

MAGNIFIERS

A BUYERS/OWNERS GUIDE



EDMUND SCIENTIFIC CO.

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INTRODUCTION

The origin of the first magnifier is unclear but it probably pleased and amazed the craftsman who discovered or developed it. After that first discovery only a few major developments have taken place in the design of magnifiers. Most of the major advances have been in their uses.

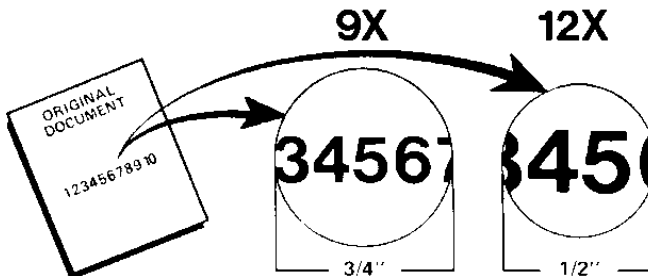
Magnifiers are useful in any kind of work that requires close inspection of relatively small objects. Their users include hobbyists and educators, scientists and engineers. The chief application of magnifiers is in industry as a means of quality control and inspection.

The most common mistake made by purchasers of magnifiers is to simply buy a magnifier. This leads to dissatisfaction because what is bought just doesn't fit the job requirement.

This Buyers/Owners Guide has been specially written to help you select the most appropriate magnifier for your specific need.

WHAT IS MAGNIFICATION?

The closer an object is to the eye, the larger it appears. Actually, the unaided eye can only comfortably focus on an object that is about ten inches or more away. However, a magnifier allows the eye to focus on an object that appears to be much closer than it actually is, hence giving it the appearance of being large, while still allowing the eye to focus on it without strain. Therefore, power of magnification refers to how close the object appears to be, relative to how far it actually is from your eye. For example, 10X (or ten power), means an object one inch away from the lens, appears approximately ten times closer to your eye than you would normally be able to view it comfortably. Thus it appears to be ten times larger. Actual magnification of the object will, of course, vary slightly due to variations of the individual's eye as well as the working distance and eye relief distance of the specific magnifier.

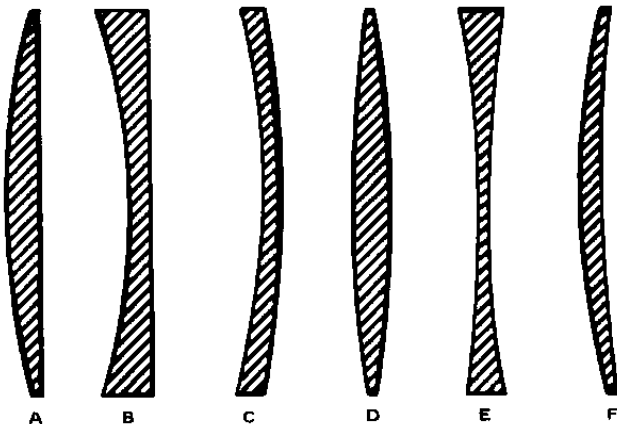


SIZE VS. POWER IN MAGNIFIERS

All magnifiers are subject to specific physical laws of optics. Because of these laws, the size of the lens and the power of the magnifier are physically limited. Generally, the higher the power of the magnifier, the smaller the diameter of the lens, the less working space under it and the smaller the area in focus. A hand held high power magnifier is virtually impossible to make with a large diameter. Magnifiers that have large diameters and lots of working space underneath them will usually have a low power of magnification. High power magnifiers, however, have a rather small diameter and limited working space. If you are faced with the problems of size and power, the best possible solution may be the simplest; analyze each problem separately and buy one magnifier to fit each specific need.

TYPE OF LENSES

There are as many types of magnifiers as there are uses for them. Each has certain characteristics which are especially appropriate for a particular kind of job. In order for you to select the right magnifier for your specific purposes, it is necessary to be familiar with four of the basic magnifying optical systems. Each system has some very specific advantages. Each system is made up of the following types of simple lenses.



Basic Simple Lenses: a) Plano-convex b) Plano-concave c) Convex-concave d) Double-convex e) Double-concave f) Concave-convex

Basic Magnifier Optical Systems



Simple Lens



Doublet Lens



Achromat



Triplet

Simple Lens: The simple lens is a single lens. In magnifiers it is usually positive (increases the size of the image). Simple lenses are satisfactory for work that requires only low power magnifiers, such as 2X or 3X reading magnifiers. Simple lens magnifiers distort color on the outer fringes of the image and lose sharpness there by. An important aspect of simple lenses is that they are the building blocks for more complex and better magnifiers.

Doublet Lens: This is two simple lenses used in conjunction with each other but not cemented together. The doublet produces an image of better quality because it corrects some of the color distortion and the outer image distortion. It does not necessarily have more power than the simple lens, but it does give a better quality image. Pocket magnifiers are most often doublet lenses.

Achromat: This is a positive simple lens cemented to a negative simple lens. The primary advantage of an achromatic lens is that it is corrected for two colors and works well at high power. Most high quality magnifiers have superior performance due to their being achromatic, which eliminates color fringing at the edge of objects.

Triplet: Cementing three lenses together produces a triplet lens. They produce a better quality image because they are corrected for three colors and give little or no image distortion. Triplets are best used for jobs that require a great deal of precision at high magnifying levels of 10X to 12X. Comparators are good examples of triplets.

SELECTING THE RIGHT MAGNIFIER FOR YOUR PURPOSES

Always get the correct magnifier to suit the job. There is no such thing as an all-purpose magnifier. Before selecting your magnifiers find out: 1) what tools are going to be used on the job, 2) what the size and character of the subject will be, and 3) what the surface of the

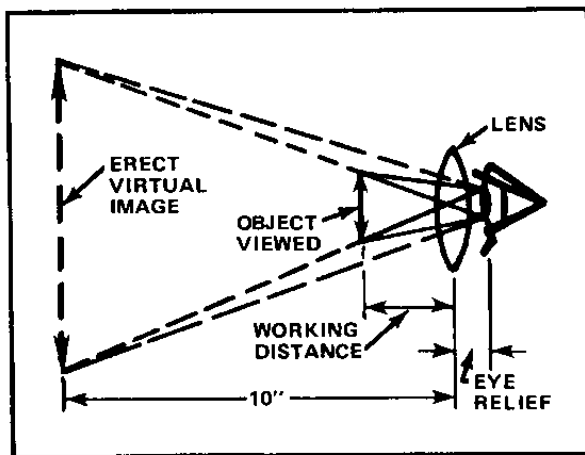
object will be like. Answering these questions will give you a good idea what your needs are. Then in selecting a magnifier, take in consideration all of the following aspects of magnifiers.

Field of View:The area that can be seen through the magnifier. As the power of the lens increases, its image diameter and its field of view decreases. For example, at 5X the field of view is about 1-1/2" in diameter, while at 10X the field of view is about 1/2" in diameter. High power lenses are most appropriate for close inspection of small areas, whereas, low power lenses are more suitable for scanning surfaces where you will need to view a wider area.

Depth of Field:This is the distance between the closest and furthest points that can be seen in the magnifier at proper focus at the same time, without moving the magnifier to refocus. This would be especially important when dealing with uneven surfaces. The more uneven the surface is, the lower the power you will need to use to keep a clear image within the desired depth of field.

Working Distance:The distance between the magnifier and the object that you will have to work with. This is an important consideration with regard to the type of work that must be done under the magnifier. The most appropriate magnifier will allow enough space under the lens to use any necessary tools you may require to do the job. However, the higher the power of the magnifier, the smaller the amount of working distance that will be available.

Working Distance And Eye Relief Distance



Eye Relief Distance:Somewhat related to working distance, eye relief distance is the distance your eye will be from the lens. Generally

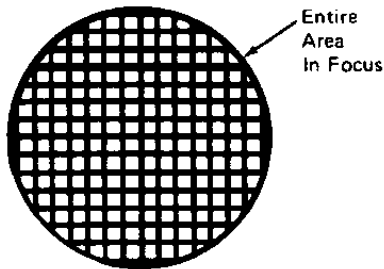
speaking, your eye should be placed no more than the same distance from the lens as the lens is from the object. This will give you the maximum field of view, the maximum magnification with the lens, and the most working distance. The higher the power of the magnifier, the closer your eye will be to the lens. With any high-power magnifier (over 6X) it is important to put your eye directly behind the lens. Eye relief distance is important when considering the comfort of those working with the magnifier for long periods of time. When this distance is short it may be best to select magnifiers that can be mounted on stands, eyeglass frames or headbands.

QUALITY OF MAGNIFIERS

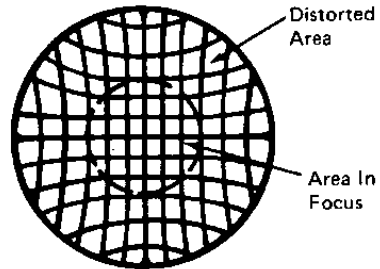
How much you spend on a magnifier should be determined by the purpose for which it is being purchased. As a convenience, a magnifier may cost very little, while the most sophisticated needs of industry may require expenditures of several hundred dollars. Buying the least expensive magnifier more often than not leads to unsatisfactory results and frustrations. Any magnifier you buy should be a tool to fit the rigors of the environment in which it will be used. Additionally, it may be equally unwise to expect one type of one power of magnifier to satisfy the requirements of several functions. Below are several factors which affect the quality of the magnifier as well as the function for which it is best suited.

Magnification:The power of the magnifier and its quality are often interrelated. The more powerful the magnifier, the more care in workmanship needed. The more closely you will need to view the work, the more power you will need and the better the quality needed. It should be noted here that if your magnification needs are above 20X you will need to use a low power microscope because practical magnifiers will not exceed that power.

Flatness of Field:Due to physical laws the outer part of the image formed by a simple lens may appear out of focus. The greater the magnification the greater the curvature of the lens and therefore the greater is this problem. This can be easily overcome by designing a magnifier that has more than one lens. A triplet has three lenses cemented together giving it a "flat field", that is, the entire area of view is in focus, and is undistorted.

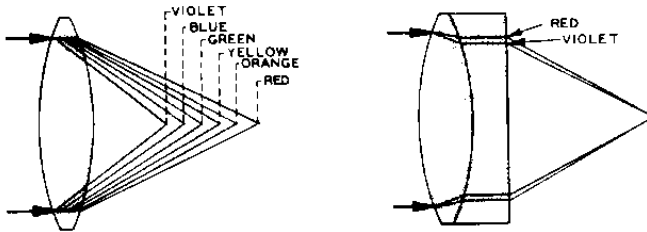


Corrected Image
"Flat Field"



Distorted Image

Color Distortion: Because of physical laws the lens may have a prism effect giving the image false color fringes known as chromatic aberration. When it is important to have true color in the image, unnatural color can be avoided by using an achromatic lens which is color corrected for two or more colors.



Achromatic Lenses (Color Corrected) Simple lenses focus various colors at different points. Achromats correct this by using one flint glass and one crown glass, usually cemented together.

Mountings: The lens of a magnifier is held in place on a mount. Obviously some mountings are better and more durable than others. Mountings become an important consideration when looking at the kind of environment where the magnifier will be used. In a more rugged work area magnifiers having top quality mountings are a worthwhile investment, considering the alternative is frequent replacement of magnifiers.

Some fields of work have special needs and there are special magnifiers that are designed to address those needs. In meeting one need, a design may satisfy someone else's requirements. There are a wide variety of options available. In order to insure that you purchase the right magnifier for your special needs we will examine some of the different types of magnifiers that are available and look at some of the various ways they are being used.

TYPES OF MAGNIFIERS AND THEIR USES

As stated before there, are as many kinds of magnifiers as there are jobs that require them. Magnifiers are versatile tools. One specific type of magnifier may be used by machinists, stamp collectors, and gem dealers alike, but several types are better suited to some work than others. In order to offer some overall guidelines for selecting magnifiers, they will be grouped into five broad categories according to design and possible advantages. These categories are not inflexible. Some magnifiers will be mentioned in more than one group, indicating that although they were designed for a specific function they are very useful for other types of jobs.

Consumer Magnifiers: Consumers use a wide variety of magnifiers, including some that might be considered for industrial use only.

Reading magnifiers represent the popular image of magnifiers. Generally speaking they are low power (2X to 5X) and have the advantage of providing a wide viewing area for scanning large surface areas. Some are designed in a rectangular shape for greater viewing area while still others have light attachments for increased visibility. One such magnifier is built into a flashlight which would make it ideal for hikers reading maps at night. Another has a 3" lens with its own light built into it and sits right on the surface of the object.

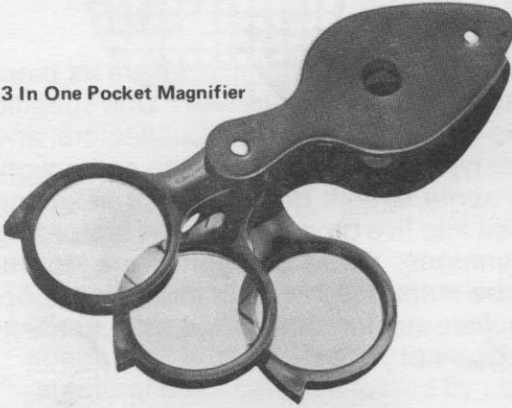
A large part of the consumer magnifier group are the pocket magnifiers. They can range from the simple 2X lens that folds into a case, to a metal cased 10X Hastings Triplet. They fit nicely into a pocket, handbag, or briefcase. A sales representative may find a pocket magnifier an effective sales tool for showing merchandise to a prospective client. One pocket magnifier that offers some of the broadest applications is the three in one magnifier. It has three 3X double convex lenses which can be used individually or by adding up to 9X. It folds into a slender light weight plastic case. A couple of good alternatives would be the Hastings Triplet and the 12X Doublet. They are more powerful and fold into rugged metal cases.

Hobbyists are the largest group of consumers purchasing magnifiers. They also have the widest and most diverse needs of any group. Hobbyists include everyone from stamp and insect collectors to amateur photographers. It would be a mistake to assign a few magnifiers to hobbyists because every kind and style of magnifier made is being used. If you are a hobbyist looking for the right magnifier for your purposes, read through the other categories and

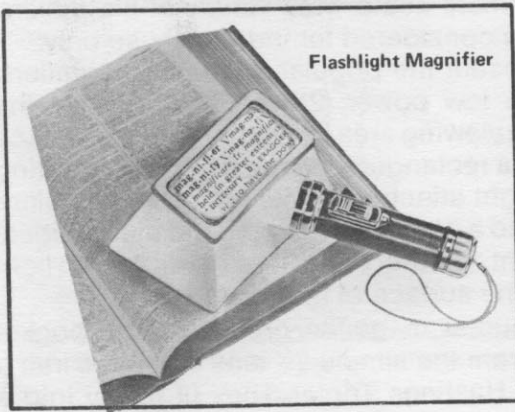
you'll probably find what you're looking for. Concentrate on the power required, the field of view you need, and the quality you desire.

Consumer Magnifiers

3 In One Pocket Magnifier



Flashlight Magnifier



Flashlight Magnifier

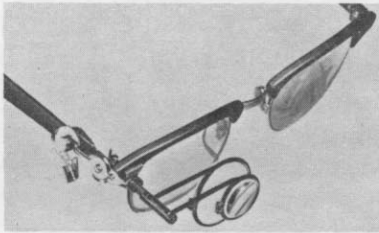
Inspection Magnifiers: The second category is a group of magnifiers that may be considered inspection magnifiers. As a whole they have a much narrower field of view than reading magnifiers being more likely to be used for inspecting small areas very closely. Their magnifying power can extend upwards to 15X. Inspection magnifiers are held up to the eye by the muscles of the face, which permits complete freedom of the hands. The watchmaker loupe, for example can be used in virtually any position as a jeweler or collector would require. Some have clip-on attachments for use with eye glasses. These have a special advantage in that they may have a two lens arrangement which can be swung away individually to be used separately, or in combination for added power. Loupes are especially handy to machinists in checking small parts right off the line without leaving the machine attended or creating unnecessary down time. There are also binocular

type magnifiers that can be clipped onto glasses and can flip-up like goggles. Binocular types are especially handy because they eliminate squinting and give depth to the object, thus allowing better eye-hand coordination, a very important factor in precision tasks such as assembling printed circuit boards. If there is a problem with glare off the inspected object, there are lenses made of a special kind of glass which reduces glare for increased contrast.

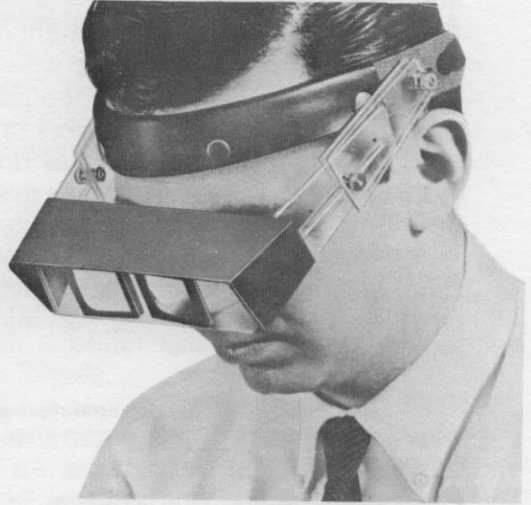
Inspection Magnifiers



Watchmakers Loupe



Clip-On Loupe



Binocular Magnifier

Another inspection type of magnifier is the linen/product tester. It sits right on the work and features a folding aluminum stand with a measuring scale included in the base. Often used in examining stamps, it is an excellent tool in inspecting printing, engraving, and textiles.

The important thing to remember is that in looking for the right inspection magnifier you should not feel restricted to those mentioned above. There may be some mentioned in other categories that may suit your needs.

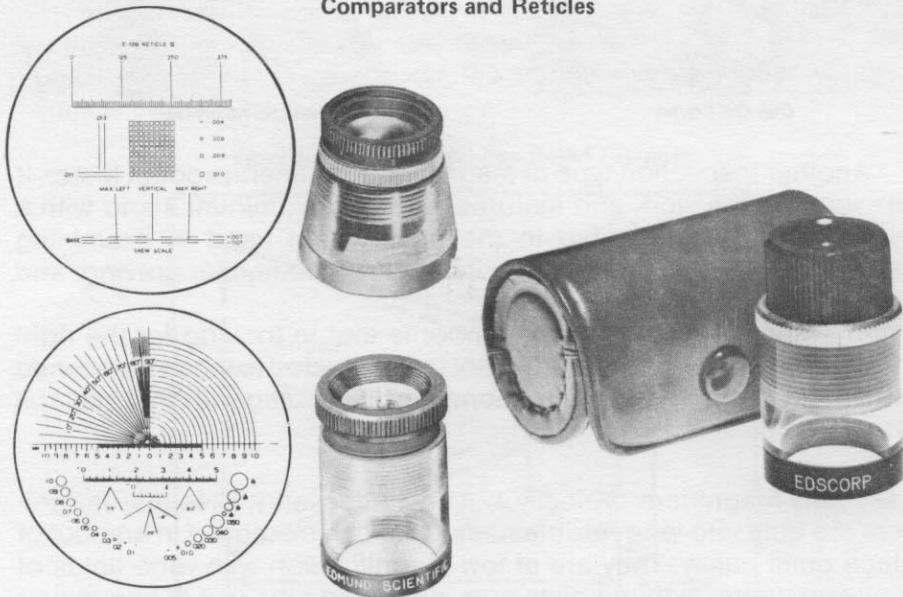
Assembly Magnifiers: Typically, but not necessarily, assembly magnifiers are built into long flexible necks that can be moved in and out of place quite easily. They are of low magnification with wide fields of view and longer working distances, enhancing the use of hands and tools under the lens. Quite often assembly magnifiers are constructed with lamps to light up the work. Some assembly magnifiers can be clamped to a work table while others sit on a short adjustable stand for easy movement and storage.

Measurement Magnifiers: These are the more precision oriented magnifiers. They include what are commonly called Comparators which contain calibrated dimensional reference scales within the magnifier itself. Comparators are used for very precise measurement of small detail. The lens is set in a clear glass cylinder or cone and can be easily rotated and locked into focus. The lens of a comparator is generally a more sophisticated lens. Cemented triplet lenses are often used to provide an unusually flat field and a color corrected view. This is critical to a comparator because you're dealing with very small detail and need image precision.

The reticle is the measurement part of the comparator. A reticle is a circular plastic or glass plate with a scale or pattern printed on the bottom that is viewed simultaneously with the object to be measured. It may sit exactly on top of the work or be within the optics. Reticles can easily be changed to facilitate different types of comparison and measurement. There are reticles available for just about every need in both English and metric dimensions.

Comparators are the most popular magnifier that industry tends to purchase. This is not surprising given that for exact measurement in a small area there is little that can match their accuracy, versatility, and cost effectiveness.

Comparators and Reticles



Technical Magnifier: The last category is made up of the technical magnifiers. These tend to be the higher power magnifiers, although some 5X magnifiers are considered to be for technical use. Their lenses are more sophisticated in that they are achromatic (color

corrected) and have flat fields of view. Both characteristics are critically important when examining color prints and photographs, or engravings where clear, sharp images are a necessity.

Technical magnifiers are designed in a host of styles for a number of varying environments so that they will continually produce good results. The most favored magnifier is the Hastings Triplet. It is a powerful magnifier that is completely color corrected, has a flat field, and may be purchased in pocket size. It also folds into a protective metal case for rugged handling. A favorite among jewelers and gem collectors, it has such a great degree of versatility that it is also needed by engravers, machinists, printers, photo-engravers, and proof-readers.

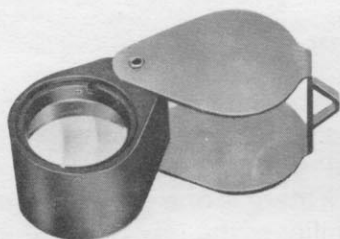
There are two kinds of technical magnifiers designed with a cone shaped base, each offering some unique advantages. Both rest directly on the work to free the hands for working and both have adjustable lenses that lock into place. The first is the opaque base magnifier. It shuts out light, making it ideal for working over a light table or some other lighted surface.

The other is the transparent base magnifier. This one admits light into the viewing area and is excellent for close viewing of photographs, and checking printed material.

There are technical jobs that require working space under the lens to allow free use of the hands. In that case there are several options. The first is the swivel arm magnifier. The 9X -12X lens is secured to a spring loaded arm that can be rotated to any position, to view your work. Because the lens is kept off the work surface and will not injure it, the swivel arm magnifier is most popular in the Graphic Arts field. Another feature of this magnifier is its weighted base that gives it great stability in any position making it a very reliable tool in many other occupations.

Another technical magnifier that provides ample working space

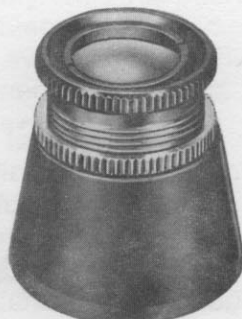
Technical Magnifiers



Hastings Triplet



Transparent
Base Magnifier



Opaque Base
Magnifier

and stability is the "easy grip" magnifier. Its clear plastic base allows it to sit right on the work without blocking light from the subject matter. Additionally, the base is a plastic that resists acid and other corrosive materials and can easily be picked-up without having to remove rubber gloves. It is popular among etchers, photographic retouchers, and finishers.

One final magnifier that can be classified as a technical magnifier is one whose stand is collapsible and is scaled for precision. It comes in a wide range of magnification and has diverse uses. At lower magnification it is suitable for printing and textile applications, while at middle levels, photo labs and graphic artists find it excellent. Higher powers serve research scientists and technicians and those working in specialized electro-mechanical applications.

Technical Magnifiers



We hope that this booklet will be of assistance to you when purchasing magnifiers for your purposes. As you are now aware, there are a number of important factors that you should take into consideration in the selection process. But if there is one general rule you should remember, it's this: fit the magnifier to the job. So, take a good look at what the job requires and chances are there will be a magnifier that fits that need quite adequately. And chances are Edmund Scientific will carry it.

TYPE	POWER	ADVANTAGES	USERS AND USES
Comparator	6X, 12X	Equipped with reticles for precision measurement of small parts, angles, holes, diameters, thread size, etc.	Printers, aerial photography, magnetic code users, machinists. Printed circuit inspection.
Loupes	2X - 20X	worn at the eye or mounted on a spectacle frame, for easy handheld inspection	Watchmaker, jewelers, quality control inspectors, toolmakers, instrument makers.
Linen/Product Tester	5X, 9X	magnifier with folding stand with grid scale on base for hand free use.	Counting threads in textiles, printing, engraving, circuit boards, etc.
Opaque base Magnifier	9X, 12X	Base shuts out undesirable light, rests directly on work.	Examining negatives, stripping Graphic Arts work over light table, aligning camera systems, gaging artwork size.
Transparent base Magnifier	9X, 12X	For pinpoint examinations; base admits light to subject	Proofreaders, Editors, stamp & coin collectors, photographers
Hastings Triplet	10X	Handheld, pocket size, color corrected, flat field.	Gemologists, engravers, machinists, printers, photo finishers, proofreaders, hobbyists.
Self-standing Magnifiers	2X	Wide field of view, longer working distance, adjustable arms, and light attachments.	Graphic artists, draftsmen, the most versatile of magnifiers.
Direct Measuring Microscope	50X	Pocket size "microscope", for jobs requiring more than 20X. Reticles available	Extremely versatile for detection of flaws, scratches and imperfections.



These illustrations are accurate magnifications, but are not representative of full fields of view.

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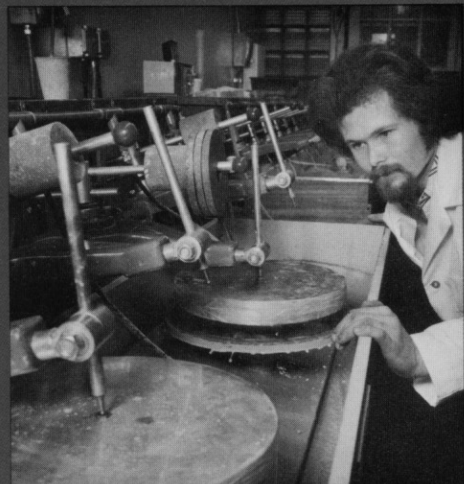
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To meet the critical tolerances of refractive and reflective optics demanded by consumers and industry today, our 10,000 square foot Optical Design and Manufacturing Facility is equipped with the most modern equipment and machinery available. High capacity optics generators and grinders, and a state-of-the-art test tunnel featuring ronchi, Foucault and laser interferometric systems assures you of the highest quality. No matter what you're looking for...magnifiers for use at home or for industry, binoculars for sporting events or serious nature study, or telescopes to study the stars...you want the finest instruments available - optical instruments from Edmund Scientific.



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