's pupil. For example, a 2 mm diameter fibre bundle produces an image 2 mm in diameter, which results in very efficient and uniformly distributed illumination of the fundus. Owing to the small size of the beam image the eye can be examined with small pupil. Because there is very little stray light in the focal plane of the fiberoptic source, the reflex from the cornea is spatially well defined and can be easily avoided by the examiner.

The fact that the image is within the instrument makes it easier for the user to locate the image and makes it accessible to viewing screens, graticules, and other optical devices for television ophthalmoscopy, the face plate of an image converter, or image intensifier. It should be noted that the image is not planar,

and such auxiliary devices may have to be shaped accordingly to match the shape of the image.

The instrument combines the ease of use of a direct ophthalmoscope with the wider field of view, better illumination, and possibility of stereoscopic vision of an indirect ophthalmoscope. The only disadvantage of the present prototype is its relatively heavy weight when compared to a condensing lens. Future modifications may make it less bulky and heavy.

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