A Glossary of Spectacle Mounted Telescopes Commonly Used in Vision Rehabilitation

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With an increase in the aging population in the United States comes an increase in the number of people suffering from age-related visual impairments. Optometrists will be challenged to treat patients with age-related macular degeneration; the leading cause of blindness in the U.S. for individuals over sixty-five, as well as other visually-impairing diseases such as diabetic retinopathy. The patients that are dealt such pathology face serious physical and psychological roadblocks in carrying on normal daily activities such as driving a car or reading the newspaper. While there are surgical treatment options available in certain cases, most people are left searching for other sources of aid. Thus, paralleling the rise in visual disabilities is the increase in number of telescopic devices intended to help these individuals. The large number of devices available and enormous differences in each scope's characteristics can make choosing the telescopic device appropriate for each unique patient's needs very confusing. This confusion can lead to inappropriate assignment of a device, or worse; no attempt at prescription at all. The intend of this paper is to present an objective glossary and description of some of the currently most commonly prescribed spectacle-mounted telescopes in visual rehabilitation.

Telescopes are used as low vision devices to magnify a desired object. These devices can be divided into several categories. The classic division of telescopes is according to optical design; galilean vs. keplarian. The difference between these two lie in the optics of the telescope's lenses. There are two basic lenses that makeup a telescope in order to produce a magnified image of the regarded object. The objective lens is the lens nearest the object. The ocular lens is the lens nearest the observer's eye. In a galilean telescope both the objective and the ocular lenses are convex; creating a virtual, erect image. In a keplarian telescope the objective lens is convex, while the ocular lens is concave; creating a real, but inverted image. Thus in order to erect the image, an additional lens must be added, making the keplarian a longer telescope. Depending on design of each unique telescopic system, numerous other lenses may be used such as prisms and/or mirrors to direct the lightpath in the unit. The galilean scope as a low vision device has the benefit of being smaller, more compact, and lighter. The keplarian scope, while being longer and heavier, typically offers a larger field of view than the same magnification galilean scope. (table 1)

Another way in which spectacle-mounted telescopes are referred to is according to the position in which the telescope is placed in the carrier lens and resultant field of view. This paper will suggest that there are two basic divisions of positioning; full field and bioptic. The full field position places the telescope at the center of the patient's pupil in a straight-ahead orientation. This results in the patient viewing through the telescope only and the carrier lens simply functioning to hold the telescope in the frame. The second general category, bioptic spectacle mounted telescopes, refers to a set-up consisting of the telescopic device and a useable carrier lens which holds the patient's distance prescription. Thus both the telescope and carrier lens serve a purpose. The traditional bioptic position places the scope above the line of sight at an upwards inclination. In order for the patient to view through the telescope, he or she must make a head tilt downwards to bring the line of sight into the scope. The patient will view through the distance prescription placed in the carrier lens during straight-ahead gaze. A second category of bioptic positioning was created with the advent of the miniature galilean telescopes with their very small diameters. Due to such small diameters, it is possible to position these telescopes just off of the center of the pupil laterally so that with merely an eye movement into the scope the patient can see through telescope for magnification and at the same time through the carrier lens to retain full peripheral field of view. This author will refer to this second type of bioptic positioning as the "concurrent viewing" position (this position is identical to what Edwards Optical has patented the "bi-level" or "simultaneous viewing" position for its 3/8 diameter BITA telescope). While Table 3 will attempt to categorize the telescopes presented in this paper according to positioning, practitioner and patient individuality of positioning will vary.

The final category this paper will present is based on the ability and mechanism of focusing. The earliest telescopes were non-focusable devices that were fixed for distance magnification and required what is referred to as a "reading cap"; an additional lens that could be placed over the end of the telescope for near magnification. The next generation of telescopes were designed to cover a range of focusability from distance to near that was done manually by the patient through different mechanisms. The newest design is an automatic-focus device designed by Ocutech, Inc. in which the telescope can focus at a desired distance without the patient's manual operation. (table 2)

The telescopes that will be described in this paper differ in many parameters. It is important to understand and be familiar with these differences when choosing the most appropriate scope for a patient's specific needs. Some of the characteristics that telescopes differ in are; range of magnification available, field of view, depth of field, weight, length, amount of protrusion from frame, diameter, and retinal illuminance. A few other factors that the practitioner should consider are price, type of frame available for use with the scope, and fitting method. It is important to know the range of magnification available from a certain scope as well as the appropriate magnification a patient needs before introducing a patient to a specific type. One must choose the magnification that is appropriate according to that patient's visual resolution (visual acuity), remembering if a patient's visual resolution is better that the resolution of the image that the telescope creates, then the patient will not benefit from its magnification. (Keeping in mind that with an increase in magnification there is a decrease in resolution; meaning larger magnification power isn't always better). For example, the image resolution of a 20/30 individual is 2.5 minutes while the resolution of a 6x microspiral galilean telescope is 2.7 minutes. Thus a 6x telescope actually offers this individual poorer resolution despite its strong magnification power. Field of view is another important consideration when choosing a specific telescopic device. A patient may demand a large field of view for reading the newspaper or staring at a computer terminal, while someone who wants a telescope for scanning street signs and traffic lights while driving may not need as large a field of view in the telescopic device. Depth of field is the range of clear vision that the telescope can focus. Different tasks will demand a differ range of focusability. The weight, length, amount of protrusion from frame and style of frame available will determine the cosmesis and comfort of a telescopic system. The diameter of the scope and resultant retinal illuminance is another consideration. The diameter of the telescope's objective lens aperture divided by the magnifying power of the telescope equals the diameter of the exit pupil. Retinal illuminance is directly proportional to the exit pupil; thus smaller scopes with small apertures will produce a reduced retinal illuminance, meaning the patient will receive a dimmer image than those produced by larger scopes. Other aspects that practitioner must take into consideration are the pricetag differences between telescopic devices as well as whether the scope will be sent in-lab to be mounted or whether it will be done in-office. Beyond these aforementioned characteristics that all of the telescopic devices share are the unique advantages and disadvantages that will be presented for each individual device.

Designs For Vision, Inc. (DVI), was one of the first companies to manufacture telescopes for use as low vision devices. The first generation telescope was a full-diameter galilean device placed in the full field position (table 3). This design allows for stationary distance tasks only due to the limited field of view (table 5), as well as its fixed-focus (table 2). For added field of view, DVI designed a wide angle version of the 2.2x and 3.0x telescopes (table 5). These scopes came in a range of magnification powers from 1.3x to 4x (table 4). The devices range in length from 17mm to 26mm (table 8), with most of this protruding out from the frame (table 9). The frame designed for this scope is referred by DVI as a "Yeoman 6" frame, however any frame with adjustable nosepads is suitable (table 12). The weight of the telescope runs from approximately 20-40gms, depending on magnification (table 7).

In order to make this first generation device more usable, DVI created a second generation galilean telescope by merely changing the mounting to the traditional bioptic position thus allowing mobility. These scopes come in a similar range of powers and parameters as the full-diameter telescope with the 3x and 4x telescope being identical to each category (tables 4-10).

To expand on range of use, DVI developed a focusable, spiral-expanded field prism telescope, or Keplarian design. This telescope design offers a wide range of magnification; from 2x to 10x (table 4), a larger field of view; 18-2.5 degrees (table 5), and is focusable from infinity down to ten inches (table 6). However, due to its Keplarian optics, the scope increases in length (table 8), protrusion from front of frame (table 9), and weight (table 7), in which each of these parameters are the greatest of any telescopic device currently available. This scope can be mounted in either the center of the carrier lens as a full-field or in the traditional bioptic position above the pupil (table 3).

In order to create a galilean telescope that was focusable, DVI designed one with a spiral focusing mechanism found on the front of the telescope (table 2). It then offered a galilean device with a depth of field from infinity down to twelve inches (table 6). The additional parameters are similar to the first and second generation galilean telescopes (tables 4,5,7-10).

To address the issue of cosmesis, DVI created a third generation galilean scope labeled the micro-spiral galilean telescope which offers reduced length; the longest being 20mm (table 8), decreased amount of protrusion (table 9), and weight (table 7). The available range of magnification from 2.2x to 6.0x (table 4) and depth of field from infinity to 10 inches (table 6) is similar to the first and second generation galilean devices. However, because of the miniaturized size and diameter (table 10), the available field of view is reduced slightly from these first two scopes; ranging from 7 to 3 degrees (table 5). Also, because of the decreased diameter of the device, there is a decrease in retinal illuminance provided through the scope resulting in the user perceiving a dimmer image compared to larger diameter telescopes. The micro-spiral galilean has a unique ball-and-socket housing in which allows the scope to be adjusted in the carrier lens to line up the optics with the user's visual axis. This is especially helpful for patients who eccentrically view or have large phoric positions.

An entirely differently designed telescope developed by DVI is the Eagle Eye II telescope. This is a small, galilean scope that is mounted in the traditional bioptic position (tables 1 and 3). The scope protrudes behind the lens to provide a less conspicuous device(table 9). It comes in one power of 2.2x (table 4), with a field of view of 11 degrees (table 5). It is an unfocusable, distance-only telescope (tables 2 and 6). Any frame with adjustable nosepads can be used with this device (table 12). It offers the advantage of cosmetic appeal, however a disadvantage to consider is the risk of a scope that protrudes behind the lens near the patients eye, as well as the limited power available and distance-only magnification. The Eagle Eye also offers ball-and-socket housing like the micro-spiral galilean.

The DVI telescopic low vision aids have the advantage of being easy to use; especially the full-diameter galilean devices. This is especially helpful when introducing telescopic aids to a patient for the first time. Those who can't raise their hands up or don't have the dexterity to refocus can also benefit from these devices. The patient whose primary concern is a device that offers a large field of view may appreciate the expanded-field, spiral keplarian design. Most of the DVI telescopes fall into a reasonable price range compared to some of the more sophisticated devices. However, this group of low vision aids, besides the micro-galilean and eagle eye, lack in cosmetic appeal and comfort due to the length and therefore amount of protrusion from the frame and weight of the scope, especially the Expanded-field spiral keplarian. The lack of focusability or difficulty of using the manual focusing mechanism is another negative characteristic.

The company S. Walters, Inc. has a line of spectacle-mounted telescopes similar to those offered by DVI. The Walters scope that this paper will present is the Walters focusable mini monocular galilean device (tables 1,2). It claims sharp optics, comes in magnification of 2.2x and 3.0x (table 4), has a field of view of 9 and 10 degrees respectively (table 5) and is lightweight (table 7). Its parameters and advantages are similar to DVI's spiral galilean, while some patients claim better optics with the Walters. One advantage of the Walters mini is its very low pricetag; considerably lower than any of the other scopes presented, even those such as the DVI spiral galilean claiming similar features (table 11).

Edwards Optical Corporation created the Bilevel Telemicroscopic Apparatus (BITA), a spectacle mounted telescope designed with the aim at offering increased cosmesis, decreased weight, as well as increased field of view. It is a "miniature" galilean telescope (table 1) that comes in two diameters; 3/8 inch and 1/2 inch (table 10). The small 3/8 inch sits in the center of the carrier lens offering what Edwards Optical has patented "simultaneous viewing" (the phrase in this paper to identify all other telescopes with this similar positioning has been labeled "concurrent viewing" for the sake of patent laws). This design allows the patient to "simultaneously view" out of both the telescope and the carrier lens which adds a larger field of view for the patient through the periphery of the carrier lens (table 3). The 1/2 inch diameter sits in the traditional bioptic position, requiring the patient to make a head tilt to use the telescope. The BITA telescope is mounted so that the objective lens of the scope is in nearly the exact plane as the front of the carrier lens thus their is little protrusion from the front of the lens; approximately 3-5mm (table 9) and the eyepiece is then behind the lens. There have been four generations of BITA telescopic devices. BITA IV is the most recent, with powers ranging from 2.5-6.0x magnification for both diameters (table 4). This latest design offers a broader field of view; ranging from 10.5 to 5.5 degrees depending on power and diameter (table 5). This field of view is actually larger than the micro-spiral galilean designed by DVI, but less than the earlier, larger diameter DVI telescopes. Both diameter scopes have a spiral focusing mechanism that comes standard in the rear of the scope but can be ordered in the front (table 2). The depth of field for the 3/8 inch telescope is for distance infinity to 3-4 feet and they can be refocused for closer near viewing. Without refocusing, the distance depth of field for the 1/2 diameter is dependent on magnification, the 3.0x range from 3-4 feet out to 100-150 feet and from 6-7 feet to 300-350 feet, the 4x and 6x remain in focus from

4-5 feet to infinity (table 6). These devices can be refocused with the spiral front or back mechanism to allow for near viewing as the 3/8 inch scope. The BITA IV scopes, like most micro-galilean devices, are very small and lightweight; with a length ranging from 12.6 to 22 mm.(table 8), with most of the scope behind the lens, and an average weight of .75 gm (table 7). Both of these scopes are sent into the lab for mounting with a frame that has adjustable nosepieces and properly marked monocular pupil positioning (tables 12 and 13).

The BITA IV telescope as a low vision device offers cosmesis and comfort due to its small size and weight. Its field of view is similar if not larger depending on magnification when compared to the other micro-galilean devices (table 5). The 3/8 inch diameter has the advantage of "simultaneous viewing" which allows for peripheral field of view through the carrier lens; an especially important feature for those patients who want a telescopic device for driving. However, the positioning of the eyepiece behind the lens, similar to the Eagle-Eye by DVI points out a concern for potential injury to the eye on impact. It has been suggested that patients sign a wavier expressing that they have been properly informed of this risk and wave any practitioner responsibility if injury should occur. Another disadvantage is its "clumsy" focusing mechanism, especially rear-focusing models when compared to other user-friendly mechanisms. Although the BITA IV model claims "brighter optics than previous models" due to the small diameter of any micro-galilean scope, the optics will be dimmer in most cases then larger diameter telescopes. The price may be considered high when comparing the price of telescopes with similar features (table 11).

Another miniature galilean telescope is the M-lens designed by M-Tech Optics Corporation. It is available in one standard magnification of 4.1x (table 4). The field of view of 9.8 degrees is comparable to other 4x miniature galilean devices. The M-Lens offers the widest depth of field of all of the telescopic devices compared in this paper; from infinity to six inches (table 6). It has a length of 13.8mm with the eyepiece placed behind the carrier lens, offering no frontal protrusion (tables 8,9) and is similar weight of other miniature galilean scopes (table 7). Its design differs from previously described miniature galilean devices in that instead of being drilled into the carrier lens, it is suspended independent of the lens to allow for later pupillary adjustments (table 12). Its focusing mechanism is a slide-control lever located on top of the frame that is slightly pointed to increase in ease of use, such as for those with neurological impairments that might decrease dexterity, as is the case of some diabetics. The lever has pre-set positions to go directly from distance to near, as well as fine-tuning capabilities (table 2).

Thus, the M-lens, like similar miniature galilean devices offers cosmetic appeal due to its small size and weight. It has the unique advantages of being able to reposition the scope after mounting and an easy-to-use focusing mechanism. Its concurrent-viewing position makes it a good choice for patients who seek a telescopic device for driving purposes. It claims the largest depth of field of any scope makes it the most versatile scope for those who want to use a device for distance and near tasks. It is limited in terms of only one power of magnification. The M-lens carries the risk of having its eyepiece located behind the lens like the BITA and Eagle-Eye devices. Being a small diameter telescope, patients may note dimmer images than with larger diameter scopes. This is typically considered a disadvantage, however, such decreased light gathering capabilities is actually an advantage for those patients suffering from photophobia and glare problems. The M-lens carries a moderately-high pricetag (table 11).

M-Tech Optics Corporation's solution to the problem of the M-lens's dim image was the creation of the Panavex system that became available the summer of 1995. This telescopic device is of galilean design (table 1) with a large, 18.5 inch diameter objective lens (table 10) that is mounted on top of the frame, with a vertical lightpath down to the eyepiece that is located behind the lens in a traditional bioptic position (table 3). The Panavex system has a range of powers from 2.5x to 5.0x magnification (table 4). The depth of field is from infinity to twelve inches (table 6). It provides a larger field of view than any of the telescopes compared with similar magnification; ranging from approximately 21 to 11 degrees (table 5). The focusing mechanism is a precision cam lever located on top of the scope similar to the M-lens(table 2). This device is 20mm long (table 8) with 0-5mm of frontal protrusion (table 9).

The Panavex System's most notable advantage is it's large field of view (largest of all scopes compared in this paper) and bright optics due to its large objective lens. It has an easy-to-use focusing mechanism, and comes in a large range of magnifications. These advantages make it a very versatile telescopic low vision aid. The disadvantages may be a lesser cosmetic appeal than the miniature galilean devices due to its larger size and weight. There is also a limited selection of frames available since the frame must be straight across on top with a single bridge to allow the objective lens to sit on top of the frame properly (table 12). The Panavex system falls into the low to moderate price range and thus may be an economical choice, especially considering all of its beneficial features (table 11).

Ocutech, Inc. has designed three generations of Keplarian bioptic telescopes with the goal of improving on earlier keplarian models that suffer from being cosmetically unpleasing due to optically long design and therefore uncomfortable due to its weight. Thus the Ocutech VES-Horizontal Light Path Enhancing System was developed. It combines a periscope and a keplarian telescope in one device that instead of extending outward like traditional keplarian design, extends horizontally across the entire top frame of the spectacles. There is some protrusion above the frame; 3mm depending on the frame (table 8) with a total length of 19mm (table 8). The Ocutech VES comes in a range of magnification from 3x-6x (table 4).

It's units have a comparable field of view for similar powered EF-Spiral Keplarian, BITA, and M-lens; ranging from 11.5 degrees to 8 degrees (table 5). The depth of field ranges from infinity to 12 inches (table 6). The focusing mechanism is a lever on top of the scope (table 2). The Ocutech VES is placed in the traditional bioptic position (table 3). It comes with a specifically-designed frame that is mounted in-office (table 12,13).

The Ocutech VES is an obvious improvement in terms of cosmesis and comfort when compared to the DVI EF-Spiral Keplarian telescope. Because of its larger diameter, it can offer brighter optics. It has the advantage of in-office mounting to increase fitting accuracy. A disadvantage may be that there is only one style of frame available as well as the head tilt that is necessary to view through the scope can become tiring, especially after prolonged reading.

To make further improvements in the category of keplarian design, Ocutech developed the Ocutech VES Mini; claiming it to be the "smallest, lightest, widest field Keplarian Bioptic telescope". It comes in a standard 3x magnification(table 4) with a large 15 degree field of view (table 5) and depth of field from infinity to 12 inches. Ocutech claims that it has created the Ocutech mini with crisp optics that minimize ring scotoma. It has a spiral-knob focusing mechanism in front of the scope (table 2). The Ocutech VES mini is 42mm long with the objective lens protruding half-way out from the frame and the eyepiece halfway behind, placed in the traditional bioptic position (tables 8,9, and 3). Any frame with adjustable nosepads is acceptable and it is sent in-lab for mounting (tables 12,13)

The Ocutech VES mini is an advantage over the Ocutech VES in that it has a larger field of view, improved optics and a more compact design. This makes it a versatile telescope for reading, watching T.V. and driving. Unlike the first Ocutech VES, the Ocutech VES mini can be used in any style frame with nosepads, giving the patient more options. It is comparable in size and cosmesis to the Panavex system. Its disadvantages are that it is only available in one power and may not be as cosmetically pleasing to some patients when compared with smaller scopes. The Ocutech VES mini is moderately priced (table 11).

The newest Ocutech bioptic telescope and one of the first of its kind is the Ocutech VES-Autofocus telescope. It is a keplarian telescope (table 1) available in one magnification of 4x in a similar design across the spectacle top as the first Ocutech VES (table 4). It has a large field of view compared to similar magnification; of 12.5 degrees (table 5). The weight of the scope is 70 grams (table 7). The depth of field is from infinity down to twelve inches (table 6). The Ocutech VES-AF's unique automatic focusing mechanism is achieved by computer-controlled infrared electro-optics that measure the focusing distance at thirty times per second; less than 1/3 second between any two points. The system signals the distance of the viewed object to a computerized motor which moves the focusing lens into the proper position. There is a battery pack that must be worn with a wire connection that runs up to the telescopic device. The battery is rechargeable and lasts twelve hours. The focusing unit creates a low "whirring sound" each time it changes focus (table 2). The fitting of the system is specific as to right or left eye and mounted when sent into the lab (table 13). Slight adjustments can be made for P.D. and inclination afterwards in the office.

The Ocutech VES-AF is the offers the unique advantage of a hands-off auto-focusing mechanism which can be very beneficial for those who lack the dexterity to manually focus a telescope or those that need both hands free to perform a given task. It is limited to those individuals who require 4x magnification. It is a device that is in a traditional bioptic position, which again requires a head tilt that may become uncomfortable (table 3). The large pricetag of approximately $2,250.00 which includes the telescope, frame, mounting, battery pack and recharger, is a consideration for many individuals, especially the elderly who may be on a fixed income (table 11).

From this glossary, it should be apparent that there are currently a number of different spectacle-mounted telescopic devices available for use as low vision devices. It is important to be familiar with each device's advantages as well as disadvantages in order to choose the most appropriate scope for a patient's desired task. Some of the characteristics that one needs to take into consideration are the magnification, field of view, depth of field, cosmesis and comfort as well as pricetag when selecting a specific telescope. Because of the rise in the aging population in the U.S. and thus rise in age-related visual impairment, optometrists must be aware of the low vision devices such as telescopes that are available to meet such patient's needs. Hopefully proper prescription of telescopic devices will allow visually-impaired individuals to enjoy a more productive and fulfilling lifestyle.

Catagories of Spectacle Mounted Telescopes

TABLE 1

Optics

	DVI Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
Optics	galilean	galilean	keplarian	galilean	galilean	galilean	galilea	galilean	galilean	galilean	galilean	keplarian	keplarian	keplarian

TABLE 2

Focusing Mechanism

	DVI Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
Focusing Mechanism	non-focus (reading cap for near)	non-focus (reading cap for near)	man-focus spiral knob-front	man-focus spiral knob-front	man-focus ball-and-socket spiral knob-front	non-focus	non-focus	man-focus spiral knob-standard rear, opt front	same	man-focus lever on top frame	man-focus precision cam lever on top frame	man-focus spiral knob-on top	man-focus spiral knob-front	autofocus computer-control infrared optics

TABLE 3

Position in Carrier

	DVI Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
Position in Carrier	full-field	trad. bioptic	full-field or trad. bioptic	full-field or trad. bioptic	trad. bioptic	trad. bioptic	trad. bioptic	con-current viewing	con-current viewing	con-current viewing	trad. bioptic	trad. bioptic	trad. bioptic	trad. bipotic

TABLE 4 Magnification Available

DVI													
Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
1.3x	1.7x	2.0x	1.7x	2.2x	2.2x	2.2x	2.5x	2.5x	4.1x	2.5x	3.0x	3.0x	4.0x
1.7x	2.2x	3.0x	2.2x	2.7x		3.0x	3.0x	3.0x		3.3x			
2.2x	3.0x	4.0x	3.0x	3.3x			3.3x	3.3x		4.0x	4.0x		
3.0x	4.0x	5.0x	4.0x	4.0x			4.0x	4.0x		5.0x			
4.0x		6.0x		5.0x			5.0x	5.0x			6.0x		
Wide Angle	Wide Angle	7.0x	Wide Angle	6.0x			6.0x	6.0x					
2.2x	2.2x	8.0x	2.2x										
3.0x	3.0x	10.0x	3.0x										

TABLE 5 Field of View (degrees)

1.3x - 18	1.7x - 18	2.0x- 18	1.7x- 20	2.2x- 7	11	2.2x-9	2.5x- 9	2.5x-10	9.8	2.5x-21	3.0x-11	15	12.5
1.7x - 28	2.2x - 16	3.0x- 14	2.2x- 11	2.7x- 6		3x- 10	3.0x-8.5	3.0x- 9		3.3x-14	4.0x-10		
2.2x - 16	2.2x - 11	4.0x- 9	3.0x- 8	3.3x- 5.5			3.3x-8.5	3.3x- 9		4.0x-11	6.0x-8		
3.0x - 8	3.0x - 8	5.0x- 8	4.0x- 6	4.0x- 5			4.0x- 8	4.0x-8.5		5.0x-			
4.0x - 6	4.0x - 6	6.0x-6.5		5.0x- 4.5			5.0x- 6	5.0x- 7					
		7.0x- 5		6.0x- 3			6.0x-5.5	6.0x-6.5					
Wide Angle	Wide Angle	8.0x- 4											
		10x- 2.5											
2.2x - 16	2.2x - 16												
3.0x - 11	3.0x - 11												

DEPTH OF FIELD

TABLE 6

DVI													
Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
dist-only	dist-only	inf.- 10"	inf.- 12"	inf.- 10"	dist-only	2.2x= inf.- 12′ 3.0x= inf.- 12′	inf.-3-4′ (refocus for near)	2.5-3x= 100-150′ - 3-4′ and 300-350′ - 6-7′ 4x-6x= inf.-4-5′ (refocus for near)	inf.- 6"	inf.- 12"	3x= inf.-7" 4x= inf.-12" 6x= inf.- 14"	inf.- 12"	inf.- 12"

TABLE 7

WEIGHT OF SCOPE

Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
3.0x= 11.0 gm.	3.0x= 11.0 gm.	3.0x= 29.8 gm.	n/a	n/a	n/a	2.2x= 4.7 gm 3.0x= 14 gm	average= .7 gm	average= .7 gm	n/a	n/a	n/a	n/a	70 gm. Battery pack wt.= 112 gm.

TABLE 8
DVI

Axial Length (millimeters) (scopes focused to infinity)

Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
1.7x=17mm	1.7x=17mm				2.2x=15	2.2x=	2.5x=14	2.5x=18	13.8mm	20.0mm	19.0mm	42.0mm	19.0mm
2.2x=17mm	2.2x=17mm					17mm	3.0x=14	3x=17.8					
3.0x=20mm	3.0x=20mm	3x=52mm					3.3x=15	3.3x=21					
4.0x=26mm	4.0x=26mm		4.0x=26mm			3.0x=	4.0x=17	4x=21.2					
		6x=54mm		5.0x=20mm		21mm	5x=19.5	5x=20.0					
wide angle	wide angle						6x=19.5	6x=25.0					
3.0x=30mm	3.0x=30mm												

TABLE 9
DVI

Amount of Frontal Protrusion (millimeters)

Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
same as length	same	same	same	same	none	same as length	3-5mm	3-5mm	none	0-5mm	3.0mm	21.0mm	3.0mm

Table 10
DVI

Objective Lens Diameter (millimeters)

Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
3.0x=22mm wide angle 3.0x=34mm	3.0x=22mm wide angle 3.0x=34mm	3x=23mm	n/a	n/a	n/a	2.2x= 13 mm 3.0x= 17.5mm	9.5 mm	13 mm	9.52mm	18.5mm	n/a	n/a	n/a

TABLE 11
DVI

Approximate pricing (practitioner price, monocular, scope only unless specified)

Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
1.3x=250.	1.7x=280.	all=	3.0x=320.	2.2x=525.00	n/a	2.2x=	880.00	630.00	990.00	2.5x=	all mag.=	no frame	2250.00
1.7x=260.	2.2x=300.	510.00	4.0x=335.	2.7x=595.00		179.00				399.00	685.00	395.00	(frame,
2.2x=270.	3.0x=305.			3.3x=605.00									mounting,
3.0x=280.	4.0x=320.			4.0x=635.00		3.0x=				3.3x=	(scope,	w/ frame	battery-
4.0x=310.				5.0x=645.00		169.00				499.00	zyl frame	495.00	pack,
wide angle	wide angle			6.0x=655.00							case)		charger)
2.2x=270.	2.2x=300.									4.0x=			
3.0x=290.	3.0x=320.									499.00			
(all DVI prices										5.0x=			
listed include:										599.00			
single vision stock													
lenses and Yeoman 6													
frame along w/ scope)													

FITTING SPECIFICATIONS

TABLE 12
DVI

TYPE OF FRAME USED (check with each company for more specific requirements

Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
any with adjustable nosepads Yeoman 6 for binocular fits	same need 9 mm below top of frame for bioptic position	same need 13mm below top of frame for bioptic position	same position depends on power and P.D.	same need 15 mm. below top of frame	same need 10mm below top of frame	any with adjust nosepad	any with adjust nosepads	same	any with adjust nosepads need 22mm from top of frame	frame with adjust nosepads single bridge only, flat top	specific frame provided in zyl or metal	any with adjust nosepads	specific frame provided in zyl or metal

TABLE 13

MOUNTING PROCEEDURE

Full-Diam Galilean	Bioptic Galilean	EF Spiral Keplarian	Spiral Galilean	Micro-spiral Galilean	Eagle Eye	Walters mini	BITA 3/8 diam	BITA 1/2 diam	M-Lens	Panavex	Ocutech VES	Ocutech VES-Mini	Ocutech VES-AF
in-lab	same	same	same	same ability to adjust w/ line of sight	same ability to adjust w/ line of sight	in-lab	in-lab	same	in-lab ability to make lateral P.D. adjusts in-office	in-office	in-office	in-lab	in-lab

COMPANY LISTINGS

Designs For Vision, Inc.(DVI)
760 Koehler Avenue
Ronkonkoma, NY 11779
Phone: 800-345-4009
Fax: 516-585-3404

Edwards Optical Corporation
2441 Windward Shore Drive
Virginia Beach, VA 23451-1752
Phone: 800-452-5988
Fax: 757-481-3501

M-Tech Optics Corp.
4514 N. Woodward Ave.
Royal Oak, MI 48073
Phone: 313-266-2181
Fax: 810-549-0752

Ocutech, Inc.
P.O. Box 625
Chapel Hill, NC 27515
Phone: 800-326-6460
Fax: 919-968-4601

S. Walters, Inc.
30423 Canwood, Suite 115
Agoura Hills, CA 91301
Phone: 800-9-WALTER
Fax: 818-706-2206

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(All individual device specifications were obtained from each company's specification listings.)