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MODIFICATION OF THE HAAG-STREIT DESIGN SLIT-LABP BIOMICROSCOPE FOR OCULAR PHOTOGRAPHY OF THE ANTERIOR AND POSTERIOR SEGMENTS

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INTRODUCTION

The purpose of this project is to develop a method of obtaining quality photographs of ocular structures, particularly the fundus, using the slit-lamp biomicroscope and a convex field lens, similar in principle to indirect ophthalmoscopy. It is the authors' intentions to develop a system for photodocumentation which would convert a non-photographic slit-lamp biomicroscope to one with capabilities of both anterior and posterior ocular photography.

It is the opinion of the authors that ocular photography is a much needed tool in the optometric profession. Photodocumentation can provide accurate and unbiased baseline date, monitor the progression of ocular disease, facilitate interprofessional communication and provide added legal protection for the optometrist.

The authors believe that one of the drawbacks to ocular photography is the cost of photographic equipment. For this reason the authors have utilized a non-photographic slit-lamp, one which may already be existent in the average optometric office.

Also, by increasing the number of photo slit-lamps at the Pacific University Optometry clinic, it will give more interested students and faculty experience in slit-lamp photography.

HISTORICAL REVIEW

Aubert and Greenough, in 1891, developed a truly stereoscopic microscope. Czapski and Schatz modified this microscope in 1897, and this basic design is still found in many modern slit lamps.[1] In 1911, Gullstrand[2] presented his first model of the slit-lamp and the optical principles underlying its use. The Gullstrand lamp was combined with the Czapski microscope on one stand by Henker in 1916 as the first true slit-lamp biomicroscope.[1]

In 1918, Koeppe[3] was the first to attempt examination of the fundus with the slit-lamp. This was accomplished by using a plano front surface contact lens which abolished the refractive power of the eye. He attached a mirror in front of the illuminating lens in order to bring the axes of illumination and observation nearly parallel.

Valois and Lemoine[4] (1923) used a concave (-55D) lens placed in front of the eye instead of a contact lens as used by Koeppe. Zamehoff[5] was able to modify Gullstrand's slit lamp in such a way as to project a slit on to the fundus which could be viewed binocularly and stereoscopically.

Goldmann[6] (1937) made improvements in the methods of fundus examination with the use of a Haag Streit slit-lamp, a contact lens, and a Goldmann reduction prism which permitted the angle of observation and illumination to be reduced to five degrees.

Hruby[7] (1940, 1941, 1942) advanced the idea of Valois and Lemoine with his "minus glass", a -58D lens held close to but not in contact with the eye. (Figure 2)

Littman[8] (1950) introduced the Zeiss-Opton slit-lamp biomicroscope which allowed the light source to be moved across the axis of observation. This did away with the need for the Goldmann reduction prism, it was now possible to reduce the illumination-observation angle to zero.

El Bayadi[9] was the first to attempt the use of a convex 'lens (+60D) in much the same way as is done in indirect ophthalmoscopy. (Figure 2) He was able to view a real inverted image of the fundus binocularly and in stereo. This system produced a field of view equal to six disc diameters, whereas the Hruby method gave a view of only one disc diameter.

Rosen[10] (1959) used a +55D convex lens with the Zeiss slit-lamp. This required a greater working distance because of the increased focal length of the condensing lens. Again in 1963 Rosen[11] reported success with the use of a +32D volk conoid lens.

Goldmann[12] (1968) continued using his concave contact lens system and described excellent results.

Boyer[13] (1975) experimented with methods of slit-lamp fundus photography using a convex condensing lens with limited success. He described difficulty obtaining quality photographs of the fundus, primarily because of surface reflections on the condensing lens.

Cohan (1979) and Kajiura (1978) have made contributions to slit-lamp fundus photography, but copies of their reports have not been received by the authors to review.

METHODOLOGY

This thesis project is basically an equipment modification procedure so a great deal of the time was spent in designing and building the modified attachments used in the system. The work done can be divided up into four major areas. The first part of the project was to familiarize the authors with and become proficient with taking slit-lamp and fundus photographs with traditional equipment. The second stage involved organizing a filing system for the photographs and slides that were taken. The third part involved the design and construction of the adaptors used in the project. The fourth and final stage involved the actual implementation of the photography through the modified system.

The authors were fortunate to be able to develop skills in ocular photography while participating in a clinical rotation through the Veterans Administration Optometry clinic located in Vancouver, Washington, and Tacoma, Washington. The patient population afforded a wide variation in pathological conditions that needed to be photographed. The photographs were obtained using a Topcon fundus camera, a Topcon 5D photo slit-lamp, and a Kowa portable fundus camera. This experience was very valuable not only formulating the technique of ocular photography, but also to develop an understanding of the principles involved in the instrumentation that led to the various modifications used in this project.

The method of cataloging and filing of the slides was designed with the emphasis on making sure the proper name was on the slide. The authors felt it extremely important that the correct name was put on the slide for the patient's benefit as well as the practitioner's protection. The method designed was implemented in the Vancouver V.A. clinic. The first and most important procedure was to enter on the pertinent information into the log book that is adjacent to each camera. The roll number of each roll of film was recorded at the top of the page and then there were spaces for the 36 entries for that roll. The information required included the name number; the patient's name, age, and sex; the eye that was being taken; and a brief history and condition that was being photographed. At the end of the roll the film was sent out for processing and when returned each slide had to be labeled according to the information that was contained in the log book. A code system was used to initially identify the slide and was placed on the slide upon receiving it back from the lab. (Figure 1) F 10/3 or A 4/10 are examples of the code with F standing for Funuds, 10 being the tenth roll of the year, and 3 being the third slide on that roll. The A in the other code represented anterior segment which was obtained from the slit-lamp camera. After the initial coding, the slides were then projected and those that were of poor quality were eliminated. The next step was to record the information contained in the log book in duplicate on pre-printed file cards, one of which was placed in the patient's file and the other in a separate alphabetized card file. The name, date, eye, and condition was then printed on the slide holder for easier identification. The slides were then filed in a storage case in alphabetical order.

With the knowledge and skill obtained in ocular photography the authors were now ready to undertake the task of converting an existing Haag Streit design slit-lamp into a functional photo slit-lamp with the lowest cost possible. After numerous design changes and theoretical calculations, the preliminary specificating were arrived at. The camera body adaptor is a modification of the one designed by Neben and Puckett at Pacific in 1978 and described in Duane's.[1] The adaptor is designed to incorporate the ocular lens of the slit-lamp into the camera body without the normal 50 mm camera lens. The vertex distance from the plane of the film of the camera to the ocular lens was determined on a trial and error basis. The camera was placed on a tripod and moved back and forth while also adjusting the focus on the ocular to get a clear view of the focus rod in the camera view finder. The lens was also adjusted back out of the sleeve to change the vergence as needed. Measurements were then taken of the distances found with both the 10X and the 16X eyepieces. The adaptor was then machined out of solid core aluminum on a metal lathe. The precision was such that the lens would just slip into the adaptor with no excessive movement. The T-mount was then selected for the camera back that was to be used and then attached to the adaptor. The camera can then be mounted to the slit-lamp and adjusted to get a clear view of the focus bar through the view finder.

The next task was to introduce a strobe flash into the optics of the slit-lamp illumination system. It was decided to accomplish this in a manner similar to that of Nikon and Topcon in that the light source is moved up and the strobe introduced where the lamp was located. (Figure 5) The lens values and distances were calculated and the adaptor was again machined out of aluminum with distance refinements made on a trial and error method. (Figure 3) The image of the lamp filament was formed on the mirror using white paper and the lamp was then focused by changing the distances on both sides of the lenses. The strobe was modified by removing the bulb from the housing and connecting the new bulb by wires that then allows the power source to be separated from the strobe bulb by a distance of two feet. The bulb was then glued to the adaptor housing exactly in the middle of the opening for the lenses. The lamp housing was then attached to the adaptor using the threaded bolts from the slit-lamp that are now screwed into the adaptor. The light is now able to go through the strobe bulb to illuminate the eye and then the strobe can be fired for the high intensity, short duration pulse of light needed to make the image on the photograph. The fill flash was an external flash that was added to get a more uniform illumination over the entire full field of view. The flash was mounted on the table with a flash shoe and the flash tube is angled up 45° to directly illuminate the entire area around the globe,. The amount of flash was regulated by adjusting the varipower on the flash. The setting for the varipower was determined by taking conjunctival photos at each magnification and at each power setting.

The lens for imaging the fundus is a multi-coated aspheric lens mounted in a housing that was machined to put the focus of the lens in the center of the bar that is mounted in the focus rod hole on the slit-lamp. (Figure 7) The focus of the lens was measured on an optical bench and this distance in front of the lens is fixed in the lens holder and at a fixed distance in front of the slit-lamp.

After completion of all of the adaptors for the system, the next step was to implement it. The strobe adaptor was mounted into the illumination system of the camera adaptor mounted to the camera body and then to the slit-lamp. Photographs were then taken of various ocular structures with all four magnifications. The fundus lens was used to image the fundus through a dilated pupil. The lens holder was rotated slightly to reduce reflections in the lens. The flash setting was on manual and the illumination opened to full spot for the fundus picture. The slides were all taken on EKtachrome 200 film and all of the processing was done by the authors in order to standardize development time and temperature. The finished slides were then evaluated for exposure technique.

DISCUSSION

The results of this project proved to be very promising for being able to implement this system into the office of the eye care specialist. The corneal pictures obtained appeared to be of very similar quality to that obtained on the commercially available photo slit-lamp. It was only at the highest magnification using the optic section that there was not enough light to image the entire height of the camera. The fundus photographs were nearly as 'sharp and of similar field size as that of the Olympus fundus camera. (Appendix E) There are same specular ref7exes from the 1ens but they are positioned below and out of the way of the desired ocular structures.

This system is flexible in design in that you can use the whole system or only parts of it. For example the least expensive is to use only the camera body and use the available light of the illumination system. The main drawback of this is the long exposure times that quite often can lead to blurred images. In order to aid in the full field illumination of ocular structures that don't require a corneal section the external flash can be used. This may also be of use of conjunctiva, lids, and contact lens fit evaluations. The most expensive part of the system is the illumination flash which is a great aid in reducing blur and patient discomfort. The high intensity of the strobe is needed for lens and cataract evaluations as well as for using the fundus lens.

It is the opinion of the authors that ocular photography is a very important adjunct to the practice of optometry. The slides form a valuable comparison for monitoring conditions over time. It can be very helpful for referring patients as well as communicating with the patient's family physician. The photographs also offer a way of practice building in offering a service not already available in the community.

This system can be used with any 35 mm single lens reflex camera body that one may already have in his possession. If a new camera is needed the authors recommend the Nikon FE for its versatility. It has the ability to change the internal focusing screen to the matte finish that is needed to get a clear image in the view finder. It also has the automatic exposure feature that can be used for available light if the flash system is not used.

The authors believe that this system can be economically used in the Optometrist's office to successfully implement setting up ocular photography. This complete system can be put together for less than 300 dollars if you have a camera body and someone that can do the machining for you or to do it yourself. (Appendix F) There are some modifications and improvements that will be made in the future to perfect the system. The filing system appears to involve a lot of work but if ocular photography is going to be used in the office it should be set up correctly because there is no sense in having slides if they cannot be found later when needed for comparison purposes. A data back can be purchased that will imprint a code number and the date directly on the film and this could be an advantage for legal protection as well as being a time saver in the long run.

CONCLUSION

The authors have developed a system that can be used to further benefit the practice of optometry. It is much less expensive than buying a complete photo slit-lamp or buying a commercially available conversion packagethat will add at least 2,000 dollars to the price of a slit-lamp. An interesting aspect of the system that was a side line was the use of the fundus lens for examination of the fundus similar to the binocular indirect ophthalmoscope. (Figure 6) The lens gives a 35° view with a magnification of 7.2X which is about half that of a direct ophthalmoscope and two to three times more magnification than the binocular indirect ophthalmoscope. This project has been very useful in teaching the authors the skill in using ocular photography as well as providing a means to implement ocular photography in an office that might not start it because of the expense involved. It is the hope of the authors that this system can and will be used in the office to further the practice of optometry.

REFERENCES

1. Clinical Ophthalmology, Duane, Vol. 1, Ch. 59, pp. 1-4.

2. Gullstrand, A.: Demonstration der Nerstspaltlampe, Ber. Dtsch. Ophth. Ges., 37:374, 1911.

3. Koeppe, L.: v. Graefes Arch. Ophthal., 95:282, 1918.

4. Lemoine, P. and Valois, G.: Ophthalmoscopie microscopique du fond d'oeil vivant, Bull. Soc. Ophthal. Franc., 36:366, 1923.

5. Zamehoff, A.: Arch. F. Ophth., 124:87, 1930; 129:149, 1932.

6. Goldmann, H.: "SV Concilium Ophthalmologicum, Cairo", Vol. 6, p. 10, 1937.

7. Hruby, K.: v. Graefes Arch. Ophthal., 143:324, 1941; 144:435, 1942; Ophthalmologica, Basal, 115:290, 1948.

8. Littnian, H.: Amer. J. Ophthal., 33:1863, 1950; v. Graefes Arch. Ophthal., 37:625, 1953,

9. El Bayadi, G.: New method of slit-lamp micro-ophthalmoscopy, Brit. J. Ophthal., 37:625, 1953.

10. Rosen, E.: Biomicroscopic examination of the fundus with a +55D lens: a further study, Amer. J. Ophth., 48:782, 1959,

11. Rosen, E.: Biomicroscopic examination of the fundus with a +32 D lens: a further study, Amer. J. Ophth., 55:374, 1963.

12. Goldmann, H.: Biomicroscopy of the eye, Amer. J. Ophth., 66:789, 1968.

13. Boyer, J.M.: Adaptation of the slit-lamp biomicroscope for fundus photography, PUCO Library, 1975.

14. Cohan, B.E.: Comparison of photo slit-lamp and fundus camera photography of the optic disc, Arch. Ophthal., 97:8, 1979.

15. Kajiura, M.: Slit-lamp photography of the fundus by use of aspherical convex preset lens, JPN J. Ophthal., 22:2, 1978.

APPENDIXES

APPENDIX A

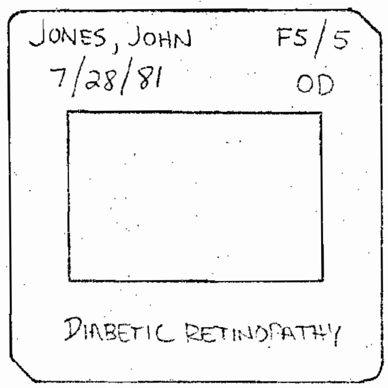


Figure 1

Sample slide showing filing system.

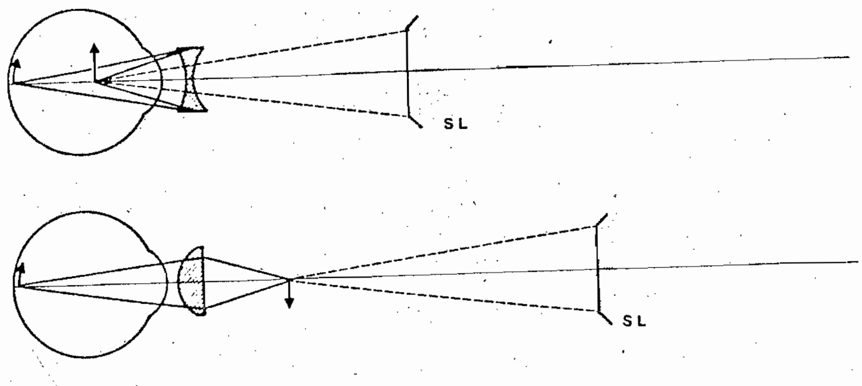
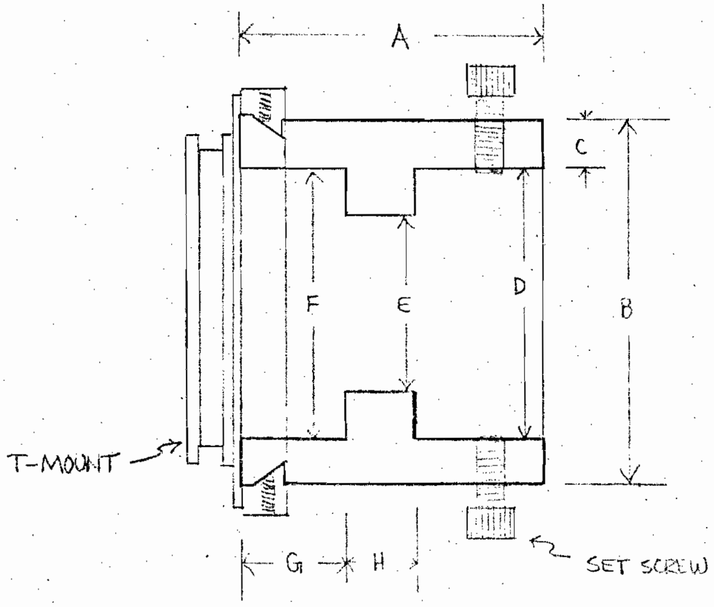


Figure 2

Optics of imaging the fundus. Top-image formation with a Hruby lens. Bottom-same eye and a convex field lens. SL - slit-lamp.

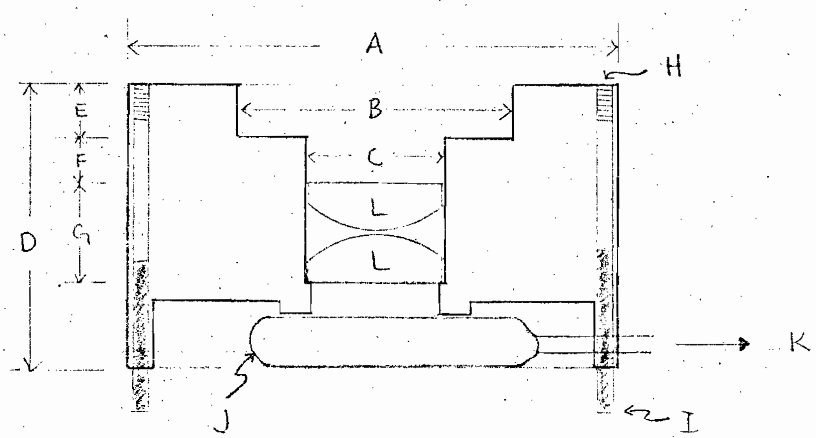
APPENDIX B



A. 40 mm
B. 47 mm
C. 6 mm
D. 35 mm
E. 23 mm
F. 34 mm
G. 14 mm
H. 9 mm

Figure 3

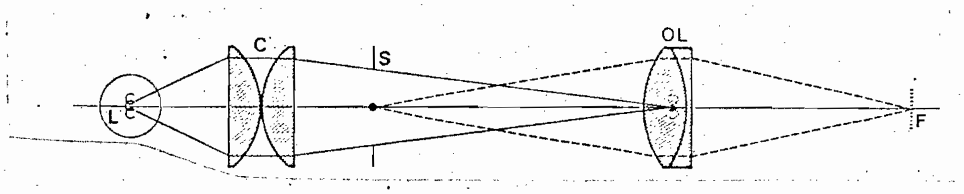
Camera Adaptor



A. 64 mm
B. 37 mm
C. 18 mm
D. 36 mm
E. 7 mm
F. 6 mm
G. 14 mm
H. Threaded hole
I. Mounting pin
J. Flash tube
K. To power source
L. 15.5 mm focal length condensing lenses

Figure 4

APPENDIX C



Optics of slit-lamp illumination
L-lamp, C-condensing lens, S-slit, OL-objective lens, F-slit focal point

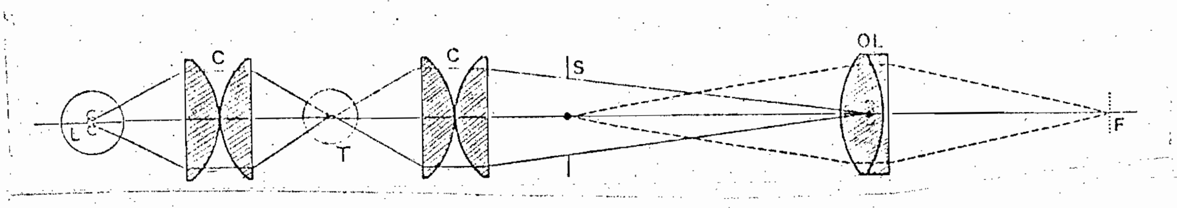


Figure 5

Optics of slit-lamp with strobe flash unit T-strobe flash tube.

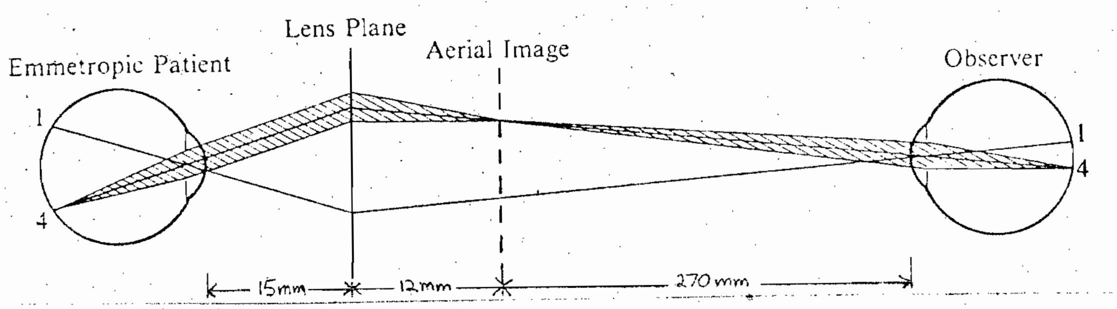
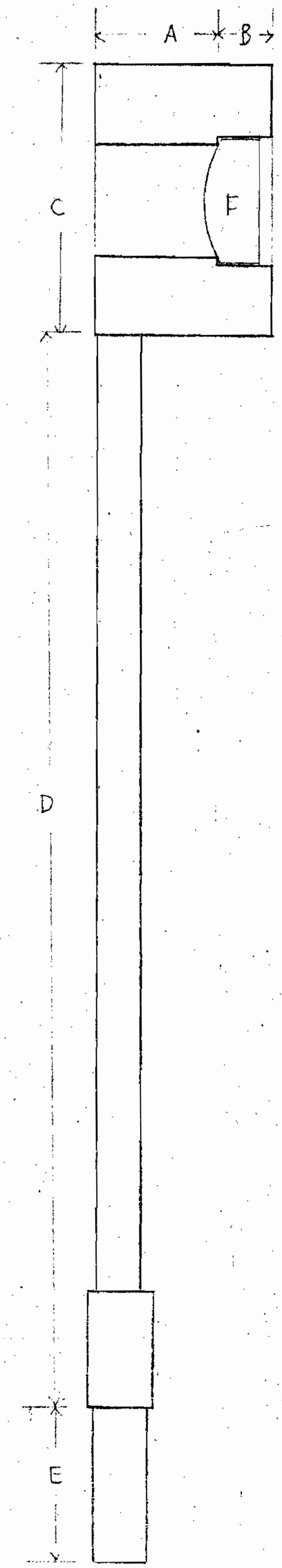


Figure 6

Principle of indirect ophthalmoscopy and actual measurements used in project.

APPENDIX D



A. 17 mm

B. 8 mm

C. 38 mm

D. 150 mm

E. 22 mm

F. 12 mm focal length condensing lens

Figure 7

Fundus viewing lens and mounting bar.

APPENDIX E

Comparison of relative image and field sizes of standard fundus camera and biomicroscope adapted fundus lens.

	Biomicroscope	Fundus Camera
Optic disc	6 units	12 units
Total field	30 units	53 units
Disc to Macula Distance	13 units (15°)	26 units (15°)
Field of View	35°	30°

APPENDIX F

Approximate Cost of Materials

Solid core aluminum 1-3/4" diam. x 1" length		$ 3.00
Solid core aluminum 2-3/4" diam. x 2" length		8.00
Solid core aluminum 2-1/4" diam. x 1-3/4" length		5.00
T-mount camera adaptor		7.00
2 vivitar 283 strobe flash units @ $80.00 ea.		160.00
Strobe flash tube		3.00
Variable power module for vivitar 283		17.00
2 flash shoe mounts @ $3.00 ea.		6.00
2 15.5 mm aspheric lenses @ $6.00 ea.		12.00
1 12 mm aspheric coated lens		15.00
	SUBTOTAL	$236.00
*35 mm camera body (Nikon FE)		275.00
	TOTAL	$511.00

*The authors recommend a camera body with automatic exposure capability and interchangeable focusing screens.

APPENDIX G

Figure 8

Photographic conversion kit

APPENDIX II

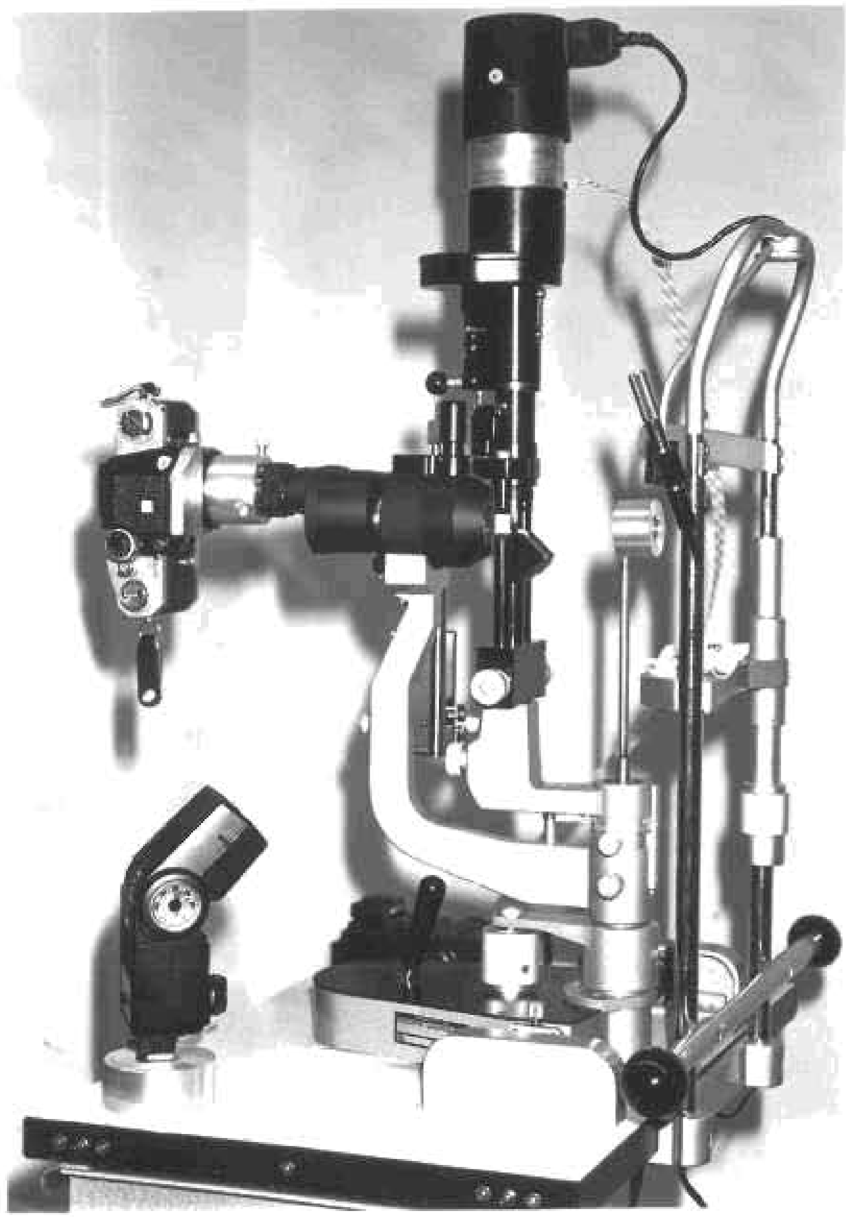


Figure 9

Photographic kit on the Slit-Lamp Biomicroscope

APPENDIX 1

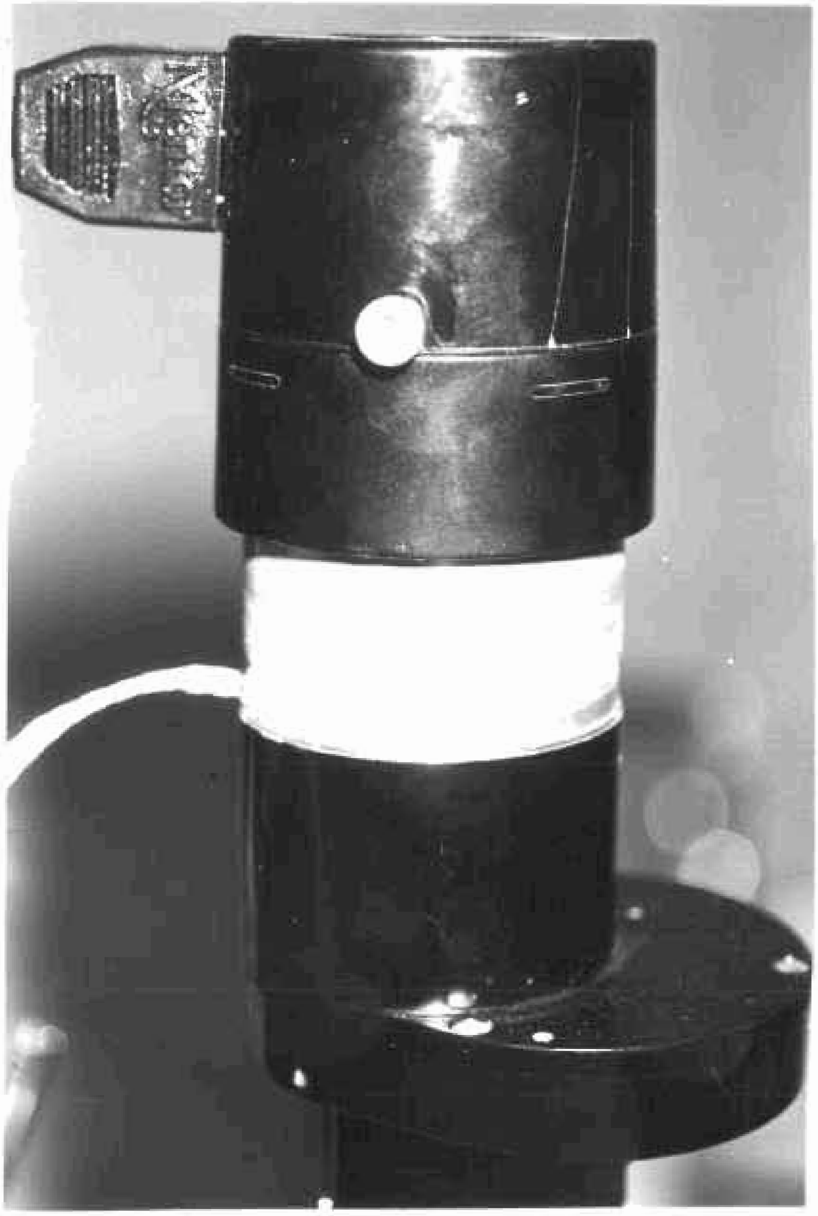


Figure 10

Strobe flash unit assembled

APPENDIX J

Figure 11

Fill flash unit

APPENDIX K

Figure 12

Camera body with adapter in place

APPENDIX L

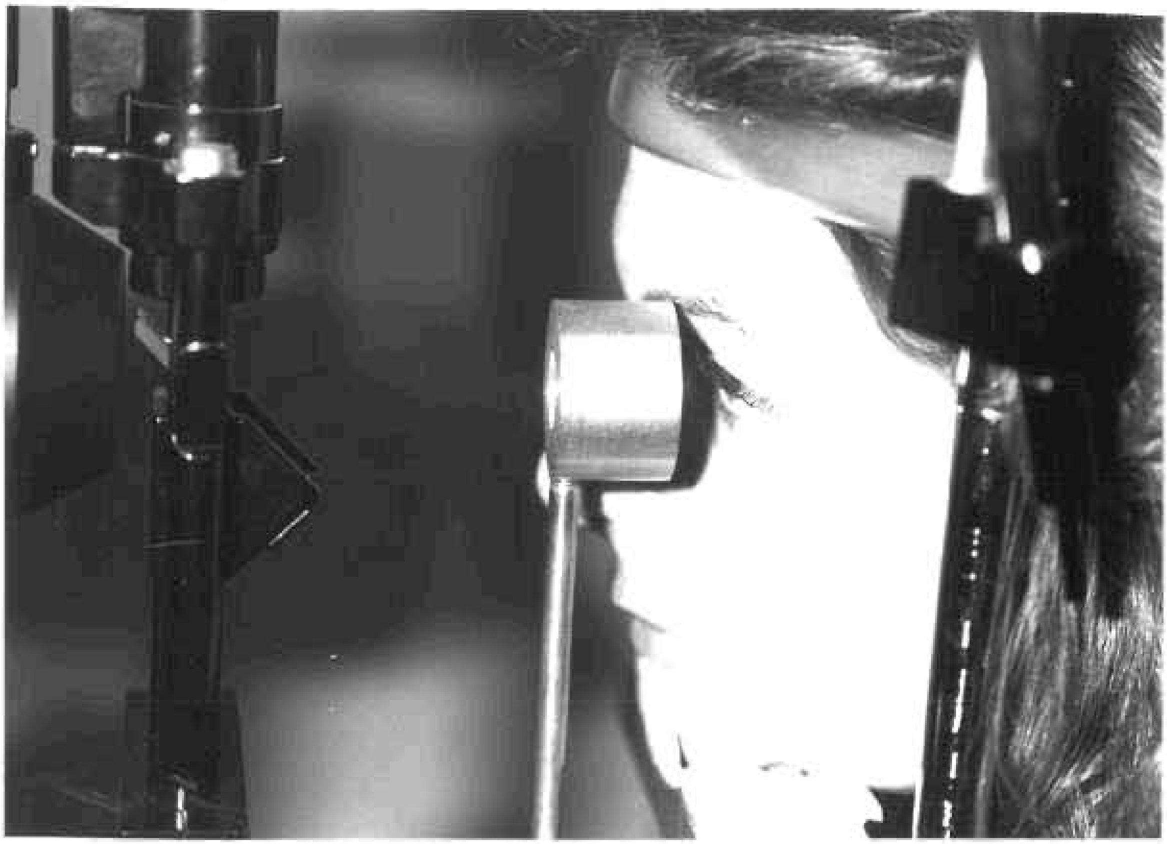


Figure 13

Fundus lens being utilized

APPENDIX M

Slides that were taken with the kit