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## A comparative evaluation of different models and brands of direct ophthalmoscopes and retinoscopes

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# A comparative evaluation of different models and brands of direct ophthalmoscopes and retinoscopes

## Abstract

The purpose of this study was to compare the various ophthalmoscopes and streak retinoscopes currently available on the U.S. market. Subjective and objective tests were utilized to assess overall performance. Each instrument tested received a sub score based on performance in each of several subjective categories which were then combined to arrive at a total score. The instruments were then ranked from highest overall score to the lowest. The Keeler Vista 20 was the highest rated ophthalmoscope largely due to excellent optical clarity. The Vista was followed by the Keeler Specialist, Propper MMI, Neitz BX alpha, Welch Allyn 11730, Visuscope, Ri-Scope and Heine Autofoc 2. Of the pocket ophthalmoscopes tested the Keeler rated first again, followed by Neitz, Welch Allyn, Propper and Maylite. Streak retinoscopes evaluation placed the Neitz on top with the Welch Allyn prototype, Propper and Keeler units placing second, third and fourth.

## Degree Type

Thesis

## Degree Name

Master of Science in Vision Science

## Committee Chair

Nada Lingel

## Subject Categories

Optometry

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A COMPARATIVE EVALUATION  
OF DIFFERENT MODELS AND BRANDS  
OF DIRECT OPHTHALMOSCOPES  
AND RETINOSCOPES

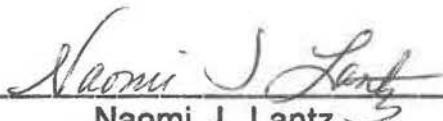
By

Naomi J. Lantz  
J. Scott Kohlstedt  
Stuart K. Machida

A thesis submitted to the faculty of the  
College of Optometry  
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Forest Grove, Oregon  
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May 1992

Adviser:  
Nada Lingel, O.D.

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The purpose of this study was to compare the various ophthalmoscopes and streak retinoscopes currently available on the U.S. market. Subjective and objective tests were utilized to assess overall performance. Each instrument tested received a sub score based on performance in each of several subjective categories which were then combined to arrive at a total score. The instruments were then ranked from highest overall score to the lowest.

The Keeler Vista 20 was the highest rated ophthalmoscope largely due to excellent optical clarity. The Vista was followed by the Keeler Specialist, Propper MMI, Neitz BX alpha, Welch Allyn 11730, Visuscope, Ri-Scope and Heine Autofoc 2. Of the pocket ophthalmoscopes tested the Keeler rated first again, followed by Neitz, Welch Allyn, Propper and Maylite. Streak retinoscopes evaluation placed the Neitz on top with the Welch Allyn prototype, Propper and Keeler units placing second, third and fourth.

## **AKNOWLEDGEMENTS:**

We would like to thank the following companies and distributors for supplying us with the instruments and information used in our study: Franel Optical Supply (Ri-Scope, Maylite), Heine USA Limited, Keeler Instruments Inc., Kowa Optimed Inc. (Neitz), Oculus of America (Visuscope), Propper Manufacturing Co. Inc., and Welch Allyn Inc.

We also want to thank Dr. Don Schuman for helping us establish the criteria for our retinoscope tests and Mrs. Charlotte Kohlstedt for supporting us and helping with scheduling and organization during our project.

# INTRODUCTION

Ophthalmoscopes and retinoscopes are an integral part of the modern eye care profession. There are a large number of these instruments currently available on the U.S. market with a wide diversity in prices, features and performance. This study is designed to evaluate each instrument and present information in a manner which will assist the professional in making an informed decision about which one will serve his or her needs best.

In 1951, Binstead<sup>1</sup> listed four features for an ideal ophthalmoscope. They were minimal corneal glare, an even, full field of illumination, no interference of returning light at the examiner's eye ("flare"), and an elimination of "shadowing" on the fundus caused by the parallax effect between the examiner's eye and the illumination system. Mitchell<sup>2</sup> gave three basic requirements for an ideal ophthalmoscope: clarity of fundus details, visibility of the macula, and an unobstructed view of the lens, vitreous, and retina. Based upon Binstead's and Mitchell's ideal features, and our own experience, we arrived at the criteria for evaluation of the instruments tested in this study. The eight standard ophthalmoscopes and five pocket ophthalmoscopes were rated on optical clarity, color rendition, apparent depth of the fundus image, ease of staying in the pupil while viewing the fundus, ease of viewing the fovea, and corneal glare. The four streak retinoscopes we tested were rated on reflex clarity and ability to spiral the streak. The ophthalmoscopes and retinoscopes were also evaluated for shape, fit, location of controls and other ergonomic features. In addition to the subjective measurements, objective measurements of characteristics such as size, weight, battery performance, and light output were measured.

## METHODS

The ophthalmoscopes were evaluated by three examiners with the assistance of ten volunteers ranging from 4 to 79 years of age and having pupil sizes between 3 and 6 mm. Performance in each of the categories listed below was rated numerically where excellent performance would receive a high score and poor performance would receive a low score. In addition, large and small aperture sizes and each filter option were evaluated separately.



Optical clarity was determined by the amount of detail visible to the examiner. Very poor clarity was defined by difficulty in visualizing common fundus details such as disc margins and vasculature. A crisp image with the ability to view fine details, such as the nerve fiber layer, was defined as excellent clarity.

Color rendition was evaluated based on color contrast and vibrancy. Washed out colors with little or no definition between ocular structures was rated as very poor, while bright, true colors were rated as excellent.

Apparent depth was based on the examiners ability to visualize variations in surface contour of the fundus. A very poor depth rating resulted from a flat fundus image similar to a photograph. Obvious variations in elevation of vessels and disc cupping would result in an excellent rating.

Ease of staying in the pupil was determined by the ability of the examiner to assess the peripheral areas of the posterior pole. If the tester was unable to keep a view through the pupil while following a major vessel away from the disc the rating was very poor. If the tester was able to follow the vessel with relative ease the rating was excellent.

Ease of viewing the fovea was based on the relative ability to visualize the foveal reflex. If the reflex could not be viewed because of glare or poor optical clarity a rating of very poor was given, and if the reflex was readily visible an excellent rating was given.

Corneal glare affects the ability of the examiner to view fundus details, color and the foveal reflex. If an ophthalmoscope generated so much glare that it was difficult to see past the cornea it was rated as very poor. Minimal glare that allowed easy viewing past the cornea resulted in an excellent rating.

Retinoscopes were evaluated by three examiners using a small sample of three subjects to assess reflex clarity, the ability to spiral and ergometrics. Performance was rated numerically as in the ophthalmoscope testing.

Reflex clarity was determined by the ability of the examiner to assess reflex movement within the pupil. Glare from the lenses in the phoropter also had an affect on this category. A poor rating was given to a retinoscope that produced an indistinct reflex regardless of the vergence adjustment. A bright and distinct reflex resulted in an excellent rating.

Ability to spiral is important for retinoscopy procedures such as assessing astigmatism and Copeland's method. This feature was primarily determined by the location and function of the controls. A retinoscope received a poor rating if the projected beam could not be rotated without affecting the vergence control and/or if it was extremely difficult to rotate. If the retinoscope allowed rotation while maintaining vergence or progressively varying vergence it received an excellent rating.

Shape and fit was evaluated for both ophthalmoscopes and retinoscopes. A score was assigned based on "balance", "feel" of the instrument and "fit" to the examiners face. In addition, the ophthalmoscope ratings were affected by "fit" to the patient's face because of the close working distance. An instrument which felt awkward and uncomfortable received a low rating and one which was comfortable was given a high rating.

Location of controls, and the relationship of controls to each other, was another area considered for both ophthalmoscopes and retinoscopes. Poor location, grouping and function, with controls scattered throughout the head, received a low rating whereas a high score was given for good location, grouping and function.

Objective tests were conducted to compliment the subjective tests listed above and provide a more complete description of the performance of each instrument.

Battery discharge rate was measured to provide an indicator of useable time between charges. Light output was maintained at an average level of 250 lumen during discharging to approximate clinical conditions. The time required to reach the point where the scope could no longer be maintained at 250 lumen output was recorded. Total time to drop below 10 lumen was also recorded as an indicator of absolute useable light. This test was repeated three times with a full 24 hour charging before each discharging.

Selection of the 250 lumen level for discharge was based on a survey of 50 Pacific University College of Optometry faculty members and students. In this survey we found the average light level used by those surveyed to be 250 lumen although there was a wide variation in the light levels used by different examiners. The minimum light output of 10 lumen appeared to be the practical limit of clinical usefulness because at this level of output the light is so dim and yellow that it is essentially impossible to visualize fundus details.

Considering that most of the pocket ophthalmoscopes utilize conventional batteries, the discharge rates were not measured (due to the variability in battery life). In addition, the retinoscopes utilized the same battery handles as the ophthalmoscopes so the test was not repeated for the retinoscopes.

Light output was measured with the batteries fully charged or with new cells. Maximum and minimum was measured to determine the useful ranges of illumination.

Aperture dimensions were measured at one meter while projected onto a black surface to allow a comparison of sizes and designs.

Dimensions, weight, available filters, special features, price and warranty information were directly observed and recorded from the instruments or requested from the distributors. Some suppliers were unable to provide all information and these omissions are noted in the text.

## **OPHTHALMOSCOPE RESULTS**

An ophthalmoscope is one of the most important diagnostic instruments available to the eye care professional. Viewing the fundus allows a direct look at the health of the eye's posterior pole, condition of the body's circulatory system and may help detect certain types of cranial anomalies. Therefore, it is imperative that the eye care professional has an ophthalmoscope that will meet the needs of a thorough fundus evaluation.

The following is a summary of our results listed in order of the highest to lowest overall score. Summaries include both subjective and objective data. For actual overall scores and ratings by categories, refer to Tables 1 and 2.

## **Keeler Vista 20**

The Keeler Vista had the highest overall score and rated first in all categories except ergometrics. It also had the highest light output, although this may be a result of having the largest aperture.

The Vista has three filters available for use with all apertures: red free, cobalt blue and yellow (which is only offered on the Keeler Vista). Some subjects reported the yellow filter to be more comfortable. Vista allows a range of 59 diopters in one diopter steps. When the auxiliary lens selector is utilized the diopter indicator does not directly read the lens power which requires the examiner to calculate the actual power.

## **Keeler Specialist**

The Specialist entered in a close second to its counterpart, the Vista, even though it rated sixth and eighth ergometrically. It is the heaviest and longest unit tested and has the lowest maximum light output. The specialist offers the largest range of lenses with 89 diopters in one diopter steps. The primary diopter indicator utilizes a lens which enables the clinician to view the lens power without moving the instrument away from his or her face. The secondary power indicator, however, requires that the instrument be held at a normal reading distance to view the lens powers. The red free filter is provided with one aperture and the fixation target.

## **Propper MMI**

The Propper MMI placed third primarily by scoring moderately well in most categories without having any major faults.

Propper provides steps of one diopter between -10 and +10 and 5 diopter steps thereafter for a total range of 55 diopters without using an auxiliary lens selector. The red free filters can be used with all apertures and an optional 4,000 K filter, which provides even white illumination for best color rendition, is available. A reserve setting on the rheostat allows a short extension of useable light once the battery has discharged to the point where the light output is inadequate. The Propper head can be adapted for use with a Welch Allyn handle.

## **Neitz BX Alpha**

Neitz rated fourth overall falling only one point behind the Propper MMI. Optically, it was comparable with Propper as it differed by only 0.3 points, but it suffered from the most corneal glare. It rated first for shape and fit of the head and second for location of controls.

The Neitz has a range of 71 diopters in one diopter steps, and the diopter indicator reads actual lens power even when utilizing the auxiliary lens selector. It has a double polarizing feature with internal Polaroid and a switchable Polaroid filter within the viewing aperture. Polaroid and 4,000 K filters may be used with all apertures; however, the red free is only available in one aperture.

A wide variety of power and charging systems are available including direct wall and well charging, C cell, AA cell, and direct power cord.

## **Welch Allyn 11730**

The Welch Allyn ophthalmoscope rated fifth and had high scores for low corneal glare and locations of controls. This instrument rated second in brightness to the Keeler Vista and was the most compact of all tested.

The Welch Allyn has automatic lens progression utilizing an internal stepper switch and displays the actual lens power. This allows a lens range from minus 30 to plus 38 in one diopter steps. Red free and Polaroid filters may be used with all apertures and cobalt blue is available with one aperture. Overall battery performance was comparable to other scopes however power drops off rapidly when the battery is nearly discharged.

## **Visuscope**

The Visuscope placed first for location of controls but scored lower in the optical categories.

Lens range goes from minus 31 to plus 24 in one diopter steps without the use of an auxiliary lens selector. Red free and cobalt blue filters may be used with all apertures. The targets may be focused for the patient over a range of minus 12 to plus 8 diopters by means of a separate control. Optional test targets are available such as E-hooks to test crowding phenomenon.



Discharging time was considerably longer than found with other batteries tested due to a unique illumination power delivery system. The Visuscope is provided with AA nickle cadmium rechargeable batteries which can be interchanged with standard AA batteries. The Visuscope turns on automatically when the handle is grasped.

## **Ri-Scope**

The Ri-Scope is a very basic ophthalmoscope. A single lens wheel provides one diopter steps between minus 6 and plus 6 with a total range of 65 diopters. Red free is available with only one aperture. A focusable projection system is also provided.

Because battery performance decreased more on each test, it is reasonable to assume that the batteries supplied in our handle were defective, so our results may not be an accurate representation of normal expected battery performance.

## **Heine Autofoc 2**

Although the Heine Autofoc rated eighth, it was only one point behind the Ri-Scope. Ergometrically, it scored well in both shape and fit, and location of controls.

The Heine provides one diopter steps over 51 of the 65 diopter total lens range. It features automatic focusing for the targets which operates simultaneously with the primary lens selector. Lens power may be observed through the viewing aperture by means of a slide control. The rheostat also features a power reserve.

Two red free filters may be used with all apertures. The interference red free is for viewing retinal vasculature and the transmission red free is designed for visualizing the nerve fiber layer.

## **POCKET OPHTHALMOSCOPES RESULTS**

### **Keeler Vista Pocket**

The Keeler Vista Pocket ophthalmoscope rated the highest of the pocket ophthalmoscopes by scoring consistently in all of the categories. Lenses are in one diopter steps between minus 3 and plus 4, with a total range of 40 diopters. The red free filter is provided in one aperture and with the fixation target. There is no illumination rheostat.

### **Neitz Pocket Ophthalmoscope GX**

The Neitz pocket ophthalmoscope rated number one optically; however, due to the incredible amount of glare and poor ergonomics it placed second overall. Lenses are in two diopter steps between minus 16 and plus 10 with a total range of 40 diopters. The red free filter is provided in one aperture only. The diopter indicator is not illuminated and there is no illumination rheostat. This is the lightest of the pocket scopes.

### **Welch Allyn Pocket Ophthalmoscope**

The Welch Allyn pocket ophthalmoscope scored first in ergonomics. It had the least amount of corneal glare most likely due to the front polarizing filter. An auxiliary lens selector allows lenses from minus 25 to plus 22 in one diopter steps. There are separate apertures for the red free and 4,000K filters. This instrument also features an illumination rheostat, and the option of a conventional or rechargeable battery handle.

### **Propper Plus Magnalume Pocket Ophthalmoscope**

The Propper pocket ophthalmoscope has an auxiliary lens selector which allows minus 30 to plus 20 in one diopter steps. The red free filter may be used with all apertures. Although this is the brightest pocket ophthalmoscope tested, the rheostat allows adequate control of illumination levels. Power may be provided by either conventional or rechargeable batteries.

### **Maylite Pocket Ophthalmoscope**

The Maylite is a very simple ophthalmoscope basically composed of an illumination system and a lens bank. Because of the simplicity, it scored well in location of controls. The lens range is the largest of the pocket scopes at 65 diopters, however, it only goes from minus 2 to plus 4 in one diopter steps. The illumination switch does not include a rheostat and power is provided by conventional AA batteries.

## OPHTHALMOSCOPE DISCUSSION

Keeler seems to have developed an optical design that works extremely well. Both the Vista and Specialist have exceptional optics which was the main reason they placed higher than the other ophthalmoscopes. After 10 hours of continuous ophthalmoscopy, the Vista was the number one choice by the examiners to view the fundus. When other scopes did not compensate for over-worked and tired examiners, the Vista consistently delivered a crisp and clear fundus image.

In comparing performance based on age and pupil size of the subjects we found the Keeler Vista performed slightly better with those subjects over 14 years of age who had pupil sizes of 3, 4, and 6 mm. The Neitz rated better with those subjects 14 years and under with 5mm pupils. Although we noted this trend, our small sample size prevented us from drawing any firm conclusions based on age or pupil size.

Of all the ophthalmoscopes evaluated, the Visuscope is the most innovative and has the best design for controls. Visuscope controls are compact and grouped within easy reach. Even though it has an exceptional design, the Visuscope optics are only mediocre and very disappointing. In contrast, the Keeler Specialist has extremely good optics but the control layout on the head makes it more difficult to operate.

The Heine Autofoc caused the greatest disagreement among the examiners in scores for optical clarity. This should be taken into consideration when assessing the overall and category ratings of the Heine Autofoc.

We found that some of the pocket ophthalmoscopes performed very competitively with their standard counterparts and felt that in some cases, such as when working with children or when on a screening, these smaller versions may provide a suitable alternative to the larger ophthalmoscopes.

Most ophthalmoscopes use an illuminated diopter indicator window in which the examiner must pull the instrument away from his or her eye to view the lens power in place. Two ophthalmoscopes tested used a plus lens to allow the examiner to read lens power without moving away from the unit. We found the diopter indicator on the Specialist to be located too far down the body of the instrument (away from the viewing aperture) to be convenient. In contrast, the Visuscope indicator, which is located directly adjacent to the viewing aperture was very useful. In addition, the secondary



lens selector viewing window on the Specialist requires the operator to move away to view the auxiliary powers. The Heine ophthalmoscope has a feature which allows the diopter indicator to be temporarily observed through the viewing aperture by means of a slide switch which we found very convenient. Actual lens powers are not shown in the diopter indicator on the Vista when the auxiliary lens selector is used. We found this bothersome and something that other manufacturers have improved on. The Neitz Pocket ophthalmoscope did not have an illuminated diopter indicator making it impossible to determine which lens was in place under reduced room illumination.

Some of the instruments tested such as the Specialist, Visuscope and Welch Allyn 11730 were equipped with extended lens banks or automatic internal lens selectors. Others were equipped with manual auxiliary lens selectors which we found inconvenient because of the drastic dioptric change experienced at the time the manual selector needed to be switched.

Welch Allyn and Vista had the brightest maximum light output (approximately two times that of the others); however, we felt that all of the ophthalmoscopes, including the pocket versions, provided adequate illumination. We did notice that higher illumination levels were helpful when using the Welch Allyn Polaroid filters. The Neitz and Keeler Vista pocket ophthalmoscopes did not have a rheostat, and some patients found their light levels uncomfortable.

Attachment systems between the ophthalmoscope head and handle vary between scopes. Many manufacturer use a bayonet system where the head is pressed downward and rotates a partial turn to lock in place. Another system used by Heine utilizes a spline shaft which inserts into the handle and is locked in place by the barrel on the handle. This provides a very positive attachment. Keeler has opted for a threaded attachment system where the head is "screwed" into the handle. Although this system provides a positive attachment, the coarse threads and loose initial fit do not inspire a feeling of quality and this system is not preferred to other methods of attachment.

Many ophthalmoscopes had the option of a charging system which plugged directly into a wall outlet. Most of the scopes had a portion of the handle which must be unthreaded to expose the prongs for charging. The handle is then left projecting straight out from the outlet. One unique feature of the Neitz scope is the wall charging system which has prongs that slide out of the side of the handle allowing the unit to hang against the wall rather than projecting straight out from the outlet.

# **RETINOSCOPE RESULTS**

## **Neitz RX Streak Retinoscope**

The Neitz Streak retinoscope received an excellent rating for its ability to spiral and for location of controls. It also scored very well in reflex clarity and shape and fit. The Neitz has good optics and focuses to a very sharp streak. An optional plus 2 lens may be installed in the viewing aperture for presbyopic clinicians. The head can be rotated to align with any position of the handle. Neitz utilizes the same battery handle for both the ophthalmoscope and retinoscope so the same power and charging system options exist as noted previously.

## **Welch Allyn Streak Retinoscope (Prototype)**

The Welch Allyn rated second overall, and received an excellent score in ability to spiral. It also received good marks in ergonomics. Special features include a rubber spectacle guard, magnet for mounting a dynamic retinoscopy card, double polarized filter system, and a completely enclosed and dust proof head which is unique to this scope.

## **Propper Streak Retinoscope**

The Propper Streak Retinoscope is the brightest, biggest and heaviest of those tested. It has the largest range from plano and concave, a reserve setting on the rheostat, and two viewing apertures. The larger peephole allows more light for observing a dim reflex and the smaller peephole provides sharper reflex definition.<sup>3</sup> Two interchangeable forehead rests are provided, one for use with spectacles. A sliding dust cover for the front opening is also provided.

## **Keeler Vista Streak Retinoscope**

The Keeler Retinoscope performed well in shape and fit but poorly in location of controls and ability to spiral. The streak was less well defined than we found on other retinoscopes. Two viewing apertures and interchangeable forehead rests are provided.

## **Retinoscope Discussion:**

Neitz has an excellent ability to spiral because the vergence and beam rotation controls are separate and yet both fall within easy simultaneous reach. The other retinoscopes tested utilize a single control for both beam rotation and spiralling.

Welch Allyn has a double Polaroid system which greatly reduces the glare from the phoropter lenses but dims the reflex so higher levels of illumination are required. The Welch Allyn head is sealed which helps keep the optical system clean. Viewing through this retinoscope felt very different than the others due to peripheral constriction caused by the depth of the head. The Welch Allyn retinoscope is a newly developed model which was specifically sent to us for inclusion in this evaluation. Our results may not be representative of a production model as various modifications may take place before it is marketed.

The Propper retinoscope performed well except in location of controls, largely due to the distance between controls and stiff action. This scope would not be recommended for individuals with small hands.

The Propper and Keeler retinoscopes have two interchangeable forehead rests, one for use with spectacles. One examiner found the spectacle rest too short to be useful.

## **CONCLUSION**

All of the ophthalmoscopes and retinoscopes tested performed admirably, however based on our findings the Keeler Vista 20 was the ophthalmoscope of choice and the Neitz RX was the preferred Streak Retinoscope. It should be remembered that although we found certain instruments to perform better than others, each individual clinician will have to make the final decision as to which scope will serve him or her best based on the features desired. As an example, the Propper and Heine instruments have larger dimensions and may be preferred by an examiner with large hands.

The manufacturer's reputation for service and parts should also be an important consideration in the selection of any instrument. Some companies, such as Welch Allyn, make a firm commitment to stand behind their products while other companies are relatively weak in the service area. It would be wise to discuss the manufacturers reputation for service with others professionals in the region before purchasing any new instrument.

If considering a diagnostic set, the Neitz rated highest with an excellent retinoscope and very good ophthalmoscope. The Welch Allyn with the prototype retinoscope rated second.

In our opinion, the ultimate ophthalmoscope would be the Visuscope with it's state of the art technology and excellent ergonomics combined with the crisp Keeler optics.

## **REFERENCES:**

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- 2) Mitchell, D.W.A. (1951): The Clinical Uses Of The Ophthalmoscope; Trans. Int. Opt. Cong., London.
- 3) Borish, I.M. Clinical Refraction. New York, Professional Press Books; 1970 (pages 667-669)

**Table 1**  
**Ophthalmoscope Ratings**

Score	Price	Optical Clarity	Color Rendition	Apparent Depth	Ease of Staying in Pupil	Ease of Viewing Fovea	Minimal Corneal Glare	Shape and Fit	Location of Controls	
228	\$314									Keeler Vista
207	\$644									Keeler Specialist
200	\$450									Propper MMI
199	\$325									Neltz BX Alpha
196	\$309									Weich Allyn
193	\$727									Visuscope
189	\$225									RI-Scope
188	\$417									Heine Autofoc
207	\$220									Keeler Pocket
201	N/A*									Neltz Pocket
196	\$249									Weich Allyn Pocket
183	\$350									Propper Pocket
158	\$69									Mayllite Pocket

\*Mfr. could not provide price information







Table 3

Table of Objective Findings for Ophthalmoscopes

	<u>Lens Range (diopters)</u>	<u>Max. Light Output (lumen)</u>	<u>Battery Discharge Rate (to &lt;10 lumen)</u>	<u>Overall Height (millimeters)</u>	<u>Weight (grams)</u>
Heine Autofoc	65	650	71	250	373
Keeler Specialist	89	420	68	260	462
Keeler Vista 20	59	1500	67	224	377
Neitx BX alpha	71	625	59	224	295
Propper MMI	55	430	79	243	346
Ri-Scope	65	500	19	230	406
Visuscope	55	390	227	244	295
Welch Allyn	68	1295	65	215	348
<b>Pocket Ophthalmoscopes</b>					
Keeler	40	280	NA*	173	114
Neitz	40	270	NA*	169	94
Propper	50	325	NA*	180	164
Welch Allyn	48	185	NA*	178	NA
Maylite	65	95	NA*	199	101

\*Most pocket ophthalmoscopes tested utilized standard replaceable batteries

**Table 4**  
**Retinoscope Ratings**

Score	Price	Reflex Clarity	Ability to Spiral	Shape and Fit	Location of Controls	
168	\$421					Neltz Streak
140	\$230					Welch Allyn Prototype
127	N/A*					Propper Streak
107	\$362					Keeler Streak

\*Mfgr. could not provide price





Table 5

**Table of Objective Findings for Retinoscopes**

	<u>Plane mirror maximum range (centimeters)</u>	<u>Concave Mirror maximum range (centimeters)</u>	<u>Light Output Maximum (lumen)</u>	<u>Overall Height (millimeters)</u>	<u>Weight (grams)</u>
<b>Keeler</b>	-50	24	810	241	366
<b>Neitz</b>	-50	18	810	271	345
<b>Propper</b>	-16	36	920	292	408
<b>Welch Allyn</b>	-77	31	810	256	383

# APPENDIX 1:

## CRITERIA AND NOTATION USED ON INFORMATION PAGES

**HEAD DIMENSIONS:** Height x width x depth in millimeters.

**LENSES:** Arrow (-->) indicates one diopter steps.

Example: -3 --> +3 translates as follows:  
-3, -2, -1, 0, +1, +2, +3

**APERTURES:** All figures of the instruments' apertures are drawn to scale. These illustrate a sample of the apertures on the scopes utilized in this study and do not represent all aperture options available from some manufacturers. For those scopes that have a red-free filter only for one aperture, the size of this aperture is the same as the large aperture.

**LIGHT OUTPUT:** Large apertures were used in measuring the maximum and minimum light output (in lumen).

**BATTERY DISCHARGE RATE:** Discharge rate is written as two numbers separated by a slash. All ophthalmoscopes (except pocket ophthalmoscopes) were discharged at a setting of 250 lumens, therefore, the first number indicates the time for the light level to drop below 250 lumens. The second number indicates the time for the light level to drop below 10 lumens.

**SUGGESTED RETAIL PRICE:** Most prices listed were effective June, 1991, and are subject to change. Student prices may differ from those listed. Contact the appropriate supplier in your area for current prices.

**MANUFACTURER'S WARRANTY:** Contact the appropriate supplier in your area for more details concerning warranties.

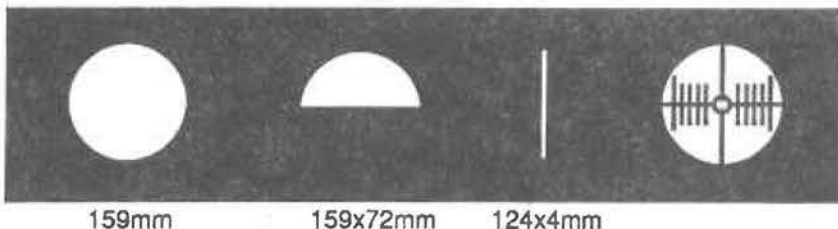
## HEINE AUTOFOC 2

**Overall height:** 250mm  
**Head dimensions:** 88mm x 45mm x 26mm  
**Weight:** 373 grams

### Lenses:

**Range:** 65 diopters (-40 to +25)  
**Primary lens selector:** -20, -15, -12, -10 --> +10, +12, +15  
**Auxillary lens selector:** -20, +10  
allows -30 to +20 in one diopter steps

### Apertures:



### Filters:

Clear\*  
Red free for viewing retinal vasculature\*  
Red free for viewing nerve fiber layer\*  
\*Useable with all apertures

**Maximum light output:** 650 lumens (large aperture)  
**Minimum light output:** < 10 lumen

**Battery Discharge Rate:** 69/2 minutes

### Options:

**Apertures:** Small spot  
**Charging systems:** Wall outlet, well charger

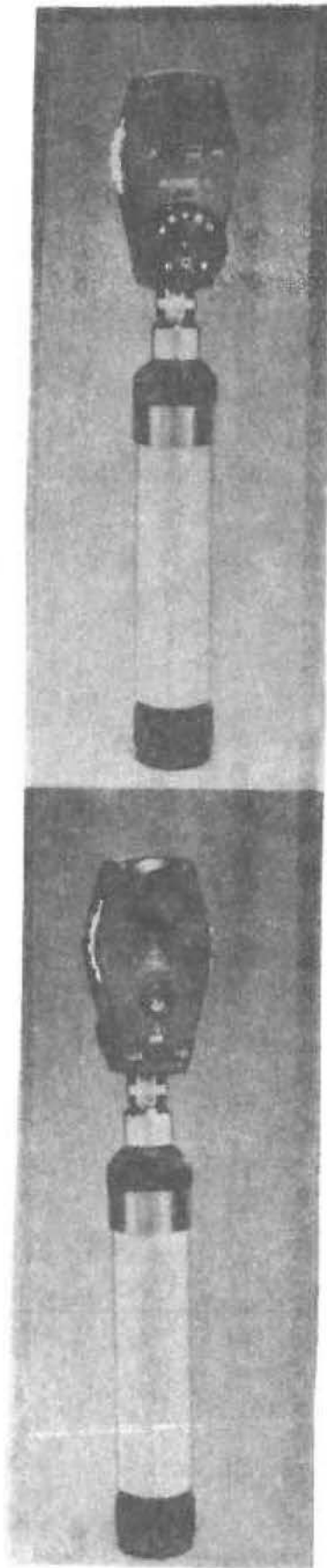
### Special Features:

Automatic simultaneous focusing of projection and viewing systems  
Switch allows visualizing lens power within viewing aperture  
Illumination rheostat with reserve

**Suggested Retail Price:** \$ 330.70 (head), \$ 67.40 (handle)  
\$ 416.66 (set with spare bulb)

**Manufacturers warranty:** 1 years parts and labor  
Lifetime for manufacturer defects

Heine USA Limited  
3500 Regency Parkway, Suite "C"  
Cary, North Carolina 27511-8569  
1-800-FOR-HUSA



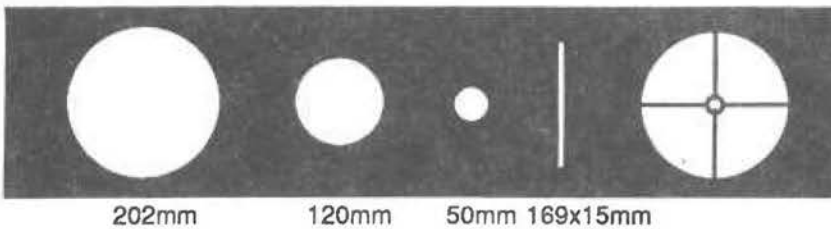
## KEELER SPECIALIST

**Overall height:** 260mm  
**Head dimensions:** 112mm x 24mm x 29mm  
**Weight:** 462 grams

### Lenses:

**Range:** 89 diopters (-45 to +44)  
**Primary lens selector:** -15 --> +14  
**Auxillary lens selector:**  $\pm 30, \pm 15, \pm 10$   
allows -45 to +44 in one diopter steps

### Apertures:



**Filters:** Clear  
Second large aperture and fixation target available only with red free

**Maximum light output:** 420 lumens  
**Minimum light output:** <10 lumen

**Battery Discharge Rate:**  
Full power: 62 min.  
250 lumens: 60/8 minutes

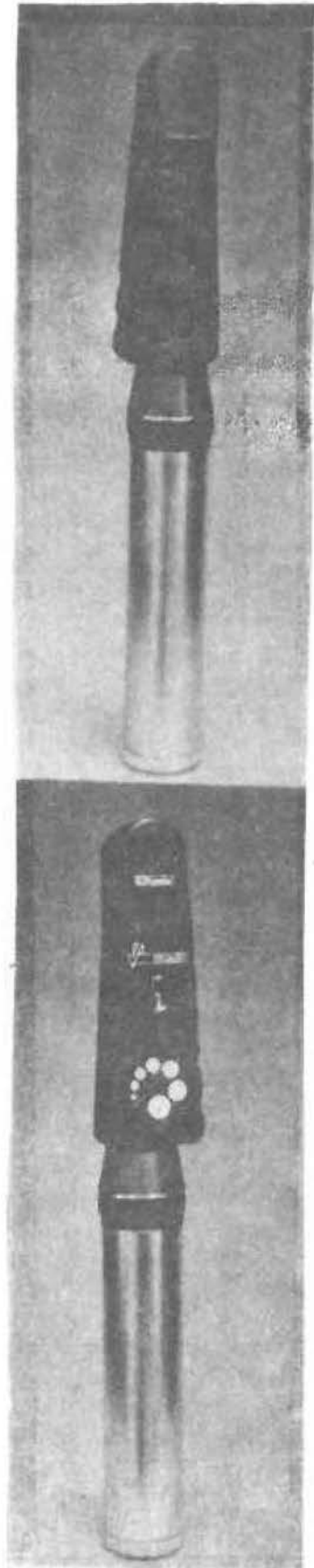
**Options:**  
Charging systems: Well charger, coil cord

**Special Features:** Pupillometer, Focal illuminator  
Illumination rheostat

**Suggested Retail Price:** \$ 644.00 (without case)

**Manufacturers warranty:** 1 year parts and labor excluding bulbs

Keeler Instruments, Inc.  
456 Parkway  
Broomall, PA 19008  
1-800-523-5620



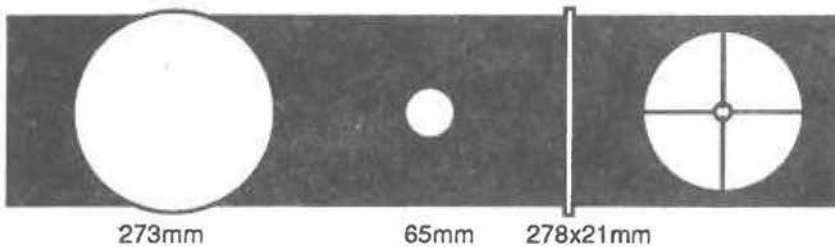
## KEELER VISTA 20

**Overall height:** 224mm  
**Head dimensions:** 76mm x 43mm x 24mm  
**Weight:** 377 grams

### Lenses:

**Range:** 59 diopters (-30 to +29)  
**Primary lens selector:** -10 --> +9  
**Auxillary lens selector:**  $\pm 20$   
allows -30 to +29 in one diopter steps

### Apertures:



### Filters:

Clear  
Red free\*  
Cobalt\*  
Yellow\*  
\*Useable with all apertures

**Maximum light output:** 1500 lumens  
**Minimum light output:** <10 lumen

**Battery Discharge Rate:**  
250 lumens: 65/2 minutes

### Options:

Charging systems: Well charger, mobile charger

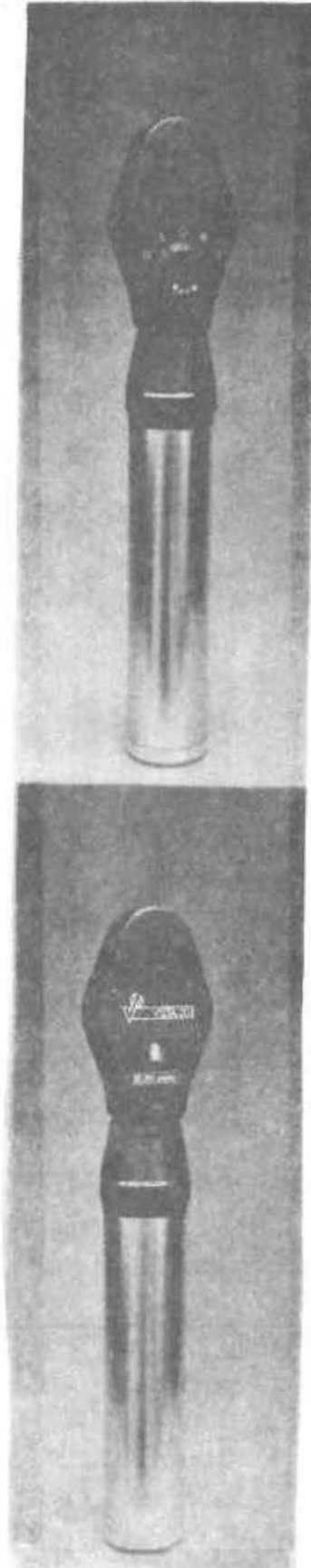
### Special Features:

Cover for viewing aperture  
Illumination rheostat

**Suggested Retail Price:** \$ 283.00 (w/o case), \$ 31.00 (case)  
\$ 708.00 (diagnostic kit)  
\$ 390.00 (double charger)  
\$ 150.00 (single charger)  
\$ 68.00 (mobile charger)

**Manufacturers warranty:** 1 year parts and labor excluding bulbs

Keeler Instruments, Inc.  
456 Parkway  
Broomall, PA 19008  
1-800-523-5620



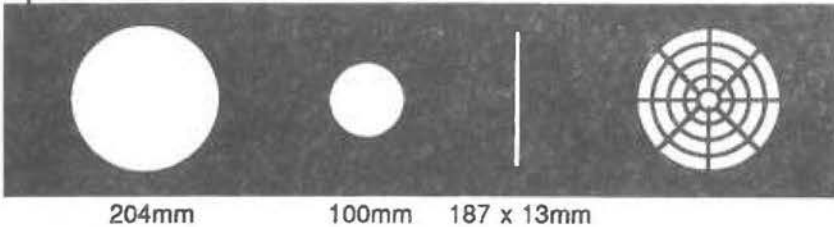
## NEITZ BX ALPHA

**Overall height:** 224mm  
**Head dimensions:** 88mm x 45mm x 23mm  
**Weight:** 295 grams

### Lenses:

**Range:** 71 diopters (-36 to +35)  
**Primary lens selector:** -12 --> +11  
**Auxiliary lens selector:**  $\pm 24$   
allows -36 to +35 in one diopter steps

### Apertures:



**Filters:** Clear  
Red free only for one aperture  
Polaroid\*  
4,000K\*  
\*Useable with all apertures

**Maximum light output:** 625 lumens  
**Minimum light output:** 110 lumens  
**Battery Discharge Rate:** 56/3 minutes

### Options:

**Charging systems:** Wall outlet, well charger  
**Other power systems:** C-cell, AA-cell, rechargeable batteries, cord handle

### Special Features:

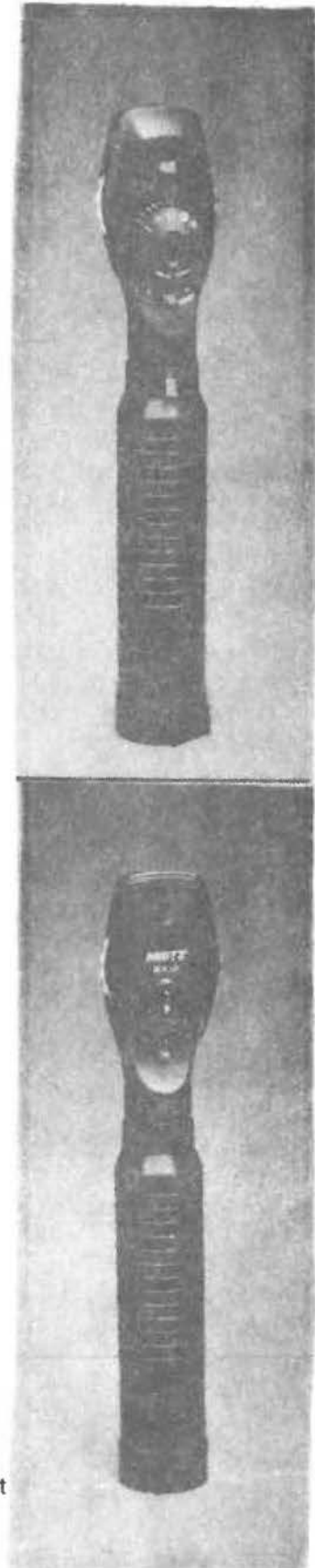
Diopter indicator reads actual lens power even when utilizing auxiliary lenses, polarizing filter in viewing aperture, viewing aperture cover, rubber brow rest, slide out plug for charging, illumination with rheostat

**Suggested Retail Price:** \$ 158.00 (head), \$ 167.00 (plug in handle),  
\$ 130.00 (well charger handle),  
\$ 212.00 (double charger)

**Manufacturers warranty:** 1 year unconditional

Kowa Optimed, Inc.  
20001 S. Vermont Avenue  
Torrance, CA 90502  
1-800-678-6433

Available in Northwest at Opticraft or Lombart

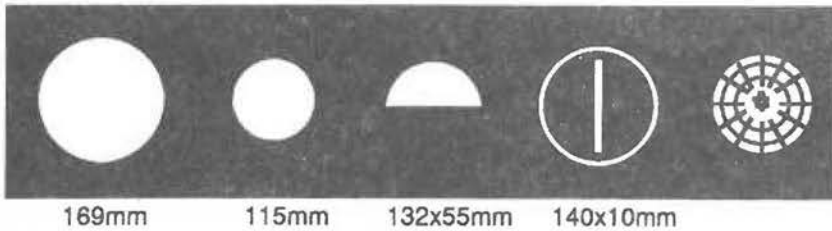


# PROPPER MMI

**Overall height:** 243mm  
**Head dimensions:** 88mm x 48mm x 27mm (height x width x depth)  
**Weight:** 346 grams

**Lenses:**  
Range: 55 diopters (-35 to +20)  
Primary lens selector: -35, -30, -25, -20, -15, -10 -->  
+10, +15, +20  
allows -10 to +10 in one diopter steps

## Apertures:



**Filters:** Clear  
4,000K only for one aperture  
Red free\*  
\*Useable with all apertures

**Maximum light output:** 430 lumens  
**Minimum light output:** <10 lumens  
**Battery Discharge Rate:** 74/5 minutes

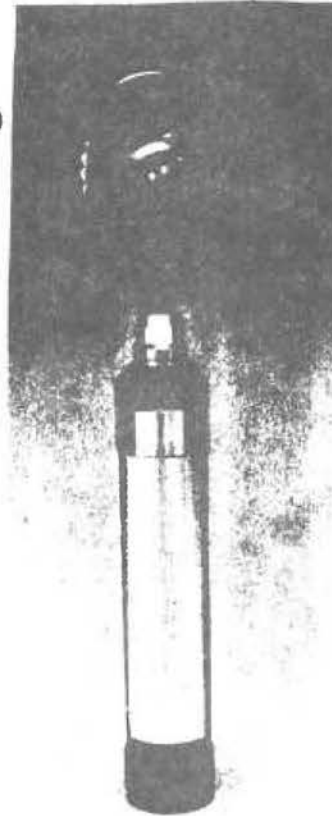
**Options:**  
Charging systems: Wall outlet, well charger  
wall transformer

**Special Features:**  
Illumination rheostat with reserve  
Rubber brow rest

**Suggested Retail Price:** \$ 450.00

**Manufacturers warranty:** Contact your sales representative

Propper Manufacturing Co., Inc.  
3604 Skillman Ave.  
Long Island City, N.Y. 11101  
718-392-6650



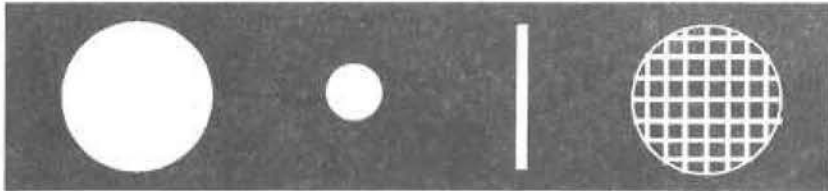
## RI-SCOPE VARIFOCAL

**Overall height:** 230mm  
**Head dimensions:** 88mm x 45mm x 20mm  
**Weight:** 406 grams

### Lenses:

**Range:** 65diopters (-25 to +40)  
**Primary lens selector:** -25, -20, -15, -10, -8, -6 --> +6,  
+8, +10, +12, +15, +20, +40

### Apertures:



195mm

71mm

186x22mm

**Filters:** Clear  
Red free useable with only one aperture

**Maximum light output:** 500 lumens  
**Minimum light output:** < 10 lumens

**Battery Discharge Rate:** 17/2 minutes

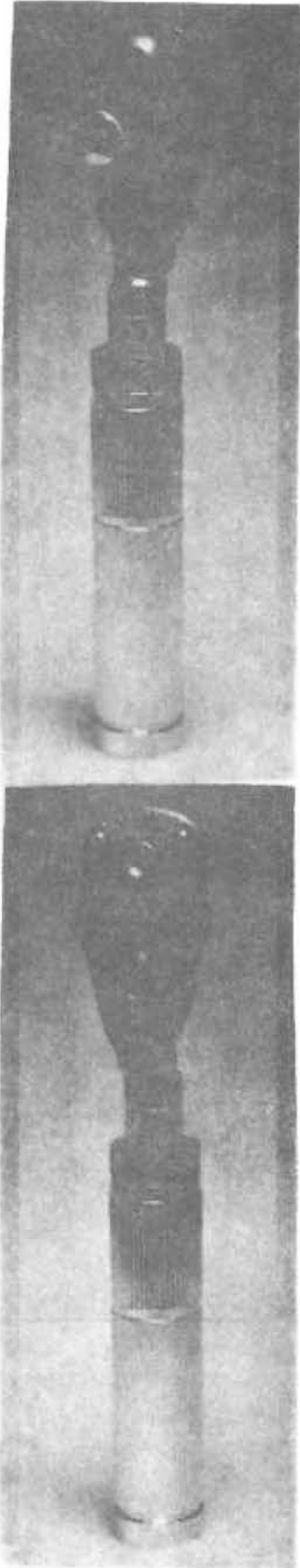
**Options:**  
Charging systems: Wall outlet

**Special Features:**  
Illumination rheostat  
Focusable projection system

**Suggested Retail Price:** \$ 225.00 with condensing lens

**Manufacturers warranty:** 90 days full warranty

Franel Optical Supply Co.  
111 Atlantic Drive  
P.O. Box 940096 (??)  
Maitland, FL 32751  
1-800-327-2070



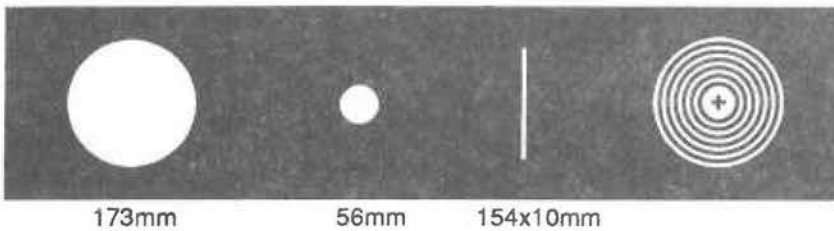


## VISUSCOPE 2000

**Overall height:** 244mm  
**Head dimensions:** N/A x 36mm x 25mm  
**Weight:** 295 grams

**Lenses:**  
Range: 55 diopters (-31 to +24)  
Primary lens selector: -31 to +24 in one diopter steps

### Apertures:



**Filters:** Clear\*  
Cobalt blue\*  
Red free\*  
\*Useable with all apertures

**Maximum light output:** 390 lumens  
**Minimum light output:** < 10 lumens

**Battery Discharge Rate:** 3 hrs. 47 min.  
(time to drop from 250 to 0 lumens)

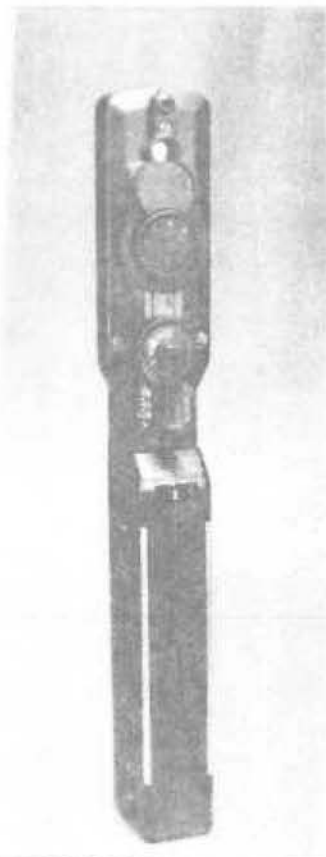
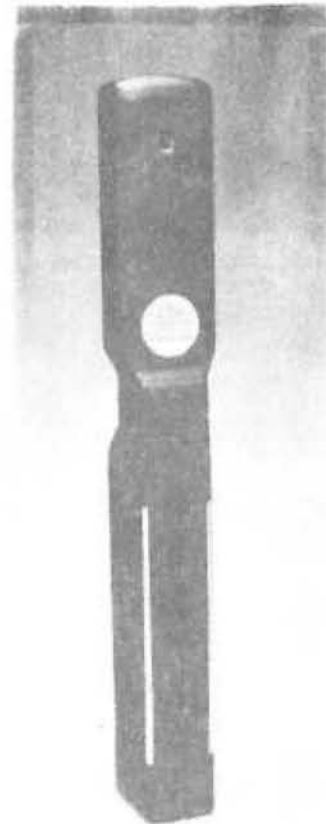
**Options:**  
Charging systems: Well charger, AA batteries  
Apertures: E-hooks for testing crowding phenomenon  
Reticule to survey tumors  
Others upon request

**Special Features:**  
Auto on by contact  
Illumination rheostat  
Focusable projection system (range: +8 to -12 D)  
Diopter indicator located close to viewing aperture.

**Suggested Retail Price:** \$ 727.00 (scope), \$ 182.00 (charger)  
\$ 36.24 (case)

**Manufacturers warranty:** 1 year parts and labor

Oculus of America  
1958 N. State Road 427, Suite #108  
Longwood, FL 32750  
1-800-255-8354

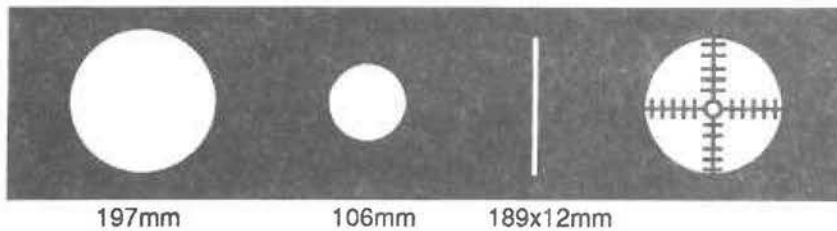


## WELCH ALLYN 11730 AUTOSTEP

**Overall height:** 215mm  
**Head dimensions:** 71mm x 43mm x 26mm  
**Weight:** 348 grams

**Lenses:**  
Range: 68 diopters (-30 to +38)  
Primary lens selector: -30 to +38 in one diopter steps

### Apertures:



**Filters:** Clear\*  
Cobalt blue only useable with one aperture  
Red free\*  
Polaroid\*  
\*Useable with all apertures

**Maximum light output:** 1295 lumens  
**Minimum light output:** < 10 lumens

**Battery Discharge Rate:** 64/1 minutes

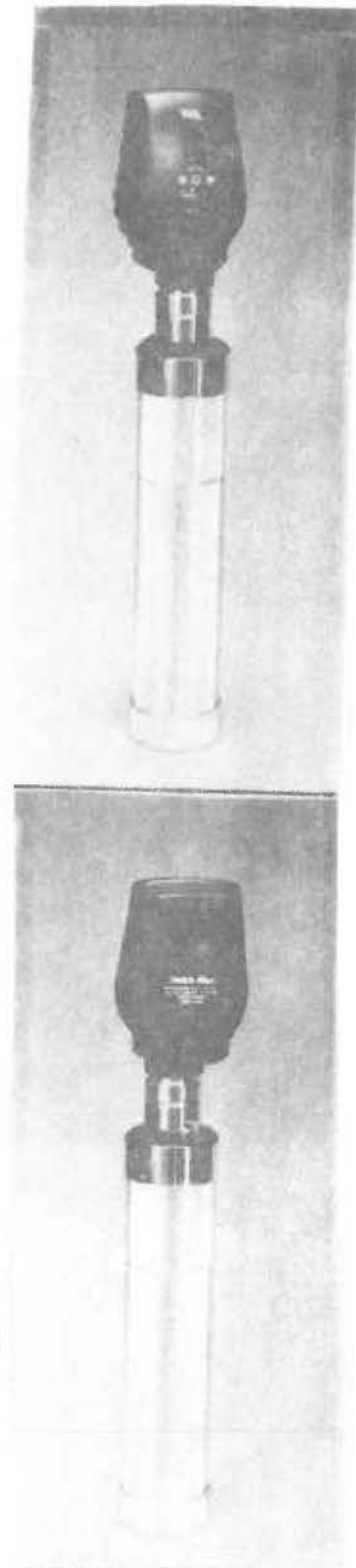
**Options:**  
Charging systems: Wall outlet, well charger  
wall transformer

**Special Features:**  
Illumination rheostat  
Rubber forehead rest  
Automatic diopter progression with actual lens power displayed

**Suggested Retail Price:** \$ 210.10 (head), \$ 99.15 (handle)  
\$ 33.55 (hard case), \$ 18.55 (soft case)

**Manufacturers warranty:** Lifetime guarantee  
(manufacturing defects only)

Welch Allyn, Inc.  
State Street Road  
Skaneateles Falls, N.Y. 13153-0220  
315 - 685 - 4560

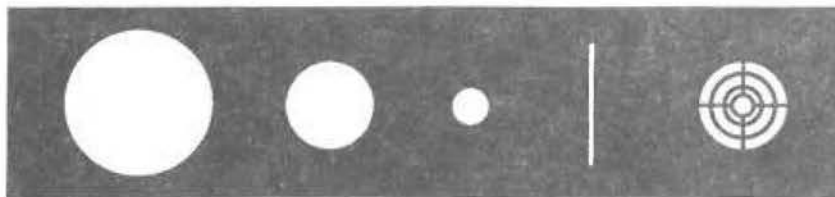


## KEELER VISTA POCKET OPHTHALMOSCOPE

**Overall height:** 173mm  
**Head dimensions:** 54mm x 22mm x 22mm (height x width x depth)  
**Weight:** 114 grams

**Lenses:**  
Range: 40 diopters (-20 to +20)  
Primary lens selector: -20, -15, -10, -5, -3 -->  
+4, +6, +10,+15,+20

### Apertures:



196mm      119mm      50mm      164x15mm

**Filters:** Clear  
Red free only for one aperture  
Red free with fixation target

**Maximum light output:** 280 lumens (large aperture)

**Battery Discharge Rate:** Not available

**Options:**  
Other power systems: AA-cell, rechargeable batteries

**Comments:** No illumination rheostat

**Suggested Retail Price:** \$ 220.00

**Manufacturers warranty:** 1 year parts and labor excluding bulbs

Keeler Instruments, Inc.  
456 Parkway  
Broomall, PA 19008  
1-800-523-5620

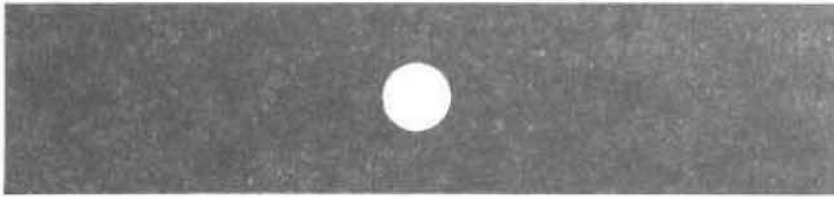


# MAYLITE

**Overall height:** 199mm  
**Head dimensions:** 79mm x 42mm x 21mm  
**Weight:** 101 grams

**Lenses:**  
Range: 65 diopters (-25 to +40)  
Primary lens selector: -25, -20, -15, -10, -8, -6, -4, -2 -->  
+4, +6, +8, +10, +15, +20, +40

## Apertures:



9.5 mm

**Filters:** Clear

**Maximum light output:** 95 lumens  
**Minimum light output:** Not applicable

**Battery Discharge Rate:** Not available

**Options:**  
Charging systems: AA alkaline batteries

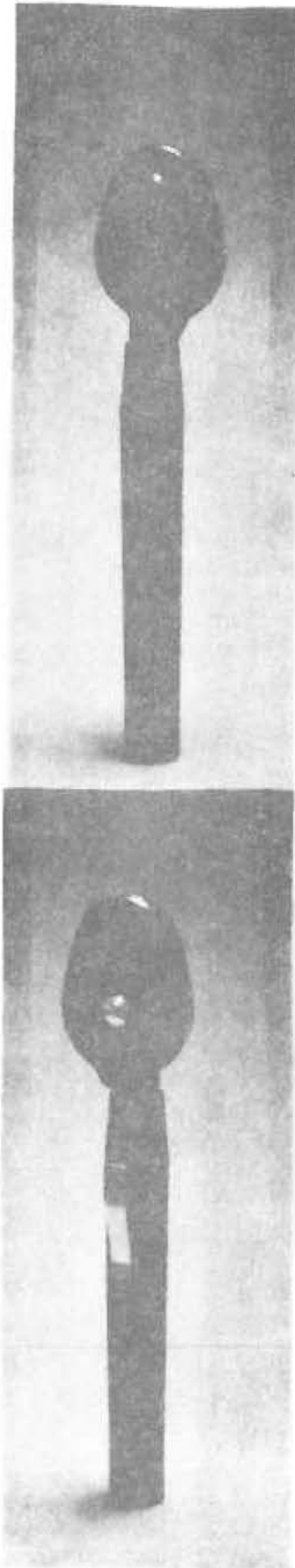
**Special Features:** None

**Comments:** No illumination rheostat

**Suggested Retail Price:** \$ 69.00

**Manufacturers warranty:** 90 days full warranty

Franel Optical Supply Co.  
111 Atlantic Drive  
P.O. Box 940096  
Maitland, FL 32751  
1-800-327-2070

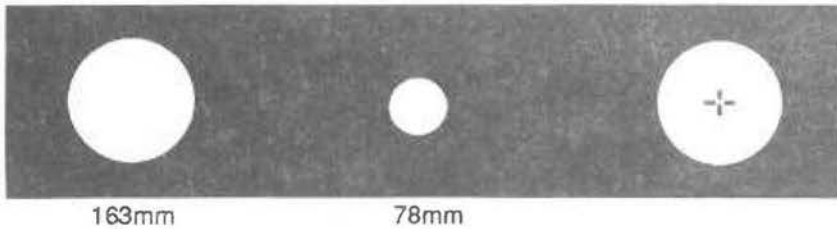


## NEITZ POCKET OPHTHALMOSCOPE GX

**Overall height:** 169mm  
**Head dimensions:** N/A x 28mm x 22mm  
**Weight:** 94 grams

**Lenses:**  
Range: 40 diopters (-25 to +15)  
Primary lens selector: -25, -20, -16 to +10 in two diopter steps, +15

### Apertures:



**Filters:** Clear  
Red free only for one aperture

**Maximum light output:** 270 lumens (large aperture)

**Battery Discharge Rate:** Not available.

**Options:**  
Other power systems: AA-cell, rechargeable batteries

**Comments:**  
Diopter indicator is not luminous. No illumination rheostat.

**Suggested Retail Price:** Contact your sales representative

**Manufacturers warranty:** Contact your sales representative

Kowa Optimed, Inc.  
20001 S. Vermont Avenue  
Torrance, CA 90502  
1-800-678-6433



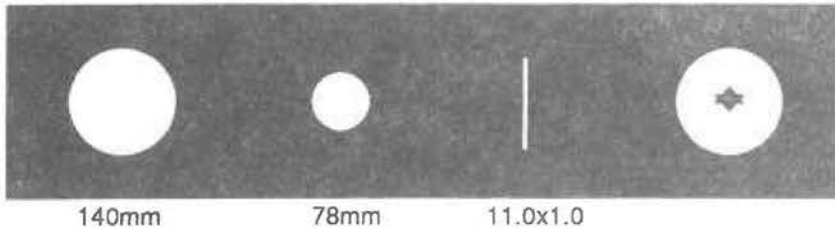
## PROPPER PLUS MAGNALUME POCKET OPHTHALMOSCOPE

**Overall height:** 180mm  
**Head dimensions:** 57mm x 31mm x 25mm (height x width x depth)  
**Weight:** 164 grams

### Lenses:

**Range:** 50 diopters (-30 to +20)  
**Primary lens selector:** -10 --> +10  
**Auxillary lens selector:** -20, +10  
allows -30 to +20 in one diopter steps

### Apertures:



**Filters:** Clear\*  
Red free\*  
\*Useable with all apertures

**Maximum light output:** 325 lumens  
**Minimum light output:** < 10 lumens

**Battery Discharge Rate:** Not available

### Options:

**Charging systems:** Well charger  
**Other power systems:** AA-cell

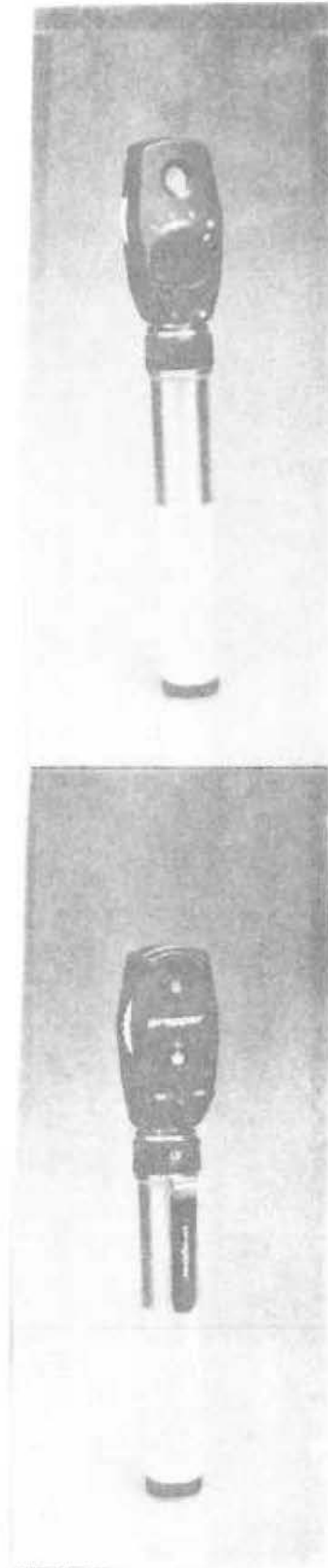
### Special Features:

Illumination rheostat  
Rubber brow rest

**Suggested Retail Price:** \$ 350.00

**Manufacturers warranty:** Contact your sales representative

Propper Manufacturing Co., Inc.  
3604 Skillman Ave.  
Long Island City, N.Y. 11101  
718-392-6650

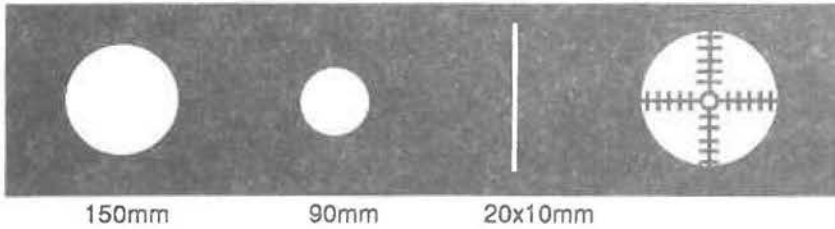


## WELCH ALLYN POCKET OPHTHALMOSCOPE

**Overall height:** 178mm  
**Head dimensions:** NA x 27mm x 23mm  
**Weight:** NA

**Lenses:**  
**Range:** 47 diopters (-25to +22 ) in one diopter steps  
(with auxillary lens selector)

### Apertures:



**Filters:** Clear  
Red free\*  
4000K\*  
\*Only for one aperture

**Maximum light output:** 185 lumens

**Battery Discharge Rate:** Not available.

**Options:**  
Charging systems: Well charger

**Special Features:**  
Illumination rheostat  
Rubber brow rest  
Polaroid front shield

**Suggested Retail Price:** \$ 249.00 (non-rechargeable w/ case)  
\$ 211.05 (w/ soft case)  
\$ 65.05 (well charger)

**Manufacturers warranty:** Lifetime guarantee  
(manufacturing defects only)

Welch Allyn, Inc.  
State Street Road  
Skaneateles Falls, N.Y. 13153-0220  
315 - 685 - 4560

## KEELER VISTA STREAK RETINOSCOPE

**Overall height:** 241mm  
**Head dimensions:** 93mm x 31mm x 35mm  
**Weight:** 366 grams

**Range from Plano to Concave Mode:** -50cm to +24cm  
(-2 D to +4.16 D)

**Streak Dimensions:** 90mm x 2mm

**Maximum light output:** 810 lumens  
**Minimum light output:** <10 lumen

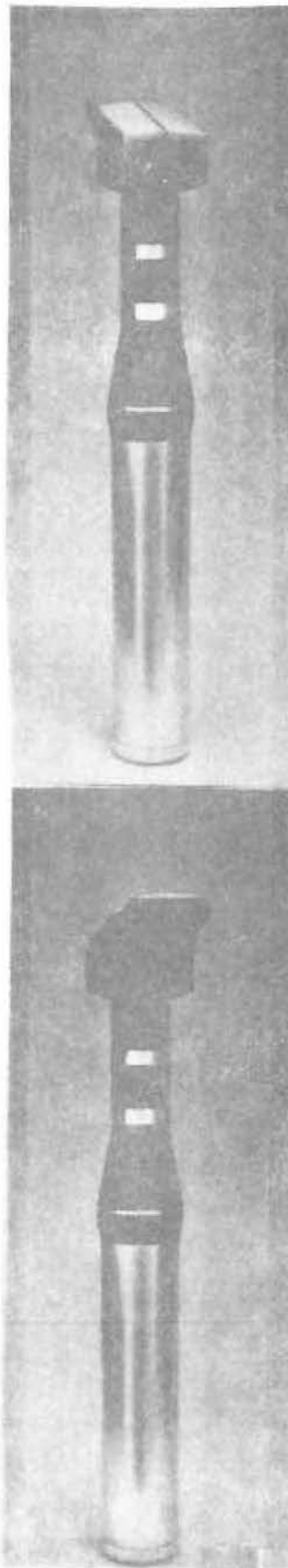
**Options:**  
Charging systems: Well charger, mobile charger

**Special Features:**  
Illumination rheostat  
Two viewing apertures  
Interchangeable forehead rests

**Suggested Retail Price:** \$ 362.00 (without case)

**Manufacturers warranty:** 1 year parts and labor excluding bulbs

Keeler Instruments, Inc.  
456 Parkway  
Broomall, PA 19008  
1-800-523-5620





## NEITZ RX SPOT RETINOSCOPE

**Overall height:** 265mm  
**Head dimensions:** 131mm x 32mm x 31mm  
**Weight:** 305 grams

**Spot Size:** 31mm (diameter)

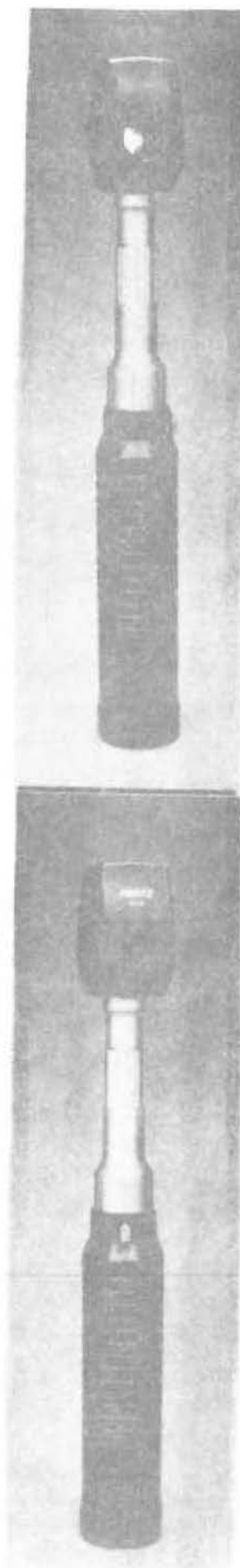
**Maximum light output:** 810 lumens  
**Minimum light output:** 30 lumens

**Power system:** C-cell batteries only

**Suggested Retail Price:** \$ 287.00 (head only)

**Manufacturers warranty:** 1 year unconditional

Kowa Optimed, Inc.  
20001 S. Vermont Avenue  
Torrance, CA 90502  
1-800-678-6433



## NEITZ RX STREAK RETINOSCOPE

**Overall height:** 271mm  
**Head dimensions:** 135mm x 32mm x 31mm  
**Weight:** 345 grams

**Range from Plano to Concave Mode:** -50cm to +18 cm  
(-2 D to +5.5D)

**Streak Dimensions:** 109mm x 2mm

**Maximum light output:** 810 lumens  
**Minimum light output:** 10 lumens

### Options:

Charging systems: Wall outlet, well charger  
Other power systems: C-cell, AA-cell, rechargeable batteries,  
cord handle  
+2D presbyopic lens can be inserted into the aperture

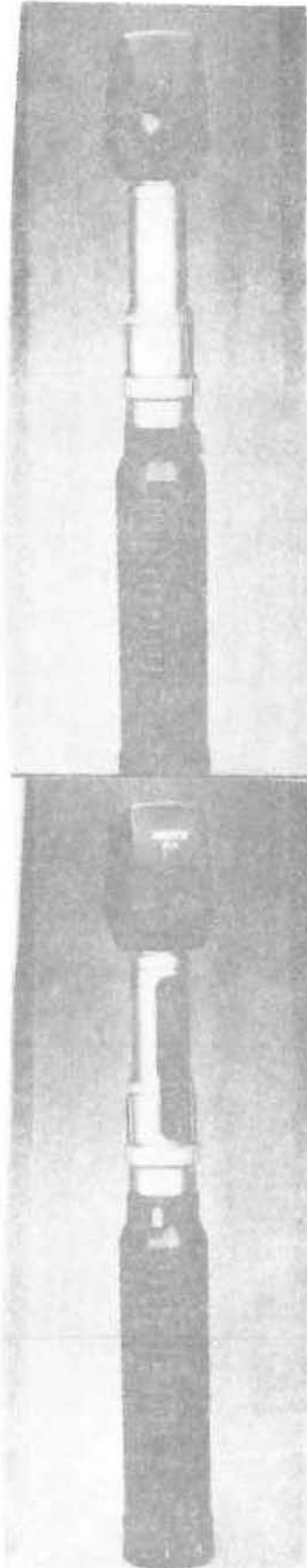
### Special Features:

Head can be rotated for any preferred position  
Illumination rheostat

**Suggested Retail Price:** \$ 254.00 (head only)

**Manufacturers warranty:** 1 year unconditional

Kowa Optimed, Inc.  
20001 S. Vermont Avenue  
Torrance, CA 90502  
1-800-678-6433



## PROPPER STREAK RETINOSCOPE

**Overall height:** 292mm  
**Head dimensions:** 137mm x 42mm x 44mm  
**Weight:** 408 grams

**Range from Plano to Concave Mode:** -15.8cm to +36.5cm  
(-6.33D to +2.75D)

**Streak Dimensions:** 105mm x 2mm

**Maximum light output:** 920 lumens  
**Minimum light output:** 10 lumens

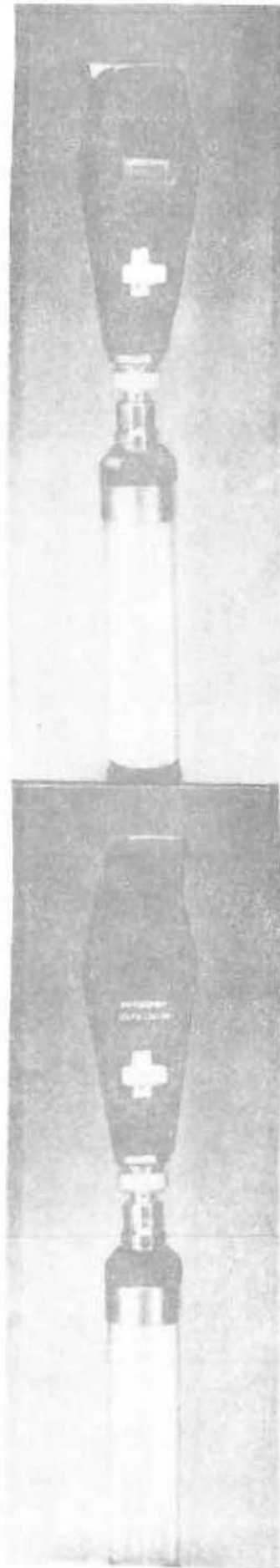
**Options:**  
Charging systems:     • Wall outlet, well charger  
                                   • wall transformer

**Special Features:**  
Illumination rheostat with reserve  
Two viewing apertures  
Interchangeable forehead rests (one for use with spectacles)  
Dust cover

**Suggested Retail Price:** Contact your sales representative

**Manufacturers warranty:** Contact your sales representative

Propper Manufacturing Co., Inc.  
3604 Skillman Ave.  
Long Island City, N.Y. 11101  
718-392-6650



## WELCH ALLYN STREAK RETINOSCOPE (PROTOTYPE)

**Overall height:** 256mm  
**Head dimensions:** 111mm x 35mm x 41mm  
**Weight:** 383 grams

**Range from Plano to Concave Mode:** -77cm to +31cm  
(-1.3 D to +3.2 D)

**Streak Dimensions:** 65 cm x 1 cm

**Maximum light output:** 810 lumens  
**Minimum light output:** < 10 lumens

**Options:**  
Charging systems: Wall outlet, well charger  
wall transformer

**Special Features:**  
Illumination rheostat  
Rubber spectacle guard  
Magnet for dynamic retinoscopy (MEM)  
Polarized filters  
Completely enclosed system -- dust proof

**Suggested Retail Price:** \$ 230.00

Welch Allyn, Inc.  
State Street Road  
Skaneateles Falls, N.Y. 13153-0220  
315 - 685 - 4560

