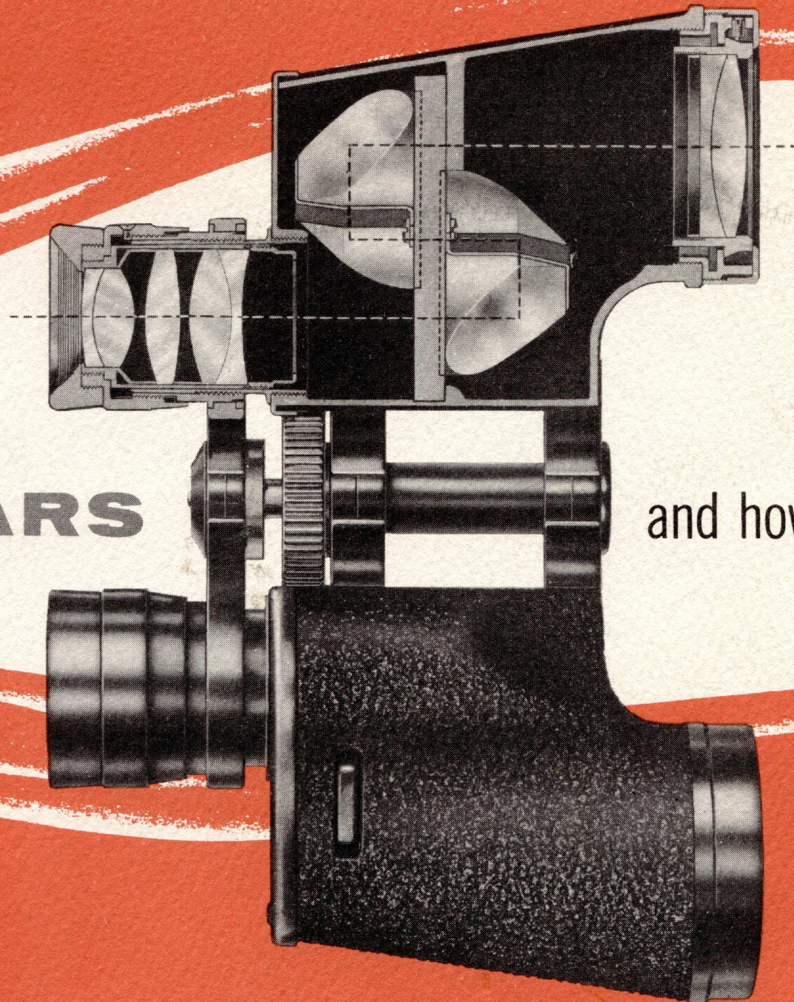
BINOCULARS and how to choose th



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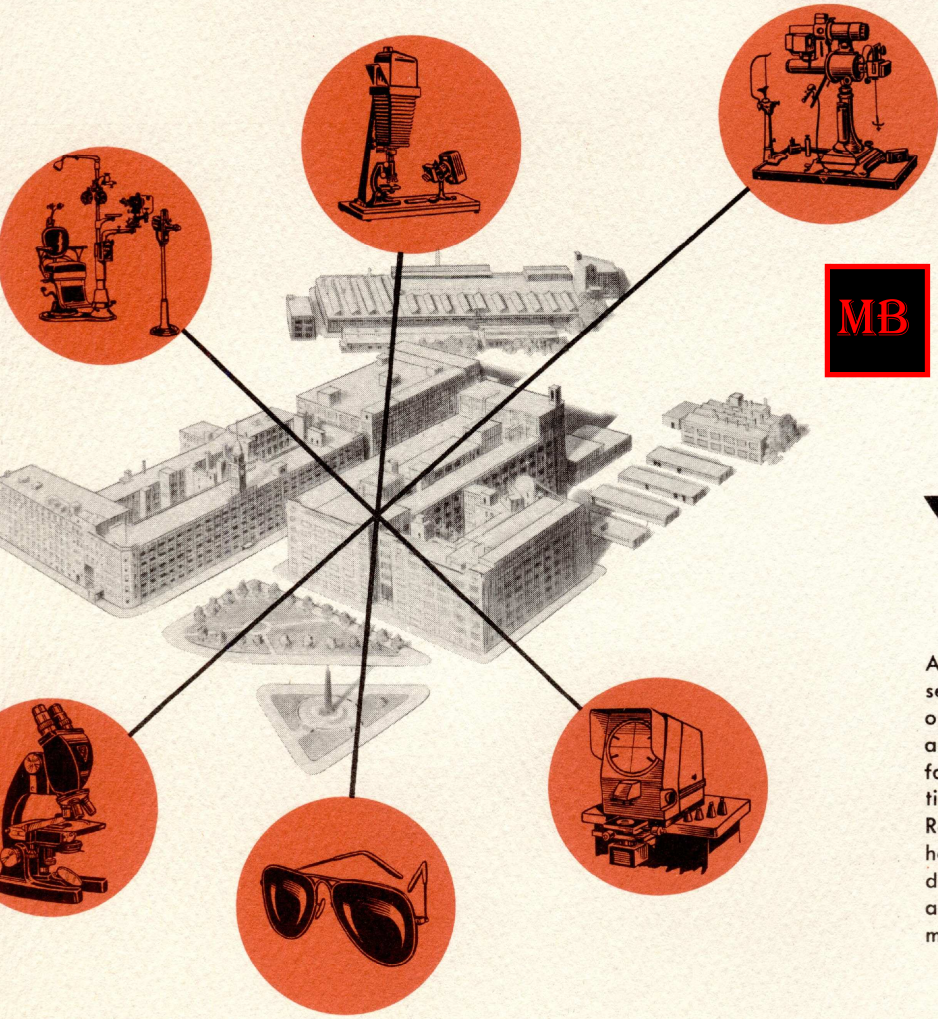


YOUR BINOCULAR

A bright, close-up view of distant scenes—and a lifetime of service—are properties of a binocular which result from its optical and mechanical qualities. Bausch & Lomb Binoculars are backed by the research, engineering and manufacturing facilities of Bausch & Lomb Optical Co., America's leading optical institution, and located for more than 100 years at Rochester, N. Y. The purchaser of a Bausch & Lomb Binocular has the satisfaction of knowing that he owns one of the world's distinguished optical instruments—product of the same scientists and craftsmen who produce optical glass and precision instruments for science, industry, education and the Armed Services.

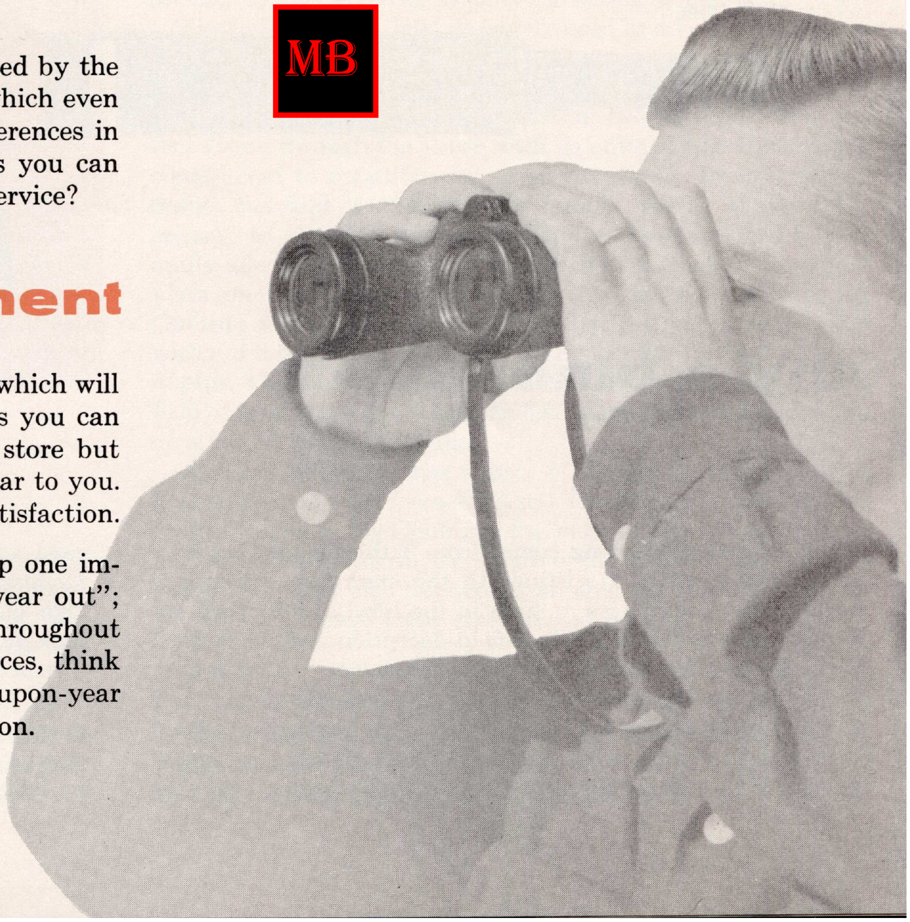
There's so much to see! And so much of it just out of the range of normal unaided vision! When you travel . . . when you attend sporting events . . . when you seek the beauties of wild life . . . your horizons are broadened and your enjoyment multiplied many times when you own a binocular.

But as you start to buy a binocular, you are confused by the choice of models and the wide variety of prices at which even those that look alike are offered. What are the differences in efficiency and durability? Are there any guideposts you can use to judge performance and expected length of service?

. . . a lifetime of enjoyment

The purpose of this booklet is to explain the things which will help you make a wise choice in a binocular. Things you can look for yourself. Differences you cannot see in a store but which are important in the usefulness of the binocular to you. How to pick a model which will give you greatest satisfaction.

As you read this booklet, we suggest that you keep one important fact in mind: a *good* binocular will not "wear out"; it can and should give you continuing enjoyment throughout a full lifetime of use. As you judge qualities and prices, think of how you can get the most for your money in year-upon-year of thrilling use and pride in a magnificent possession.



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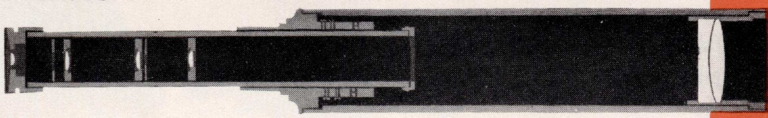
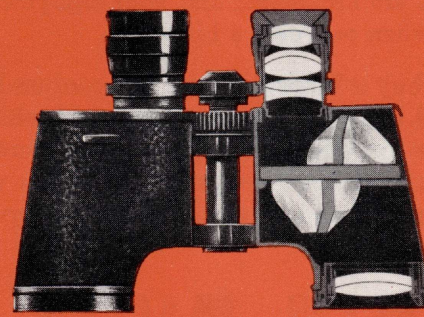




BINOCULAR

GALILEAN
FIELD GLASS

why a binocular?

A trill of melodious song comes from a thicket and the bird lover gazes intently to distinguish the markings of plumage that identify the species . . . high in the bowl, the football enthusiast tries to follow the backfield deception and the sudden break-through for the tie-breaking touchdown . . . after a day-long stalk, the big game hunter suddenly sees his quarry, and wants to evaluate his trophy quickly before he shoots . . . from his tower, the forest ranger carefully scans his horizon, knowing that if he can see the first tell-tale wisp of smoke, he may save acres of timber land, and possibly human lives . . . the yachtsman peers anxiously through the misty dusk for first sign of a buoy which will put him on his course . . . from a look-out on a National Park road, the vacationing family views a vista of grandeur that calls for a scrutiny of its finest detail . . .

. . . In all these, and dozens of other situations which you encounter regularly, the pleasure and efficiency of seeing are greatly increased by the use of a binocular. The user of such an instrument sees so much more—and so much more clearly

—that all whose vocations or hobbies take them out of doors can gain continuing and lasting extra enjoyment by carrying a binocular.

How far can I see with a binocular?

The accurate and experienced answer to this question is: you can see as far *with* a binocular as you can without.

This is not as confusing or contradictory as it sounds. It is true that your range of vision, with or without optical aid, is the same. You can see to the horizon, or to the moon or stars with a binocular . . . with a telescope . . . or with your unaided eye. But the important consideration in using a binocular is not how *far* you can see, but how *well* you can see—how big an image you can get, and how sharp and clear and bright that image appears. These are the factors to judge in trying a binocular . . . the differences in performance that distinguish a good instrument from a poor one.

What are Telescopes, Binoculars, and Field Glasses?

The principles of optical science have been used to devise several types of instruments which can produce a magnified image in the eye. These include telescopes, field glasses, and binoculars; there are differences in these various designs, and differences in their performance characteristics.

A telescope is generally designed for use at high powers, where a greatly magnified image of a relatively small area is desired. Astronomical types—either with mirrors or lenses used as light-collecting objectives—give an inverted and reversed image. Terrestrial telescopes produce an image upright and correct left-to-right; this characteristic is inherent in the simple Galilean type, and, in more complicated designs, is accomplished by an "erecting system" of lenses or prisms.

The term "Field Glass" is widely used to describe any hand-held double telescope. The non-prismatic, or Galilean, "Field Glass" is a double Galilean telescope, each barrel a combination of convex objective and concave eye lens providing direct vision through the lenses with an erect image. It is seldom constructed to magnify more than five times, because in this design the field of view becomes rapidly smaller as power increases. In very low powers, the field of view provided is generally adequate. However, in the powers in which prism binoculars are usually built (6× and above). the field of view of the Galilean field glass is so restricted that it provides little more width of field than could be gained by looking through a length of pipe. The illustration on page 8 shows both magnification and field of view of a 5×,40 Galilean field glass compared with those of a 6×,30 prism binocular.

A prism binocular has a pair of prisms mounted at right angles to each other in each barrel. The prisms accomplish two major purposes. By doubling the path of light back on itself and then forward again, the length of the tube is shortened. The prism system is also devised as an erecting system so that it provides an image right side up and correct left-to-right.

For most use, a binocular is preferred

The choice of a binocular, a telescope, or a field glass is generally made on the basis of power or magnification desired, and the relationship of magnification to field of view.

For very low powers, such as those in which opera glasses are made, the field glass design is generally satisfactory. For use where very high magnification of a small area is more important than width of field of view, a telescope is the best choice.

For most other use, where the need is for a hand-held instrument of highest usable power with a wide field of view, the prism binocular is outstandingly most satisfactory. When it is properly designed and constructed, the prism binocular offers maximum compactness, light weight, portability, ease of handling and brilliant, sharply-defined image quality.

The reference to *"a hand-held instrument of highest usable power"* is significant. To the inexperienced binocular user, high power often seems desirable—the higher the power, the better. The fact is that motion, in the field of view, or of the binocular itself, is magnified as much as is the size of objects seen. Most people can hold a binocular of 6× or 7× steady enough for comfortable viewing. With practice, many can handle 8× or 9×. At powers of 10× and above, few can hold any glass steady enough to have the magnification useful. Most conscientious manufacturers do not offer binoculars of power higher than 9×. Where need is for higher power, a telescope used on a tripod or other artificial rest is the most practical solution.

Increased stereoscopic effect

A further advantage of the prism binocular arises from its design of offset prism assembly. This can be arranged so that the objective lenses are further apart than the eyepieces. This is important because it is the separation of the two eyes—and the slightly different viewing angle from each—that enables you to judge depth, relative distance, the "third dimension."

You can easily see how this works. Close one eye and look at several objects. Their relative sizes are the only key you have to their distance from you. Open both eyes and their positions are more apparent, because you see them *stereoscopically*.

With a binocular, the stereoscopic effect enables you to determine relative distances of objects from the surrounding objects. Any binocular or field glass increases the stereoscopic effect by its magnification. Beyond this, the "stereo-prism" type of binocular—designed with objective lenses twice as far apart as the eyepiece lenses—doubles your ability to determine the relative distances of objects which are in your field of view. The type of "miniature" binocular, which is made with objective lenses closer together than the eyepieces, of course *reduces* the stereoscopic effect.

* * *

With this much evidence, and your own experience, you may have decided by now that you want a prism binocular. But there is still much unanswered. Why such a wide variety of size and weight? What do all the figures in the specification table stand for? How do you interpret them to your own need? And most of all, what are the differences between binoculars of similar specification that account for the differences in prices asked?

To help you determine the answers to these questions for yourself, we present on the following pages a two-part discussion. First, how you can select the model best suited to your use and your need. Then, how to distinguish the properties among binoculars—of similar power, size and appearance—that make for clear seeing and long life. This is intended as a useful guide to you in helping you decide what model—in what price range—will give you the most for your money.

what style, power, and size?

As you study the specification data for various binoculars, or look over the assortment in a store, you are impressed—or perhaps confused—by the wide differences in their characteristics. There is a choice in power of magnification . . . in size of objective lens . . . in method of focusing . . . in size and weight.

Each model has some specific advantages over the others. Choice of the "best" model depends on the individual who is to use it, and the purpose for which its use is intended. When you know how to recognize the differences, you can read a specification table understandingly, and you can choose among the characteristics on the sound basis of your own need, inclination and preference.

How to focus a binocular

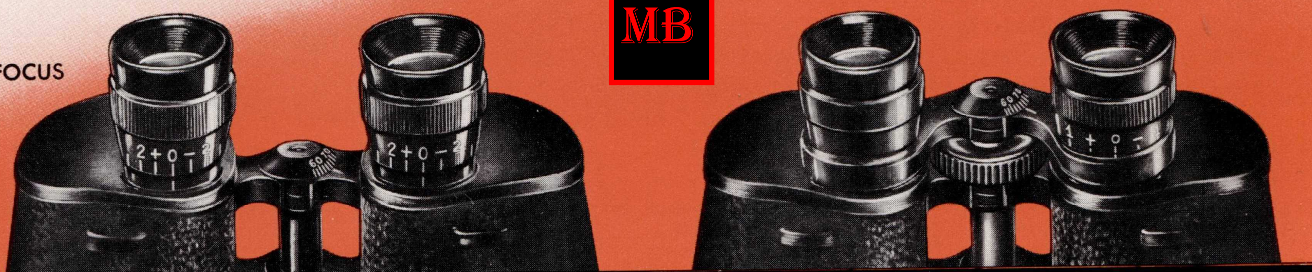
Before you can test a binocular you will have to know how to use it.

It is easy to adjust and use a binocular. But it is important to make the adjustments correctly if you are to get out of its use the full performance for which it was designed.

The first adjustment to make is the "interpupillary" adjustment. Among various people, the distance between the eyes (*interpupillary distance*) differs. Adjustment to line up the two sides, or barrels, of the binocular with the two eyes is provided in the center hinge. As you hold the binocular before your eyes with one barrel in each hand, swing them together or apart until the fields of view in your two eyes superimpose and merge as a single sharp-edged disc (*not* the overlapping joined discs incorrectly represented in the movies!)

In the focusing mechanism, you encounter the first difference in various models of binoculars. Some have a wheel over the hinge which focuses both eyepieces together; this is the "center focusing" style. Others have the two eyepieces independently adjustable; this is the "individual focusing" style.

You'll see that even in the center focusing model, one of the two eyepieces is independently adjustable. This is to accommodate eyes of unequal vision. To focus this binocular, cover the objective lens which is on the same side as the independently adjustable eyepiece (usually the right side), and rotate the central focusing wheel until the object you are viewing is as



INDIVIDUAL FOCUS

CENTER FOCUS

clear as possible. Then cover the other objective lens and turn the independent eyepiece until the object also appears clear through this eye. The binocular is now accurately focused for *your* eyes.

To use the individual focusing type of adjustment, each eyepiece must be focused independently by rotating—while covering the other objective.

By taking note of the readings which are on the interpupillary scale and the individually-focusing eyepiece scales, you can at any time quickly reset the binocular to fit your eyes. (The interpupillary scale is calibrated in millimeters. The scale on eyepieces is in "diopters," the unit of optical measurement of spherical power.)

What do "6X,30" "7X,35" etc., mean?

You will observe that each binocular carries a designation such as "8×,30," "7×,50." The first of these figures (6×, 7×, etc.) refers to the power of magnification; the second figure is the diameter in millimeters of the objective lenses. Thus, a 7×,35 binocular magnifies 7 times and has objective lenses 35mm in diameter.

Magnification

Magnification (or "power") in any optical instrument is the measurement of enlargement. It is the number of times the image seen through the instrument is larger than the object appears to the unaided eye. Power or magnification is indicated by × ("times" as in multiplication)—7× means 7 times magnification or 7 power.

In the design of a binocular, magnification is the easiest of characteristics to obtain. High power does not mean high quality. The best power is the right power for the person using it; and choice of power should be balanced against other characteristics.

CAUTION: You can't take for granted the accuracy of the power designation stamped on a binocular. Glasses of inferior or obscure make are sometimes lower in power than they are claimed to be (in an effort to make field of view, relative brightness and other characteristics appear to be better than they really are.) Here's how you can check on the power of a binocular:

Select an object which doesn't occupy the entire field of view, about 100 feet away. Place the binocular on a rest, adjust it to your eyes and focus on the object.

Now, look at the object through one barrel only, having the other eye exposed so that it looks down the outside of the glass at the object. You will then see two images, a large one seen through the binocular and a small one beside it seen with the naked eye.

Next, move the binocular until the large image overlaps the smaller and compare the sizes. The number of times the larger image exceeds the smaller in size is the actual power of the glass. If the glass is 8 power, the large image should be 8 times the size, in height and width, of the small image.

Occasionally you may see reference to magnification in terms of "areas." This is not a standard designation of magnification, and its use may be interpreted as a deliberate attempt to mislead. The magnification of an 8× binocular is, of course 64 "areas." The image of an object viewed through the binocular does cover an area 64 times greater that its area without the binocular, but in any dimension it is only 8 times as large

The circles represent views to be seen with binoculars of 6×, 7×, 8× and 9×. The background photo is the same view as seen with the unaided eye. (The deer in the background photo is in the middle of the page, about 1″ up from the bottom)

Field of view

"Field of view" is the term used to describe the width of the view which can be seen through a binocular at a given distance. A wide field of view is highly desirable, both in making it easy to locate a specific object, and in enabling you to see more of a view without moving the glass. It should be remembered, however, that you can't get the widest field of view in a binocular of the highest power. When a wide field of view is the primary factor in making your choice, a medium- or low-powered binocular should be chosen.

Field of view may be measured in two ways; *Angular field* refers to the angle between two lines drawn from the binocular to the two edges of the field of view. *Linear field* represents the diameter of the field at a certain distance, measuring from the objects as seen at one edge of the field to objects seen at the other edge. Specifications of all binoculars give the values for both of these measurements.

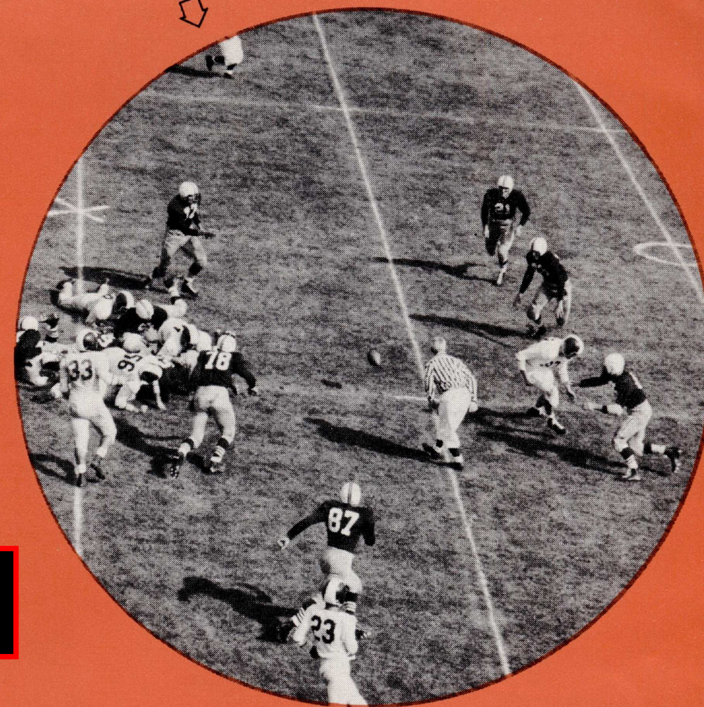
CAUTION: Sometimes a large field of view is obtained at the expense of definition at the edges. No binocular gives uniform definition center-to-edge, but a high degree of correction must be maintained for the glass to be of maximum usefulness. An instrument which achieves wide field at the expense of excessive "falling off" of image sharpness at the edge is not desirable.

Here's how you can compare two binoculars for field of view:

First, be sure that the two binoculars are the same *actual* power. A low-power binocular generally allows a greater field to be seen than a high-power glass.

Focus each binocular on any object or landscape larger than the area covered by the binocular. The binocular which shows the more widely separated objects has the larger field.

FIELD OF VIEW WITH 6×,30 BINOCULAR



FIELD OF VIEW WITH 5×,40 FIELD GLASS

Relative brightness

Relative brightness is a number which is used to compare the area of the "exit pupil" of telescopic instruments. The exit pupil of a binocular may be seen as a bright disc of light in each eyepiece when the binocular is held at arm's length, pointed at the daylight sky or other bright view. This bright disc is the bundle of light which leaves the eyepiece of the binocular and enters your eye.

The determining factors in relative brightness of a binocular are its power and the size (actual effective aperture) of its objective lenses. Technically it is *the square of the quotient of objective aperture and power*. For a 7×,35 binocular, for example, the exit pupil is 5mm (35 divided by 7, and the relative brightness is 25 (5×5). 25 is also the relative brightness of the 6×,30 binocular. Relative brightness of the 8×,30 binocular is 14.3; that of the 7×,50 is 50.4.

With a given objective diameter, the lower the magnification the higher the relative brightness. With a given magnification, the greater the objective diameter the higher the relative brightness. Naturally, the binocular with large objective lenses is heavier and bulkier than the one with small objectives.

To understand the importance of exit pupil diameter and relative brightness, it must be understood that the binocular and the eyes using it are both parts of a single optical system.

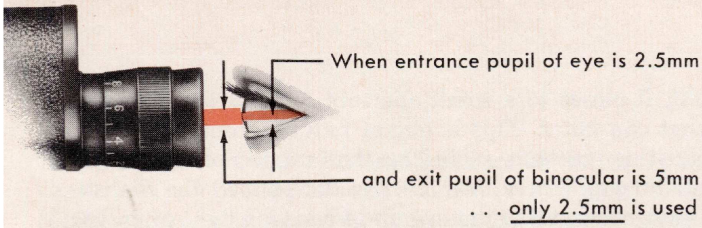
The eye is equipped with its own *iris diaphragm* which establishes the *entrance pupil* of the eye. Only as much light can enter the eye as can pass through the diaphragm or pupil of the eye. The pupil of the eye expands and contracts, depending on the amount of light available to it. When light is dim, the eye's pupil opens wide to permit more light to enter. When light is bright, it closes to a small aperture to limit the amount of light that can enter. This is one of nature's controls.

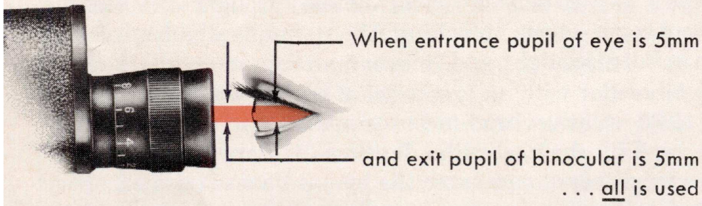
Exhaustive research, including that carried on by the government during World War II, has determined the diameter of the entrance pupil of the eye under varying light intensities. The findings show (with remarkable consistency among all individuals) that the pupil diameter is never less than 2.5mm. On a dark day it may be about 3.5mm; as light diminishes, the diaphragm opens, reaching about 5mm at dusk, about 6.5mm in full moonlight, and 7mm or more in complete darkness.

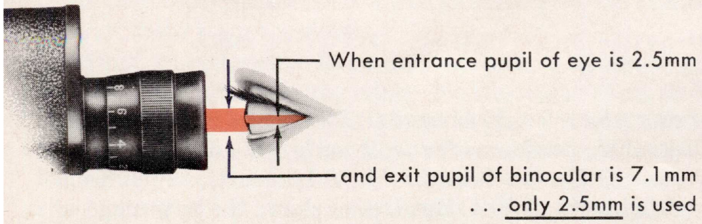
Any binocular with an exit pupil of more than 3.5mm diameter (12.25 relative brightness) provides all the light that can be used by the eye in the daytime. A 5mm exit pupil (25 relative brightness) can enter the eye at dawn and dusk. For night use, when the eye is open to 7mm, it can accept the high relative brightness of approximately 50.

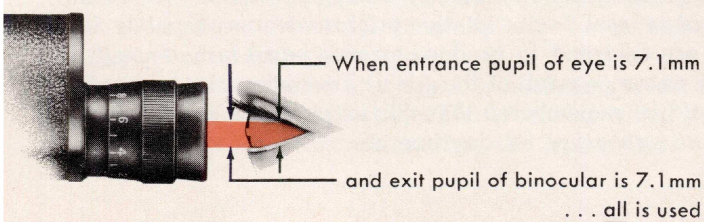
How much relative brightness do you need?

This shows why a 7×,35 binocular, for example, with relative brightness of 25, produces *identically as bright* an image during daytime use as the much larger 7×,50 binocular, which has a relative brightness of 50.4. But it also shows the advantage of the higher relative brightness for *night use*. Indeed, the term "night glass" is used to identify binoculars which have an exit pupil of at least 7mm (relative brightness approximately 50). They are designed to produce an exit pupil large enough to fill the entrance pupil of the eye at its maximum dilation. But it should be remembered that this extra size of exit pupil *provides no advantage* for daytime use.









NOTE: When the entrance pupil of the eye is approximately the same diameter as that of the exit pupil of the binocular, getting all of the light into the eye requires that it be lined up exactly with the exit pupil of the binocular. That's why it's so important to adjust the binocular for correct interpupillary distance before using (as discussed on page 5).

CAUTION: In many makes of inferior binoculars, poor design limits effective objective lens aperture to a diameter less than that of the apparent free aperture of the objective lens. Compare exit pupils by observing them at arm's length.

It should be observed that relative brightness refers strictly and solely to the exit pupil of the binocular. "Brightness of image" is greatly affected by other factors such as absorption and reflection losses within the optical system. Between two binoculars of the same relative brightness, light transmission, and resulting image contrast, may vary by as much as 50%. This important matter is discussed under "Inside Information in Binocular Differences" on page 16.

Which model to choose

Your best choice can be made only in terms of the answer to your question "What will I use my binocular for?"

In any one glass, it is impossible to obtain highest magnification, widest field of view, greatest relative brightness, and minimum size and weight—all at the same time. Those characteristics most desirable to you for your specific use must be given greatest importance and other characteristics compromised to give you the best combination of advantages.

If you expect to carry your binocular a great deal, to sporting events, on nature hikes or hunting trips, compact size and light weight are more important to you than a high relative brightness which could be of advantage in use only after dark.

If you will want to follow rapid motion, a moderate power of 6× or 7× will be more satisfactory than higher powers.

If your need is for navigation aboard a vessel, or for other use where you will sometimes need to use the binocular at night, a high relative brightness is more important to you than size or weight, since you won't need to carry it around.

If most of your observation is to be done at great distances—and you have enough experience in using a binocular to know how to hold it steady—your choice will be one of the higher power binoculars.

From the experience of thousands of binocular owners, it has been possible to work out a chart listing best models for each binocular use. Usually any of several models will be satisfactory for a specific purpose. However, if the binocular is to be used *principally* for a single purpose, there is generally a preferred choice of *one* model which offers the best combination of advantages. These recommendations are indicated on the chart on this page.

For general use

A large proportion of binocular purchasers want a glass "just to look through"—for travel, sports events, bird hikes, hunting. Preferred model for such general use is the 7×,35, which provides . . . in most-nearly perfect combination . . . magnification which most people can use, brilliant image, generous field of view, easy handling, reasonable compactness and light weight. From the first year it was put on the market, the 7×,35 has been the most popular of all binocular models.

USES	6×,30	7×,35	8×,30	9×,35
Nature Study	x	**X**	x	
Traveling	x	**X**	x	
Spectator Sports	**X**	x		
Bird Study	x	**X**	x	x
Hunting				
Mountain			x	**X**
Prairie			x	**X**
Wooded Areas	**X**	x		
Deer	x	**X**	x	x
Mountain Goats				**X**
Coyotes		x	x	**X**
Big Game	x	x	**X**	x
Wildfowl	x	**X**		
Vermin		**X**	x	
Exploration		x		x
Navigation				
Yachting	x	**X**		
Race Tracks	x	**X**		
Forest Ranger		**X**		
Control Tower Airport	x	**X**		
Air Plane	**X**	x		
Field Trials	x	**X**	x	
General Use	x	**X**	x	
Mountain Climbing	x	x	x	**X**
Target Work	A Spotting Scope should be used			
Night Use				

Black x's are primary choice; white x's are secondary choice.

Which focusing model?

Both center focusing and individual focusing models are available (as described on page 5). Because its focus can be changed quickly when passing the binocular from person to person, or for focusing objects at various distances, the center-focusing model is generally preferred.

When one person intends to be the sole user of a binocular, he may prefer the simpler, sturdy, individual focus model. When he has established the correct positions where both eyepieces are in focus for his eyes, he can reset them quickly to the proper setting on the eyepiece scales. Some users secure each eyepiece in proper position by means of adhesive tape; if all viewing is to be done at distances beyond about 200 yards, there is no need for refocusing during use of a binocular.

However, for most use, ability to focus quickly at various distances is desirable—as in nature study or in following action. For such use, the center-focusing model has the great advantage of focusing both eyepieces at once. Also, for viewing close objects, it's important that the binocular be built to focus at near distance. Check this property of a binocular by seeing how close an object you can focus sharply.

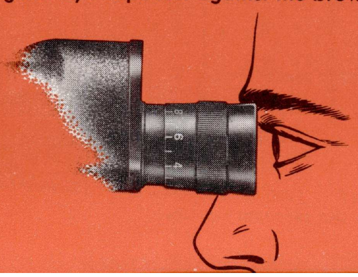
Because of the mechanical provision for center-focusing, it is possible to construct the individual focusing eyepiece binocular somewhat more nearly moisture-proof. For this reason the individual focusing type is specified by the Army and Navy.

Eye caps

Best results in using a binocular, particularly in the matter of seeing the entire field of view, require that the binocular be held at the proper distance from the eyes. To reduce extra light entering the eye around the eyepiece, the eyepieces are provided with caps of such depth that the binocular is at proper distance with the eye caps close to the brow. Users who wear glasses while looking through a binocular will not be able to bring the binocular close enough to the eye to get best performance. For such use, the binocular should be fitted with "flat eye caps," of proper depth that best performance will result from holding the eyepiece caps against the glasses.

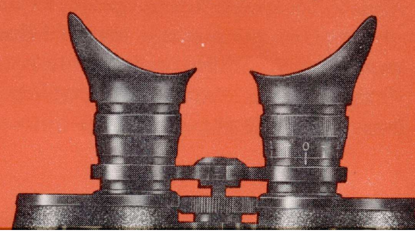
The performance of a binocular is still further improved if extra light is excluded from entering around the eyepiece. For this purpose, molded rubber eyecups are available for some binoculars; they fit close against the face, provide for the eyepiece being held at a proper distance from the eye, and assist in holding the binocular steady.

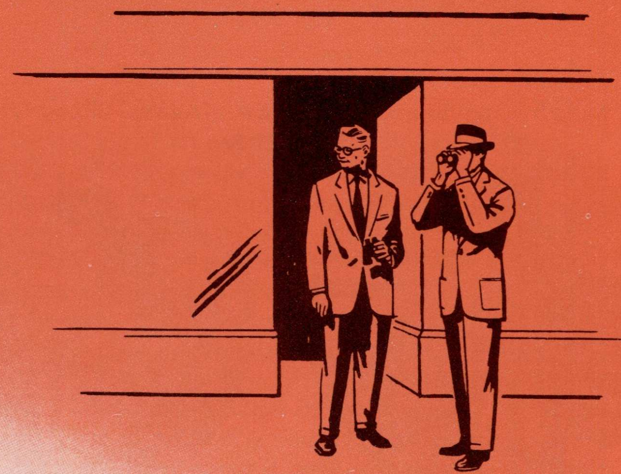
Regular eye caps rest against the brow



When glasses are worn while using a binocular, it should have shallow eye caps

Molded rubber eyecups exclude extra light from entering eye, keep rain out





inside information on binocular differences

All the previous pages have been devoted to a discussion of binoculars *in general*—magnification, objective diameter, focusing methods, etc. In even a short shopping expedition, you will have found a variety of binoculars, quite similar in appearance, and of perhaps identical specifications, but at widely varying prices. What accounts for these differences? Are there qualities which provide *better seeing* in one than another? Is there any significant difference in the length of service that can be expected from one over the other? The fact is that *even greater* than the differences in price are the *differences in performance*—differences in how clearly you will be able to see—differences between long enjoyable service and early failure. These are *inside* differences—in competence of design . . . in selection and control of materials . . . in skill and precision workmanship . . . in honor and responsibility of the maker.

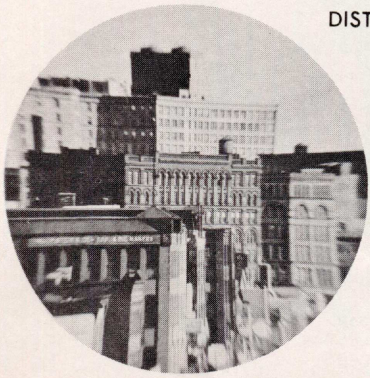
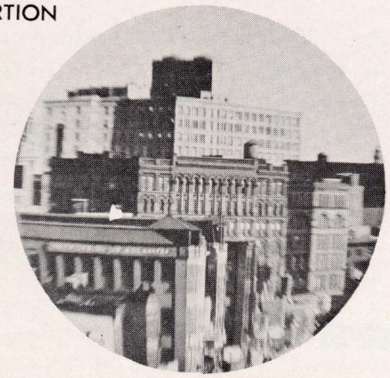
We are ready now to consider these *inside* differences. And here again there are certain tests you can make to help you judge quality, performance and durability.

Image quality . . . definition

The first requirement of the binocular is that it produce in your eye an enlarged image of what you are looking at. The clarity of that image, the sharpness of detail which it renders visible, is called "definition" of image. Mere magnification is useless to you, unless the magnified image is sharp, well enough defined for you to recognize what you see.

The quality of image definition depends on the excellence of optical design—"correction"—control of materials, precision of manufacture and assembly to design specifications.

DISTORTION

CURVATURE OF FIELD


Correction refers to the elimination or reduction of the several *aberrations* which appear in the image from any lens or lens system. Each of these aberrations has its own particular way of degrading or "fuzzing" the image, and only to the degree that these aberrations are reduced or balanced out by optical design is it possible for any instrument to produce an image that is sharp and clear.

The aberrations most often neglected in design of inferior binoculars are *distortion, curvature of field,* and *chromatic aberration.* Here's what they are and how you may be able to recognize them:

Distortion in an optical system is the result of its inability to render straight lines in the object field as straight lines in the image. Technically, it is the result of magnification being unequal in different parts of the field, and it shows up as straight lines in the object bulging inward or outward toward or away from the center of the field in the image. You can see distortion in the field by focusing on a building or other object with straight lines and square angles. If the straight lines near the edge of the field are badly curved, the instrument has excessive distortion.

Curvature of field occurs when the sharp image does not lie on a flat plane, but rather on a curved bowl-shaped area. It is seen in an image which is sharp at the center but which falls off into blurriness at the edges—or when refocused shows edges sharp and center out of focus. (In some binoculars, it is not possible to get the edges of the view sharp at any focus setting; this is the result of other aberrations in the system.) You can test for curvature of field by focusing on a brick wall, or other area of uniform detail. The image should be equally sharp all the way from center to edge of field.

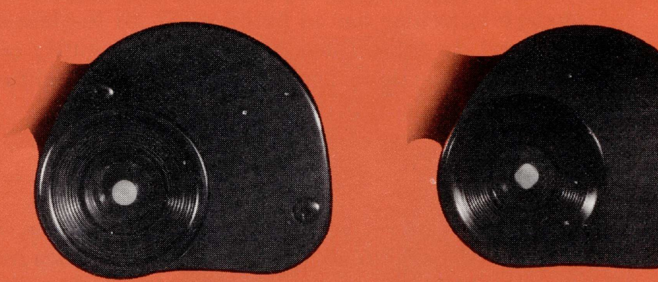
Chromatic aberration is the result of the inability of a lens or lens system to bring to common focus the light waves of different length (and therefore different color). In binoculars with inferior chromatic correction, a building, post or tree silhouetted against the bright sky will show bright color fringes along the edges. Chromatic aberration is particularly undesirable in a binocular because it results in the forming of a color halo around every point in the image, smearing and fuzzing detail.

In no binocular will you find all of these and the other aberrations completely eliminated, because optically the reduction of one usually results in increase in another. But the degree of their reduction and "balancing out" is the measure of sharpness of image—definition.

There are ways of making an overall evaluation of definition before you buy—and since your purpose in owning a binocular is to enable you to see clearly, it is well to make careful comparisons. Focus on a flat textured surface such as a brick or concrete wall across the street. Note the ability of the binocular to focus small imperfections in the surface. Or, standing on the sidewalk in front of a store, focus on the license plate of a car *several blocks away,* and see how easily you can read the number. With many binoculars, you'll see the plate plenty large, but will be unable to distinguish the figures; blurred magnification is no better than no magnification.

A definition test you can make indoors is the "newspaper test." Pin up a newspaper page at the end of the room, and looking through various binoculars of the same power, move yourself gradually back until you just can't quite read the small type. Obviously, the binocular which makes reading possible at the greatest distance is the one with best definition—a quality you'll earnestly want when searching a distant landscape or looking at an animal or bird in the woods.

Quality of definition, as said earlier, depends on skill of optical design, use of materials of exact characteristics, and precision manufacture. There's one quick inspection you can make of any binocular which will give you a clue in this matter. Look at the exit pupil of the binocular, by holding it at arm's length, pointed at a bright area. The exit pupil should appear as a bright *round* sharp-edged disc. If the disc is surrounded by a square grayish area, it is a sign that the prisms of the binocular are made of crown glass, rather than correct flint glass. This fault will result in falling off of image brightness around the edge of the field, but more importantly, it reveals faulty design or construction *inside* the binocular, where you cannot otherwise examine it.



Exit pupil should appear as a bright, round, sharp-edged dis
A square, greyish area indicates inferior design or constructio

Light transmission

Light transmission refers to the percentage of light entering an optical system which actually gets through it to form the image. (This should not be confused with *relative brightness*, discussed on pages 9-10.) Every lens, prism . . . or other piece of glass . . . *absorbs* a small part of the light entering it. But a much larger and more serious loss occurs through *reflection*—the light that is turned back at every glass surface.

As you look through a window, not more than 92% of the light on the other side gets through to you (4% being lost through reflection at each of the two surfaces of the glass). If you're wearing glasses, another 8% is lost by reflection. The fact is that at every air-to-glass surface, from 4% to 6% of light is reflected—only 94% to 96% gets past it. (The exact percentage of reflection depends on the density or *refractive index* of the particular piece of glass.)

A modern binocular has as many as 12 air-to-glass surfaces in each barrel. In total, these surfaces can be guilty of losing, by these reflections alone, as much as half of the light entering the binocular.

Contrast

More important even than the light loss, however, is what happens to these reflections. Some, of course, bounce harmlessly back toward the object being viewed. Many others, however, reflect and re-reflect from surface-to-surface and come out through the eyepiece as "flare," "scatter light" or "ghost images." This results in a haze or fog across the whole image, graying it down and degrading contrast.

Anti-reflection coating

Until about the time of World War II, nothing could be done about reflection losses or flare. But the development of *anti-reflection coating* processes has changed the whole nature and performance of optical instruments—surely being the most important development of the century in optical science.

Anti-reflection coating consists of the molecular deposit of a thin film (about four-millionths of an inch) of a special metallic salt on the surface of optical elements. Its effect is to reduce reflections from air-to-glass surfaces by amounts from 65% to 90%. In the case of a binocular of which all elements are properly coated, light transmission is increased by at least 50%. (This is an image brightness entirely independent of exit pupil or relative brightness as discussed on pages 9 and 10.)

But of even greater importance than this increase in transmission and image brightness, is the improvement which anti-reflection coating makes in *image contrast*. If you have opportunity to compare the quality of the image in an uncoated binocular with a coated one you will be amazed at the difference. By comparison, the best uncoated binocular produces an image hazy, gray and flat. Coating makes an image in which dark areas are dark, light areas light, and detail crisp and clear.

This is not a matter directly related to the correction of optical aberrations discussed on pages 13-15 as contributing to definition of image. However, the improvement in contrast made possible by anti-reflection coating is among the most important factors in image quality—in providing the clear, sharp, detailed vision you want from your binocular. Today, a binocular without anti-reflection coating is as obsolete as a Model T Ford.

There is, of course, a difference in the quality of anti-reflection coating. A proper modern "hard coating" is about as durable and abrasion-resistant as the surface of the glass itself; soft coating can easily be rubbed off. Coating must be applied under conditions of strictest laboratory cleanliness, since any surface contamination whatsoever will prevent its deposit.

The importance of coating is so great that it is a necessity on any binocular offered for sale today. Some manufacturers, however, attempt to camouflage a binocular by giving it the appearance of being coated when it is not in fact. This is accomplished by coating only one surface of objective and eyepiece lenses. Of course, for the reduction of flare, coating on the internal surfaces is even more important than that on the outside surfaces, and, since a modern binocular has either 10 or 12 air-to-glass surfaces in each barrel, coating on only two surfaces is almost worthless. This practice may be interpreted as a deliberate deception.

There is a way you can detect it, however. Hold the binocular so that you look into the large, or objective, end in such position that you can see the reflection of an overhead light bulb. If you hold it right you will see in the objective end a series of reflections, one for each optical surface of the lens and prism system. Each reflection from a coated surface will be dull and blue or purple. If any internal surfaces are not coated they will show as a bright reflection in the natural yellowish color of the light.

Alignment

A binocular is an instrument made to be used with *two* eyes. If it is in correct adjustment, you see both images superimposed as a single picture, with increased perception of depth—and looking through the instrument will be comfortable and restful to your eyes, even over long periods of use.

The characteristic that makes this ease and efficiency of use is the *alignment* (or "collimation") of the two prismatic telescopes which are the barrels of the binocular. In the accuracy—and *permanence*—of the alignment adjustment of the binocular you buy *may be the difference between a worthwhile investment in a lifetime of pleasure and satisfaction—and a glass that's no bargain at any price.*

Any user of a binocular will recognize that a "double image" indicates that the glass is out of alignment and is useless. Not so obvious is a "slight" error in alignment—but it is a fault even more serious because you will go on trying to use it, not knowing of its trouble. A slight error in alignment means that the optical axes of the two barrels are pointed in slightly different directions. The involuntary effort of your eyes to "fuse"

a single image will result in their movement to compensate for the error in alignment—so that you look "cross-eyed," "wall eyed" or with one eye pointed up while the other points down. This leads to fatigue, eyestrain, headaches, reduced clearness of vision, and frequently to stomach upset and nausea. Even a "slight" error of alignment greatly impairs the usefulness and value of a binocular to you.

How does a binocular get out of alignment?

Every binocular is aligned by a "collimation" process when it is assembled. All but the poorest binoculars can be aligned within tolerable limits—although many in the stores today are not.

Accuracy of alignment depends on the precision with which the binocular is collimated. This adjustment is made in modern binoculars by movement in their mounts of objective lenses. In older binoculars, alignment was achieved by positioning of the prisms before being secured in their mounts. An important consideration in the matter of alignment is that its accuracy be maintained throughout the full interpupillary range—the "distance-between-the-eyes" adjustment made by swinging the barrels on the center hinge.

Permanence of alignment is the all-important characteristic; it depends on the optical elements *staying* in the positions in which they were originally mounted. This is a result not only of precision fit of parts but skill and honesty of workmanship. For binocular durability and long life, the mechanical design and method of construction are of major importance—particularly in the matter of prism mounting.

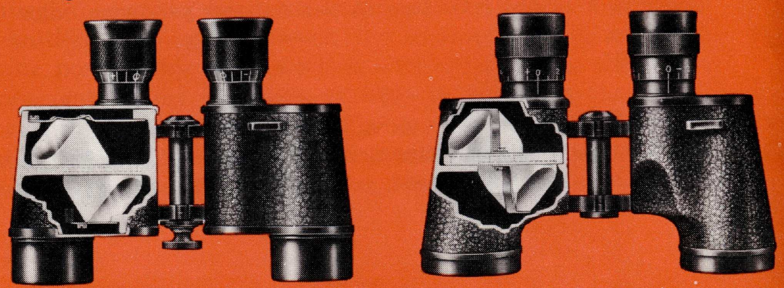
In each barrel of the binocular is a pair of "Porro" prisms, mounted one on each side of a shelf. This shelf may be of either of two types. Earlier binoculars (and some offered today) are made with the shelf cast as a single piece with the body. The body itself is machined to provide surfaces on which prisms rest. Prisms are inserted from each end of the barrel; they are positioned and secured inside the body.

A more modern construction uses a separate prism shelf. Prisms are adjusted to proper position by use of optical instruments, and fixed in that position before the shelf is inserted in the binocular. The shelf is installed by being screwed to lugs on the inside of the binocular body. A further advantage of this design is that it permits elimination of the bottom cover plate, which provides lighter weight, greater strength, improved moisture- and dust-tightness, and better hand-fitting shape.

With either type of shelf, accuracy of alignment depends on the prisms being seated squarely and at right angles to each other. Their exact spacing and lateral positioning is critical, both to correction and to alignment. The most common and most serious fault in binoculars of inferior quality is lack of

Prisms mounted on shelf cast integral with binocular body

Prisms mounted on separate shelf which is then fastened in body



alignment. And misalignment is almost always the result of movement of prisms. Any movement of a prism, even by a fraction of a thousandth of an inch, will seriously impair the performance of the binocular.

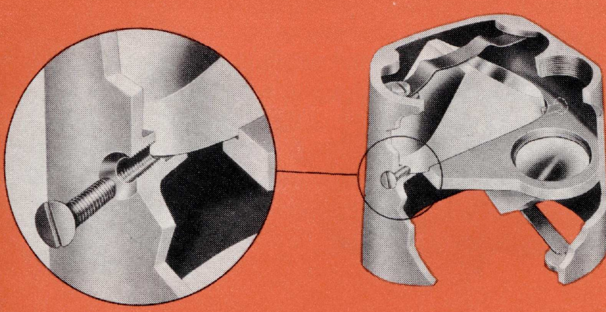
Through the years of binocular design and manufacture, a number of methods of positioning and securing prisms have been tried. Several methods are in use in binoculars being made today, and the differences in the accuracy and permanence of mounting they provide is one major factor in the differences in binocular performance, serviceability and value.

In the poorest binoculars, prisms are adjusted by hand-sliding them around on the shelf, and secured by pouring beeswax or plaster-of-Paris around them in the cavity between prism and body wall. Because of the likelihood of softening from heat or cracking from impact, this method obviously does not provide for permanence of alignment even in ordinary use.

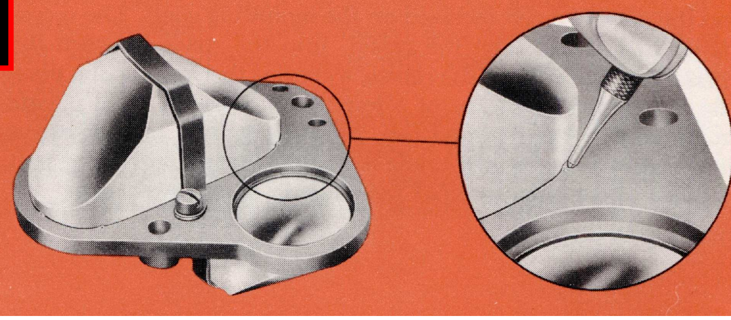
Binoculars of the World War I era, and those made for some time after that, had prisms held against the shelf by a spring clip, adjusted for position and held by screws through the body bearing against the sides of the prisms. In this design, the screws had to be tight enough to hold the prisms firmly in position but not so tight that the glass would be under strain. At any point of strain, glass will easily fracture or chip under shock or temperature change.

A somewhat better method of holding prisms in position was by "peening." This method is still in use today, and is seen in almost all imported binoculars of medium and low price. By this method, the prism is set in a recess slightly larger than the prism itself, and held down by a metal strap. Lateral adjustment of the prism to position and holding against movement is accomplished by peening spots on the shelf around each prism—with a steel punch, humps of the metal of the shelf are pushed up against the prism. Of course, these peened humps must be pushed up far enough to hold the prism immovable, but not far enough to chip, crack or impose strain on the glass prism. With this construction, prisms are sometimes loose when the binocular is assembled; often they are chipped during assembly; more often they show up as loose when they have been chipped by a light shock in use, resulting from the strain put on the prism by pressure from a peening point.

Prisms held in position by screws through sides of body



Prisms positioned by "peened" points pushed up with steel punch



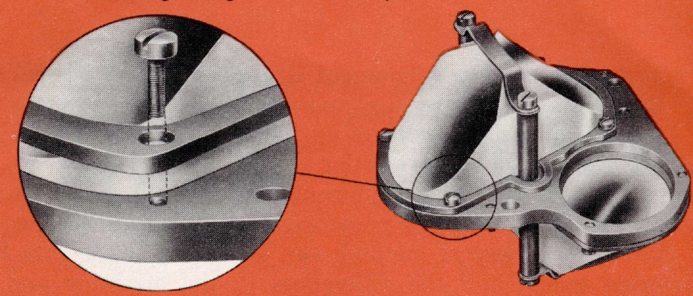
Mounting of prisms by any method is for the same two purposes . . . fastening the prisms in correct position . . . and keeping them there for the life of the binocular. With any of the methods discussed on the previous page, it is almost impossible for prisms to be held securely or without imposing strain which may result in chipping them.

A much better method of prism mounting involves use of a metal collar surrounding the prism. This collar fits the prism snugly and is fastened by screws to the prism shelf. Slightly oversize screw holes in the collar provide for lateral movement of the prism for precision positioning on the shelf. When the screws into the shelf are tightened, their tension holds the collar and the prism permanently in position without strain.

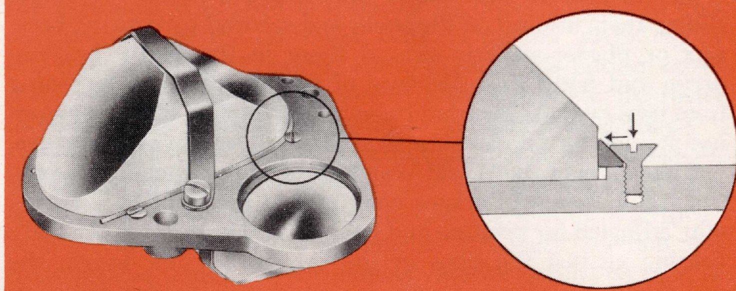
An equally good method of prism mounting, used in recent years in binoculars of high quality, employs a triangular wire surrounding the prism, and held against the prism by tapered-head screws. As this type of screw is driven deeper into the shelf, its tapered head pushes the wire further sideways, so that this method provides for critical lateral adjustment as well as permanence of mounting position.

A newer type of prism mounting has been developed since World War II. It is superior to all others in its ability to hold prisms securely under shock and permanently without strain. As in earlier methods, the prism is held squarely and firmly on the floor of a cell recessed on the mounting shelf. The recess is slightly larger than the prism. Into the space between the prism and the edge of the recess, a special thermal-setting plastic is injected by means of a hypodermic needle. This plastic material fills the recessed cell, prevents forever any sideways movement of the prism, holds it without strain, and protects it against shock and thermal movements of glass-to-metal.

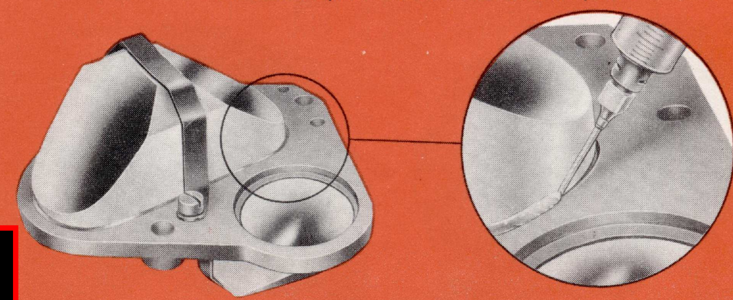
Snug-fitting collar around prism is screwed to shelf



Triangular wire wedges between prism and tapered-head screw



Permanent plastic fills recess around prism



Obsolete methods of prism mounting and inferior workmanship in assembly account for the plain fact that thousands of binoculars sold on the American market in recent years have been knocked out of alignment by a simple jar or jolt such as inevitably attends normal use of the glass. A considerable percentage of those in show cases in stores today could be thoroughly knocked out by a vigorous thump with the heel of your hand.

Regarding many of the binoculars you may see offered for sale, you won't even be able to find out what method of prism mounting is used. You certainly won't be permitted to subject any of them to any type of shock test unless you want to risk having to pay for binoculars rendered inoperative by your vigorous handling. You won't even know for sure whether or not the glass is within tolerable limits of alignment when new unless you can manage to borrow it long enough to give it the trial of an hour or so of steady use. Yet, *the method of prism attachment and precision of workmanship at this point is probably the greatest single mechanical difference between an inferior binocular and one built for a lifetime of faithful service and enjoyable use.*

Can't they be repaired?

A binocular prism or other optical part loose from its mount is not a repair job you can undertake yourself. Collimation requires specialized skill and precision optical equipment. Alignment of a binocular alone is quoted by repair laboratories at prices ranging from $12.00 to $25.00. After such expensive repair, the same failure is just as likely to happen again—sometimes even during shipment to you from the repair laboratory! *No repair or adjustment—short of a complete rebuilding job—can cover up or correct a manufacturer's inferior design, shoddy materials, faulty workmanship or misfit of parts.*

Mechanical design, construction, workmanship

To be convenient to use, a binocular must be as light as possible, but strong enough to stand up under years of normal use and abuse. Its weight and size should be distributed to make it balance naturally in the hand and before the eyes.

To provide high performance and lifetime service, internal surfaces must stay clean and be treated to provide a hard reflection-free surface which will not flake or dust off. Lenses as well as prisms must be mounted so that they cannot move or be subjected to strain, even though thermal expansion and contraction of glass elements is different from that of metals. Particular care must be taken in choice of materials. Lightness of weight must not compromise strength through soft or fragile mounting threads or points of mechanical strain. Electrolytic reaction between metals must be avoided—a brass screw in a magnesium body, for example, will set up a corrosive reaction which will, in a few years, eat the threads completely out, so that either the screw drops free, or freezes so that it cannot be removed. Covering material and external finish must be attractive, resistant against abrasion and wear, comfortable in cold, slip-proof in wet or perspiring hands, non-deteriorating in sunlight and weatherproof.

Several of the lens elements in a modern binocular are "combination" lenses, individual lenses of different types of glass, cemented together. Traditional cement for this purpose is Canada Balsam, a natural material which has the shortcoming

Here is an "expert's test" you can make as a guide to quality of workmanship in a binocular's manufacture. Feel the hinge action by swinging the two barrels on the center hinge. Movement should be firm and smooth—firm enough to hold the setting at any position, soft enough that change in setting can easily be made. Any stiffness, looseness or jerkiness not only casts doubt on alignment of the binocular, but is a sure sign of faulty workmanship which may exist in other and more important places. Similarly, adjustable eyepieces should rotate firmly and smoothly. Roughness or looseness means the binocular is not properly moisture-tight, will wear quickly and is warning of poor workmanship throughout manufacture of the binocular.

of discoloring, crystalizing and separating with age and temperature change. Modern thermal-setting plastic cements that are of superior optical quality and are unaffected by any temperatures in nature are available, but few manufacturers want to go to the expense of their somewhat more difficult use.

They aren't equally good

Not all manufacturers of binoculars in the world's market have an equal skill in the design of such precision optical instruments . . . nor in an understanding of what features make for high performance and long life . . . nor a staff of craftsmen capable of such exacting work . . . nor a responsibility that requires them to stand back of products of their manufacture. (More than half of all binoculars sold in the United States since World War II are now "orphans"—many of them were, even before they moved across the retail counter).

From independent optical repair laboratories across the nation we receive continued reports of binoculars for which repair is not practical, indeed often impossible . . . misalignment from undersize or broken prisms . . . porous and weak body castings, often with hinges broken right off . . . stripped threads due to soft metal in eyepiece assemblies or attachment, prism tension springs, objective assemblies or attachment . . . lens coating so soft it cannot be cleaned even with lens tissue . . . separated lens combinations . . . poor image quality due to inferior optical design or inaccurate manufacture.

Several laboratory owners have said that they maintain lists of trade names of binoculars on which they now refuse to do any work because of the impossibility of providing performance or durability which would justify the cost of service.

MB

how can you be sure?

How do you evaluate all this evidence to decide what binocular, at what price, will give you "most for your money" in enjoyable seeing and long service?

In the first place, you have learned of a number of tests you can make yourself, even in a store, or on the sidewalk in front of it. You can be sure that failure of a binocular to measure up in any one of these particulars is a certain sign of serious deficiency in design or manufacture.

But some of the characteristics essential to good visual performance and long life are not measurable without precision laboratory equipment, disassembly, break-down tests, and the service test of your own use. Surely no storekeeper is going to permit you to bounce his stock of binoculars off the tile floor so that you can see what happens to the prism mounting. He probably won't give you a year or two of "free trial" to see what faults show up in your own field test.

What's "good enough"?

Sooner or later, you'll have to fall back on your own judgment. You are entitled to decide that a certain instrument, at a certain price, is "good enough" for you. Nobody can argue with that decision, because you alone can make it, and it's your risk of your money. You can even decide to "take a chance" on repair bills or on the possibility that replacement parts will not be available, or that your binocular may suffer failure that will be unrepairable.

You can ask for a guarantee, but you'd do well to look behind the guarantee—if you get it—to see who makes it. Most binoculars on the market today are "johnny-come-lately's," and you want to be sure the guarantor is in business when the trouble starts. Few retailers are willing to take direct responsibility for the performance or durability of the binoculars they sell.

It can be "forever"

Before you make the decision to take a chance, remember that if you buy real quality, you will have made a lifetime investment in enjoyable seeing. Every time you use it, for as long as you use it, your binocular will render a sharp, brilliant image, with comfort and ease to your eyes. Even at the highest initial price, your cost per use, or per year, will be insignificant measured in terms of your pleasure and the gratification of owning and using a superb instrument.

There is a sure way

Three generations of Americans have found the way to life-long pleasure and certain continuity of service. They have bought, and they cherish, binoculars made by Bausch & Lomb. These are instruments that are the world's "standard of excellence" in binocular performance and reliability. They are made by the scientific firm with the world's longest experience in manufacture of binoculars and other precision optical instruments.

THE BAUSCH & LOMB BINOCULAR

. . ."world's best . . . by any test!"

A far view . . . a bright, sharp view . . . with greatest comfort and eye ease . . . over a lifetime of enjoyable looking experiences . . . at the lowest possible per-use or per-year cost . . . are yours if you are one of the great legion of Bausch & Lomb Binocular owners.

Visual performance and long life are assured in a binocular that is the product of unmatched experience, knowledge, ability and facility. Bausch & Lomb is the manufacturer with the world's longest experience in binocular production—and is today the only American manufacturer of binoculars.

Optical performance

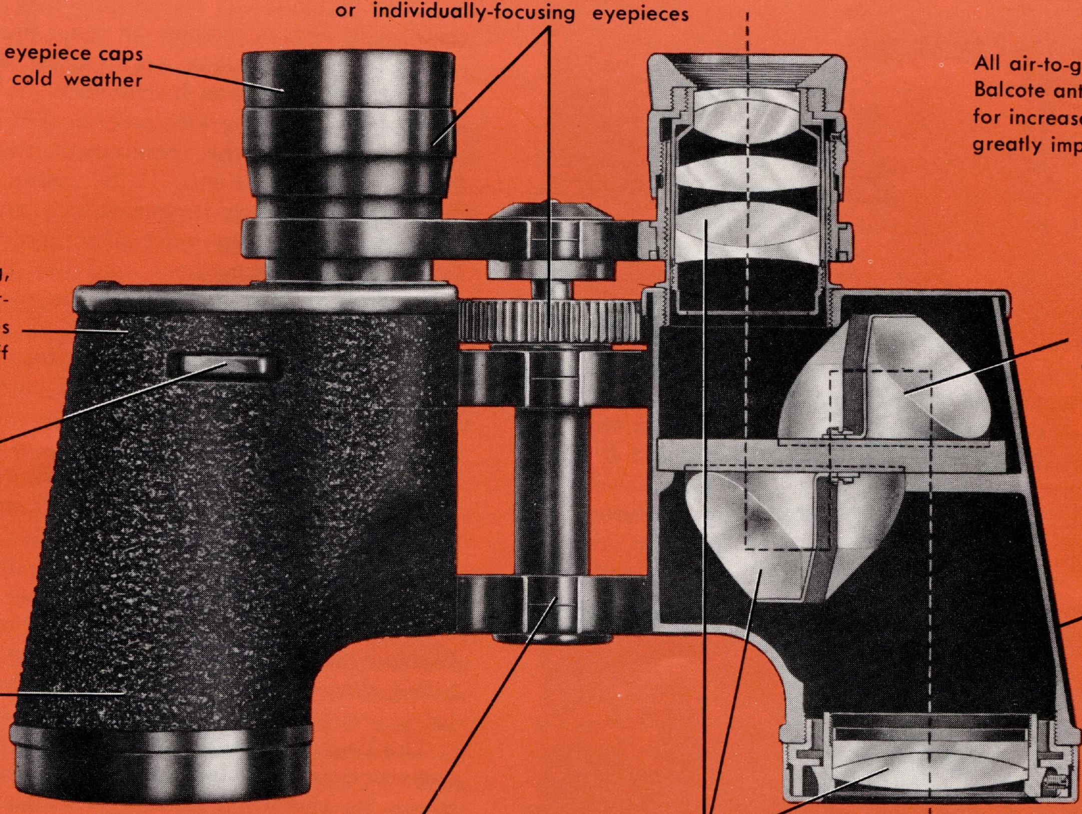
Optical performance depends on three factors: design, material, and workmanship.

Bausch & Lomb Binoculars are designed by the scientific staff which is responsible for the greatest assortment of precision optical instruments for use in research laboratories, in military fire control and other scientific applications. The current design is the product of more than 60 years' experience in the manufacture of fine binoculars, and the combined judgment of the members of the Bausch & Lomb Scientific Bureau. Included in this group are those who rank among the world's foremost optical engineers and designers.

Image quality in any optical instrument, as we have seen on page 13, is the result of reduction of optical aberrations. A design, to be successful in this aim, depends on skilled computation of lens curves, spacing of lenses and prisms, availability of glass of exact and required characteristics, and an understanding of manufacturing methods and controls to meet design specifications.

Glass, the material of the optical system itself, is produced for Bausch & Lomb Binoculars and other precision instruments in the Bausch & Lomb glass plant. This is the only plant in the United States making both instruments and optical glass, and is the site of important research in optical glass. Here more than 100 types of glass are routinely produced. Design specifications of glass characteristics are exactly maintained.

Grinding of lenses and prisms is done by American craftsmen trained and experienced in this specific work. The methods


Models available with center focus or individually-focusing eyepieces
Smooth plastic eyepiece caps comfortable in cold weather
All air-to-glass optical surfaces c
Balcote anti-reflection hard coate
for increased light transmission a
greatly improved contrast of ima
Vulcanized body covering, in morocco grain, is weather-proof, wear-proof, furnishes non-slip grip. Cannot peel off
Exclusive prism-mounti
method eliminates str
on prism and provid
a permanent alignm
Strap eyelets cast integral with body
Strongest, lightest, co
magnesium-alloy bo
One-piece body construction . . . no bottom cover plate. Increases strength and weather-tightness, provides light weight and hand-fitting shape
Precision hinge-and-axle provides accurate alignment for a lifetime of use
Optical system in this model (8 × ,30) requires nine ultra-precise elements (made from six different types of Bausch & Lomb glass) in each barrel

and the modern equipment used are the result of development of over 100 years of precision optical manufacture.

BALCOTE Anti-reflection coating

To a large extent Bausch & Lomb research has been responsible for the scientific miracle of anti-reflection coating. One of the inventors of the process has been on the Bausch & Lomb research staff since before the process was commercially feasible. First commercial application of anti-reflection coating was made by Bausch & Lomb in a series of motion-picture projection lenses in 1939. During World War II, millions of optical parts for critically-important military instruments were produced with Balcote anti-reflection coating.

Today's Balcote is a tough, durable coating which will last as long as the glass surfaces to which it is applied if given reasonable care. It makes possible a light transmission in Bausch & Lomb Binoculars of 72% to 78% (as compared with averages about 50% before coating). In addition, it contributes to an image of clarity, crispness, contrast, and color rendition never known before.

Mechanical durability

Optical quality, the sharpness, brilliance, and contrast of the image, is the responsibility of the optical system. But mechanical means must be provided for precise mounting of optical elements in specified positions, for adjustment necessary in use of the instrument, for protection of optical elements, and for permanence of both mounting and adjustment through years of use and abuse.

It can be truly said that a binocular is as much a precision instrument as a microscope or other fine scientific equipment. But it has an additional requirement not ordinarily imposed on "delicate" precision instruments—it must be able to withstand rough handling without optical or mechanical failure. To learn how to meet this requirement, there is no substitute for 60-odd years' experience . . . the manufacture of several hundred thousand such instruments . . . and the opportunity to see how they hold up under all sorts of field service. Bausch & Lomb has that experience, and the present models of B&L Binoculars are an outstanding example of the beauty of true functional design.

The frame of the binocular is a "form-fitting" sheath enclosing an optical system and optical path. The light weight of this instrument is a source of amazement to anyone who picks it up for the first time. Nearly 40% of the total weight of the Bausch & Lomb "Zephyr-Light" Binocular is in glass—the lenses and prisms of its optical system. Yet in its intended use it possesses tremendous strength. This is the result of a detailed knowledge of structural requirements, allowable thinning of non-critical sections, use of new airplane-type magnesium alloys, and close-tolerance manufacturing methods. Lightest possible weight without compromise of strength, hand-fitting shape, and natural balance make the B&L Binocular a joy to use, without fear of mechanical failure.

The Bausch & Lomb 7×,50 Binocular is not of Zephyr-Light construction. It is built for the special rigors of Navy use, where its somewhat greater bulk and considerably greater weight are not disadvantageous. It provides the only completely water-tight, fog-proof, fungus-proof construction known in binocular design. For other than severe marine use, however, these features are of less importance. In the field, at sports events, for travel, you'll be glad for the easy handling, compactness and light weight in which other Bausch & Lomb binocular models excel.

Permanent alignment

Alignment of the two barrels of the Bausch & Lomb Binocular (discussed on pages 17-21) is accomplished by the most advanced and positive method ever developed—and used exclusively by Bausch & Lomb.

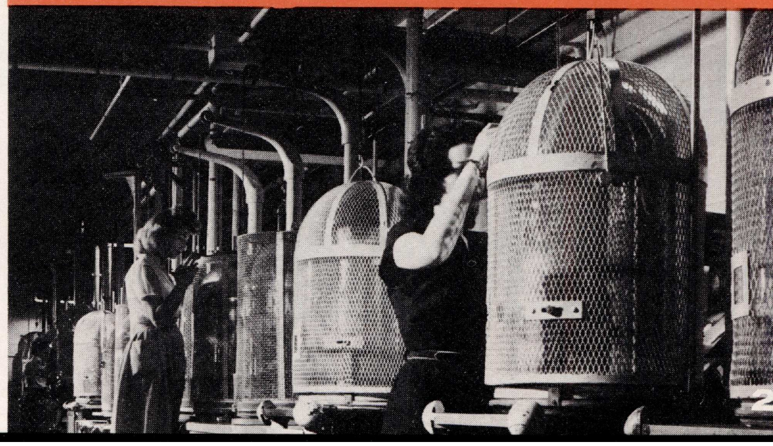
The alignment adjustment itself is made, after the binocular is assembled, through movement of objective lens mounts by a method which permits infinitely-precise adjustment of the optical axis in any direction. The method used assures that alignment will be accurate well within the limits of human visual perception. Collimation is uniformly accurate throughout the entire range of interpupillary adjustment, as the barrels swing on the center hinge. Snug fit of the hinge and permanence of alignment throughout the life of the binocular are assured, too, by precision diamond-turning of hinge and axle.

Mounting of prisms in Bausch & Lomb Binoculars is the strongest, safest and most permanent of any binoculars ever built. 6×,30; 7×,35; 8×,30; and 9×,35 Zephyr-Light models use the "injected plastic" method described and shown on page 20. For the Bausch & Lomb 7×,50 Binocular, mounting is by the "prism collar" method shown on page 20. Both of these methods provide completely rigid, but strain-free, permanent prism mounting.

In other respects the mechanical details of the Bausch & Lomb Binocular meet the same high standards of excellence.

Collimation of Bausch & Lomb Binocular. From one extreme of interpupillary adjustment to the other, alignment must be maintained within maximum deviation of three minutes of arc (1/20 of a degree) in the vertical, six minutes in the horizontal

Balcote anti-reflection coating is applied to lens and prism surfaces under high vacuum in these specially air-conditioned and air-filtered rooms under conditions of surgical cleanliness



A special chemical process is used to provide a tough, hard finish to metal parts. Internal surfaces will not chip, peel or flake to obscure lens surfaces. On outer surfaces this chemical finish provides a wear-resisting base for the tough plastic baked-on enamel.

The cover is rubber, grained to afford a firm grip even when your hands are wet from rain or perspiration, comfortable even in coldest weather, and vulcanized inseparably to the body.

Screws which are tapped into the magnesium body are of special nickel-silver to avoid corrosion from electrolytic reaction.

All-temperature cement

The glass surfaces of multiple-part optical elements are cemented together with a synthetic thermal-setting plastic material. This cement is more expensive and more difficult to handle than the natural cements ordinarily used. But it has the advantages of superior optical qualities, and it will not crystallize, discolor or separate with age or even under the extremes of temperature change. This is one of the many refinements introduced and used by Bausch & Lomb to assure the owner of a Bausch & Lomb Binocular that his is indeed *"the world's best—by any test."*

Close-up focusing

An important "extra" in the Bausch & Lomb Binocular which is not found in all glasses, is a design which permits sharp focusing from infinity down to distances as close as 20 feet. This permits intimate inspection of fine detail, and makes it possible to follow a moving object until it is very close.

Lifetime guarantee

Every binocular owner wants to think that he has an instrument good for a lifetime of use—but this is a satisfaction that can be shared only by owners of Bausch & Lomb Binoculars. Since 1853 Bausch & Lomb has been serving the world with the products of optical science. Every Bausch & Lomb Binocular is built to precision-instrument standards to give life-time service and satisfaction—and it is the only binocular of American manufacture on the market today. It is guaranteed in writing *for life* against defects of material and workmanship. This is a guarantee backed by 100 years of responsibility, and by the name which enjoys the greatest prestige in the world of scientific optical instruments.

While the record shows that fewer than 5% of Bausch & Lomb Binoculars have had need ever to visit a repair shop, it is reassuring to the owners to know that replacement parts and servicing facilities are always available at the factory. Wholly independent of foreign imports, no Bausch & Lomb instrument ever becomes an "orphan."

In addition to the guarantee certificate, a registration certificate accompanies each binocular leaving the Bausch & Lomb factory. Registration of your binocular by serial number in your name at the Bausch & Lomb factory is a Bausch & Lomb service which may help you recover your binocular in case of loss or theft.

Is it "too good"?

Some binocular purchasers have said in effect: "Your Bausch & Lomb Binocular is wonderful, in fact altogether too wonderful for my purpose—or my purse. Why don't you just make a binocular that's good enough to give a good clear image, and that will stand up under ordinary hard use? Spare me the frills and elegance, and save me some money." The fact is that this is exactly what the Bausch & Lomb Binocular is! No *unnecessary* accuracy is provided to run the cost up . . . no luxury extras. If it were possible to build a serviceable binocular at lower cost, it should be evident that the most selfish commercial interests of Bausch & Lomb would be served by entering the resulting broader market.

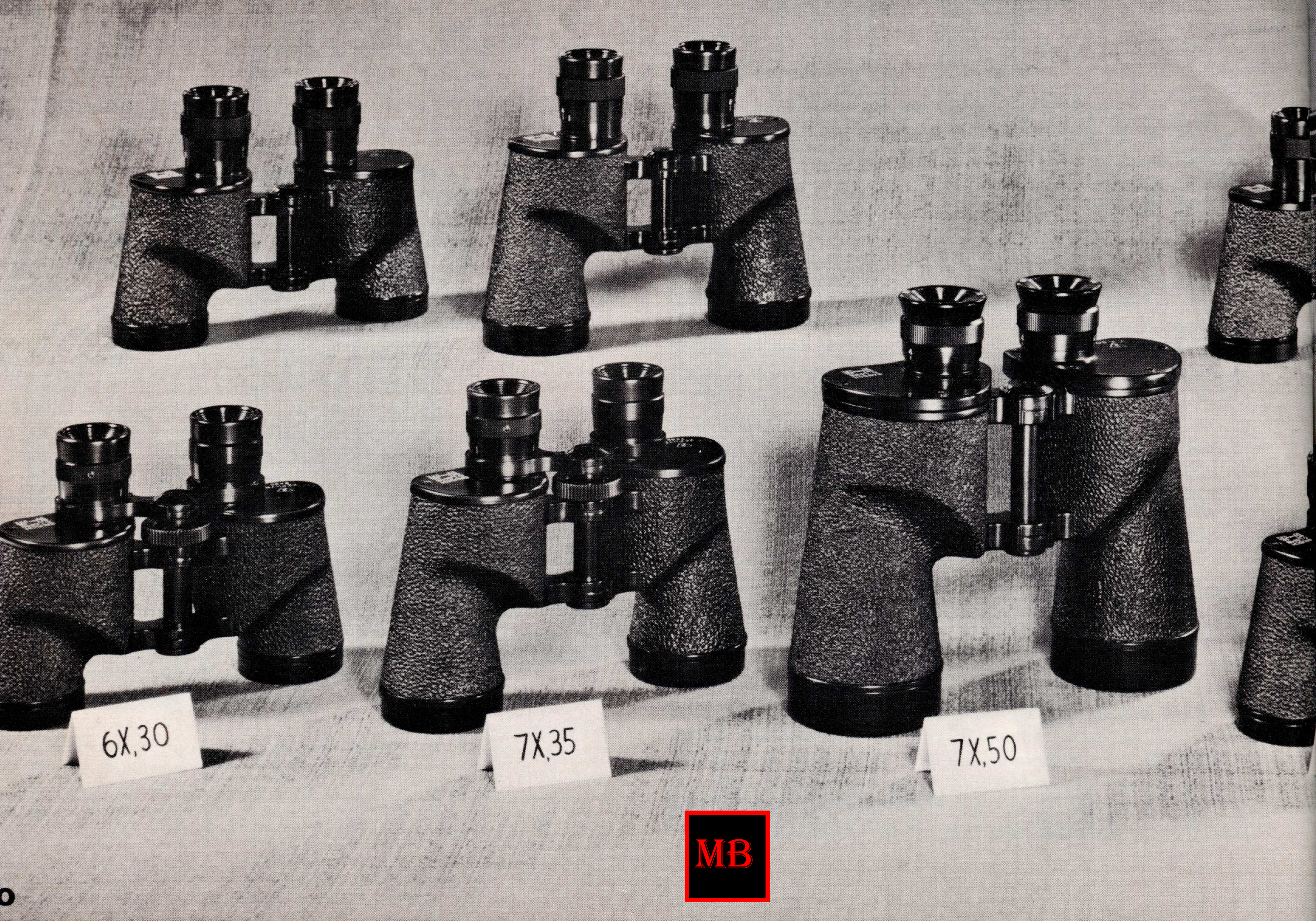
The Bausch & Lomb Binocular is built by honest, skilled American labor to a design and to tolerance specifications which skilled American engineers say is "the minimum required to provide clear, keen vision and the reliability of a lifetime of trouble-free service."

No binocular which offers less in the way of optical performance or service life is a bargain at any price!

The thrill of your life—for your lifetime

If you want a binocular at all, you want it for the pleasure it will give you in seeing close-up, intimately, comfortably, sharply, clearly. When you find that is the kind of vision you get from your binocular, you will want to take it with you almost wherever you go, and your enjoyment will multiply through the years. When you have experienced the thrill of using your own Bausch & Lomb Binocular, you join that wide but distinguished circle of outdoor lovers who have found that in this type of product the best bargain is the best quality—and you will cherish the deep satisfaction of knowing that among all the binoculars in use about you, yours is the *world's best*.

The case, provided with every Bausch & Lomb Binocular, is of rigid frame construction, covered with top-grain leather. Lightweight, long-wearing, strong and attractive, it provides maximum protection to binocular. Adjustable shoulder strap for case, and a neck strap for binocular are also provided


6X,30
7X,35
7X,50

MODEL	6×,30 Zephyr Light	7×,35 Zephyr Light	7×,50	8×,30 Zephyr Light	9× Zephy
Catalog No., Center Focus	61-21-11	61-21-21		61-21-31	61-2
Catalog No., Individual Focus	61-21-12	61-21-22	61-21-58	61-21-32	61-2
Magnification	6×	7×	7×	8×	9
Objective Diameter	30mm	35mm	50mm	30mm	35
Angular Field	8°30′	7°17′	7°16′	8°30′	7°
Linear Field (feet at 1,000 yards)	445	382	381	445	3
Exit pupil diameter	5mm	5mm	7.1mm	3.8mm	3.8
Relative Brightness	25	25	50.4	14.4	1
Length closed	4 3/4″	5 5/8″	7 1/8″	4 9/16″	5 7/
Length open	5 1/8″	6″	7 7/16″	4 15/16″	5 13/
Weight	17 oz.	19 oz.	48 oz.	18 oz.	20
Price*	$155	$155	$175	$170	$1

**Plus Federal Excise Tax (10%)*

BAUSCH & LOMB
ZEPHYR-LIGHT

7x,35 Monocular

For its light weight, extreme compactness, and lower price, many outdoor lovers prefer the Bausch & Lomb Monocular. One-half of the popular 7×,35 binocular, it offers the same high qualities of optical performance and mechanical durability.

Magnification, 7×. Objective diameter, 35mm. Angular field, 7°17′. Linear field, 382 ft. at 1,000 yds. Exit pupil diameter, 5mm. Relative brightness, 25. Length, 5⅝″ closed, 6″ open. Weight, 9 ounces.

Catalog No. 61-16-22 Bausch & Lomb Zephyr-Light Monocular, 7×,35, focusing eyepiece, in fine leather case with straps, $77.50.

Accessories

FOR YOUR BAUSCH & LOMB BINOCULAR

Eye caps...regular or flat

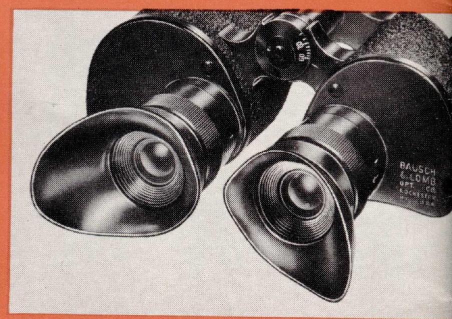
As regularly supplied, the Bausch & Lomb Binocular is equipped with eye caps which should be held against the brow when binocular is used. For those who wear glasses, flat eye caps are available for all models. They may be exchanged for regular eye caps on binoculars purchased. Regular and flat eye caps are interchangeable by unscrewing caps from eyepieces. Extra eye caps, either regular or flat, are available at $1.00 per pair.

Rubber eye guards

A brighter image can be secured, and distraction from "side vision" eliminated by use of rubber eye guards. Their use also protects the eyes from wind, snow and rain. Rubber eye guards cannot be used by eyeglass wearers.

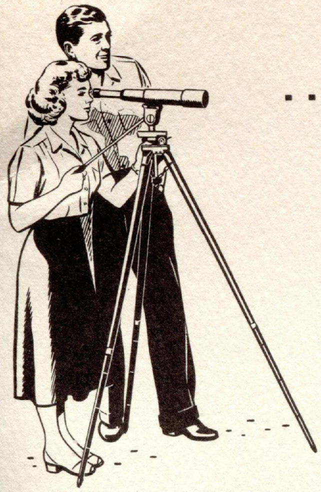
Snap-on rubber eye guards are available for all Bausch & Lomb Binocular models except 7×,50, at $1.00 per pair.

Rotating rubber eye guards are available for 6×,30 and 7×,35 models only, at $3.50 per pair. These replace regular plastic eye caps; in use they turn freely, so do not interfere with adjustment of individual focusing eyepieces.



Rain guard

Eyepieces of the binocular carried on a neck strap can be protected from rain with a rain guard placed on the neck strap. It slides easily in and out of position as binocular is used. Price $2.50.



. . . for longer ranges . . . higher power . . .

BAUSCH & LOMB

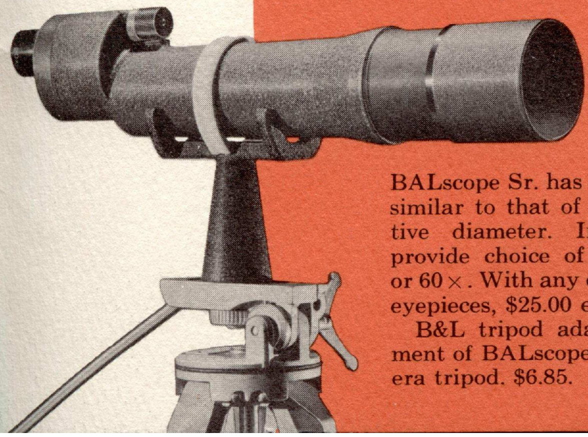
BALscope OBSERVATION TELESCOPES

For long-range viewing . . . where high magnification is more important than width of field . . . a telescope will give performance not possible with any binocular. (See pages 2-4.) In two models of its BALscope Observation Telescopes, Bausch & Lomb offers precision instruments that will bring thrills and lasting pleasure to the whole family. For nature study . . . on the porch of a cabin-with-a-view . . . for amateur astronomy . . . you will get big close-up views from the BALscope.

The shooter of the family will get double duty . . . the BALscope is preferred equipment for target spotting . . . for long-range identification of game.

For further description and specifications, write for folder G-17. Bausch & Lomb Optical Company, Rochester 2, New York.

BALscope Sr.

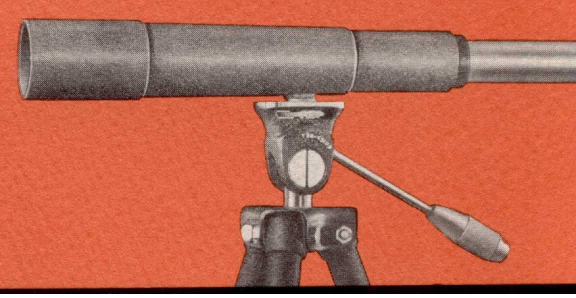


BALscope Sr. has a prismatic optical system similar to that of a binocular. 60mm objective diameter. Interchangeable eyepieces provide choice of power—15×, 20×, 30× or 60×. With any one eyepiece, $95.00. Extra eyepieces, $25.00 each.

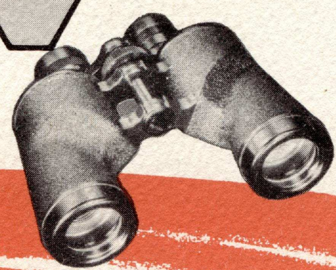
B&L tripod adapter provides for attachment of BALscope Sr. to any pan-head camera tripod. $6.85.

BALscope Jr.

BALscope Jr. has lens erecting system. 40-mm objective diameter. 20× magnification. May be fastened, without adapter, to any pan-head camera tripod. $44.75.



B&L



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Indianapolis 9, Indiana

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ROCHESTER 2, NEW YORK

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Here is your copy of "Binoculars And How To Choose Them"! Thank you for writing to us...we appreciate your interest very much!

HOW CAN YOU PROFIT MOST FROM THIS BAUSCH & LOMB BOOK?

This is not a "selling" book. It is a book of helpful information based on facts...not claims. Its function is to help you decide for yourself whether you want the thrill of using the world's finest binocular...a genuine Bausch & Lomb! We suggest that you read it over carefully cover-to-cover. Then, we believe you will be particularly interested in re-reading, How can you be sure?...............Page 23.

SEE FOR YOURSELF!

While the information in this book is still fresh in your mind...we suggest you visit your nearest dealer (card enclosed). Ask him to show you a Bausch & Lomb Binocular.

From the moment you take it in your hand, you're impressed by the outstanding qualities of this fine optical instrument. Then focus it on a distant or detailed object...and experience the incomparable thrill of the ultimate in image quality. You'll see instantly why the Bausch & Lomb is the "World's Best By Any Test". You'll see why it's worth every cent and more of its purchase price to you...a whole lifetime of enjoyment in close-up viewing of distant subjects.

Sincerely yours,

BAUSCH & LOMB OPTICAL CO.

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