Enlarging Lenses

Rodenstock®

This brochure presents our enlarging lenses – the most extensive range offered by any manufacturer in the world. It extends from budget-priced 3-element units for the beginner up to special 6-element systems for giant enlargements and murals.

In the course of over 100 years the G. Rodenstock Optical Works has evolved as a top producer of photographic optics and in certain special fields even become an international market leader. Any view camera photographer is familiar with the Rodenstock SIRONAR-N and GRANDAGON lenses. Two-thirds of all the world's process cameras are equipped with a Rodenstock APO-RONAR or APO-GEROGON system.

This booklet aims to help you in selecting your lens from 42 lenses. We have tried to present clearly some of the more complex physical facts which differentiate the lenses. MTF curves for each lens type provide objective comparisons.

We hope you will enjoy reading this booklet and that it will help you choose the correct Rodenstock lens for your application.

G. Rodenstock Optical Works

Growing quality demands

are making photographic manufacturers look for more elaborate ways of improving all their products. Among films this has led to new silver halide crystal shapes, reduced graininess and to printing emulsions of better colour saturation and simpler processing. In optics we are getting camera lenses of better definition. The goal of all that optimisation is to achieve the most faithful image reproduction.

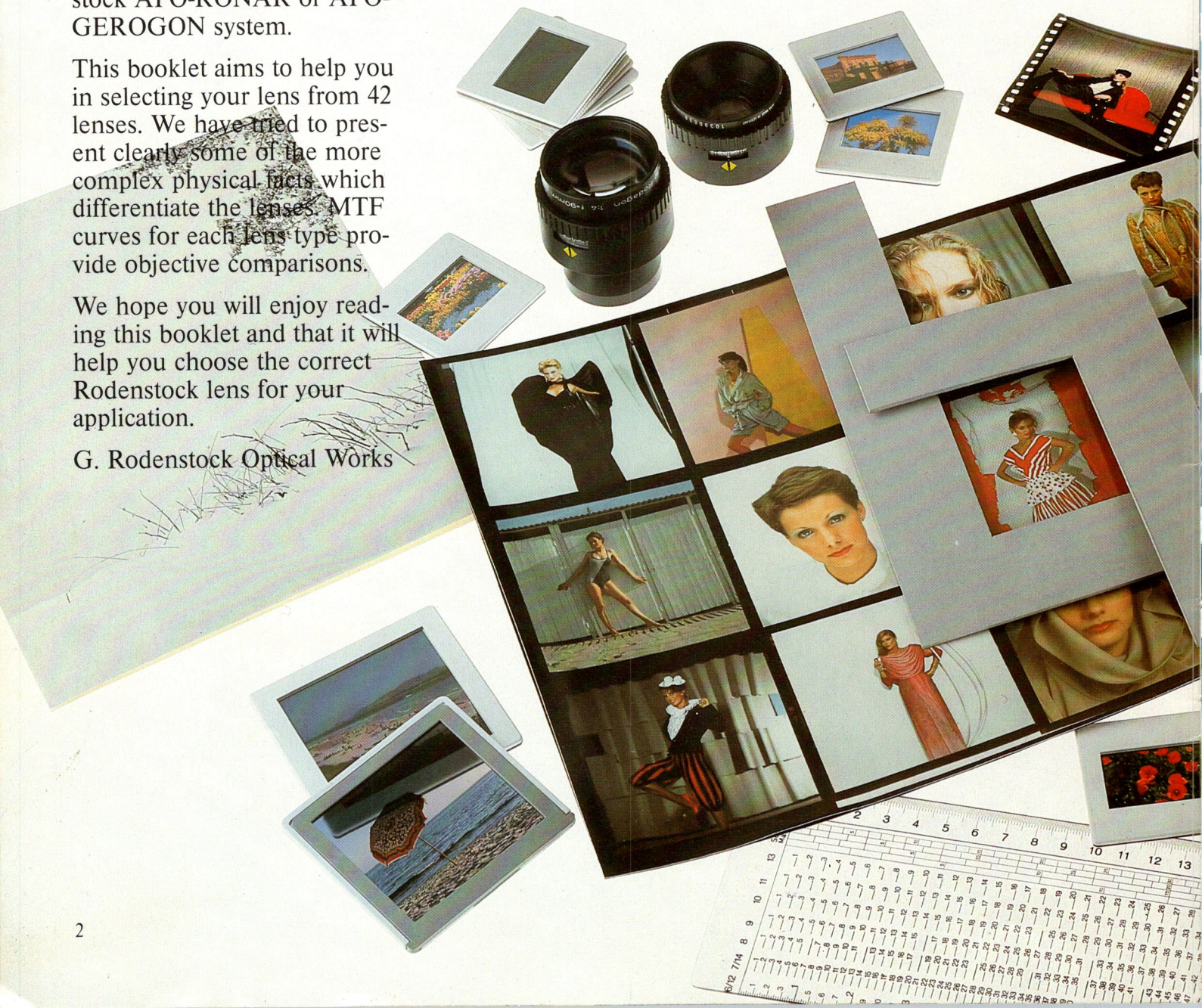
Rodenstock is constantly improving its enlarging lenses, too. Such improvements are based on the one hand on the experience and know-how of Rodenstock experts and on the other on a computer system programmed to meet scientific requirements. The result is a range of lenses to meet every user need.

Modern computer-controlled machine tools and proven manufacturing know-how for lenses and mounts convert the design specifications into top quality photographic, scientific and engineering lenses. Experience from these numerous applications benefits every single lens.

The quality control tests and instrumentation show the same striving for perfection. Thus even the MTF measuring setup used at Rodenstock (see also page 10) was designed in-plant because commercially available instruments just could not meet Rodenstock's stringent performance standards.

All these factors combine to maintain the high quality of every single lens regardless of the type chosen. This covers general purpose lenses as well as special optical systems for closely defined applications. In every case Rodenstock offers top quality.

Lens performance can be assessed from MTF curves even before practical tests are conducted (see also page 10).



The mere price of a lens

does not define quality. For example the TRINAR and ROGONAR 3-element systems are very economically priced. This optical configuration of three air-spaced elements calls for high manufacturing workmanship – which at Rodenstock can be taken for granted. These lenses are ideal for a beginner's home darkroom. The TRINAR is therefore often the lens included in an enlarger outfit.

The ROGONAR yields a slightly brighter projected image than the TRINAR, which makes focusing easier, especially with denser negatives. The convenient illuminated aperture scale also eliminates the risk of incorrect aperture settings.

The TRINAR and ROGONAR are attractive for the amateur who wants to keep costs down. They are recommended for a beginner's first enlargements. Both lenses are optimised for a 4 x magnification – the size of popular 9 x 12 cm or 4 x 5 in. prints from 24 x 36 mm negatives. But performance is fully adequate for bigger prints, too, up to around 8 x 10 in.

Price/performance ratio

is vital in enlarging lenses. The ROGONAR-S, a 4-element system, is at times used successfully in professional darkrooms - a sign of its quality. In addition, it offers exceptional value for its modest price.

The ROGONAR-S is an efficient all-round lens for images of supreme detail and definition even at high magnifications. The lens is available in focal lengths for most film sizes, from Disc, No. 110 pocket and Minox negatives up to 5 x 7 in. or 13 x 18 cm sheet film.

The ROGONAR-S is an ideal lens also for photographers who want to step up from a simpler lens for home-produced, high-quality, colour enlargements. A comparison with a simpler lens configuration can immediately show how much more detail and greater tonal range the ROGONAR-S brings out. It also proves the importance of every link in the chain of photographic image formation – from the camera lens through the film and the enlarging lens to the processed print.

The ROGONAR-S offers impressive performance at reasonable cost.

Peak optical performance

requires a more sophisticated design. The classic example is the Rodenstock RODAGON. The 6-element system of the RODAGON provides greater capability for correcting aberrations than lenses with fewer elements. The resulting quality over the whole image area meets more stringent requirements without reservations.

For extreme performance, for instance as required for exhibition prints, Rodenstock developed a unique APO-RODAGON system for 35 mm and roll-film sizes. Its special feature is apochromatic correction with reduced axial and lateral colour faults compared even with the RODAGON. The lens comes into its own in enlarging negatives of high outline sharpness and on very fine grain film where definition in the centre and – even more noticeably – at the edge of the field is significantly improved. With the APO-RODAGON optimum quality is achieved at larger apertures than with other lens types, decreasing printing times.

Lenses for giant enlargements

Based on the RODAGON, Rodenstock also developed the RODAGON-WA as a successor to the EURYGON. It greatly resembles the latter in configuration and image performance. By using new more highly refracting glasses it became possible to increase the angle of field beyond that of the RODAGON.

The RODAGON-WA covers the same film area with a shorter focal length than normal-focus lenses. With up to 30% more magnification this yields a projected image almost 70% larger, for a given enlarger height, than obtainable with a standard focal length. With big enlargements this often avoids the need for projecting on the floor or the wall. At a given magnification the RODAGON-WA also permits normal enlargements on the baseboard with a reduced enlarger head height.

Conditions are different in professional giant enlargements from sheet film negatives. Special horizontal enlargers are more common here and Rodenstock is to date the only manufacturer to offer a special lens for such giant enlargements: The RODAGON-G. It is optimised for a 20x magnification but shows improved performance already from 15x onwards.

The image quality improvement is so distinct that even less skilled observers notice the sharper grain structure, especially at the edges and in lighter image areas. The RODAGON-G is recommended whenever top quality is vital in giant enlargements from large-format negatives.

Lenses for same-size reproduction

Frequently enlarging lenses are used also for duplication, for their field is almost perfectly flat. For utmost quality, specially corrected lenses such as the Rodenstock APO-RONAR are recommended to meet the stringent requirements of same-size reproduction.

Magnification

Numbers on the column of many enlargers mark scales of reproduction of the enlargement. This linear magnification indicates by how many times the height and width of the projected image is larger than the film size. Thus a 10x magnification means that a 24x36 mm negative yields a 240x360 mm image on the baseboard.

The best image quality is achieved at the magnification for which the lens is designed and may drop at other magnifications. Hence one aim of any lens design is to keep the quality constant over as wide a range of magnifications as possible. Additional lens surfaces give the designer greater scope for correction. Lens systems using more components can thus also be corrected for higher performance. Yet – at least in theory – what still counts is the scale of reproduction for which the lens is optimised.

For its various lenses Rodenstock selects magnifications that best match practical user conditions. That is why the 3-element 50 mm ROGONAR f/2.8 is optimised at a 4x magnification for amateur darkroom use and the more professional 6-element 50 mm RODAGON f/2.8 for a higher 10x magnification.

The 6-element RODAGON-WA is appreciably less sensitive to magnification changes so that no loss of image quality is noticeable even in giant enlargements.

We cannot physically define magnification limits up to which a lens is usable. So, a general purpose lens cannot be expected to yield top performance for special applications. The Rodenstock range therefore comprises both general-use lenses and special systems that yield best possible results at extreme reproduction scales. That is why the range is so great.

The optimum aperture

The brighter the projected image, the more easily it is focused on the baseboard. Hence all Rodenstock lenses have a large maximum aperture. This is not however ideal for the exposure – at such a maximum aperture all lenses suffer from light falloff towards the edge of the field and visible aberrations. Stopping down improves the image: It reduces vignetting while the increased contrast of fine detail enhances definition. The image becomes evenly sharp out to the corners of the picture.

The smallest aperture can also degrade performance, this time due to the physical phenomenon of light diffraction. This reduces contrast and fine detail resolution, leading to inferior sharpness.

These opposing trends as you stop down need a compromise: The optimum aperture. On stopping down by 2 or 3 f-stops, residual aberrations largely disappear while the image does not yet suffer visibly from diffraction effects. At the optimum aperture the lens thus yields its best possible performance. The difference in optical quality between the full and optimum aperture depends however on the lens type.

The best way in practice is to preset the optimum lens aperture and adjust the exposure time accordingly. But very short exposures may give rise to unpredictable tolerances – afterglow of the lamp, reciprocity failure of the enlarging paper and exposure timer errors can cause colour shifts and density changes. In such cases, it is often necessary to reduce the light intensity without stopping down the lens, for instance with neutral density filters placed in the light path. A 0.30 ND filter is equivalent to stopping down by one f-stop, ND 0.60 by two stops.

At low light intensities (for instance at high magnifications or with very dense negatives or slides) lens quality becomes more important. Exposures should as far as possible still take place at the optimum aperture. However, reciprocity failure at extremely long exposure times causes loss of emulsion speed and possibly colour shifts. With the 6-element Rodenstock lenses you can, in difficult situations, use an aperture larger than the optimum aperture, for here image quality is amazingly good even with very little stopping down.

Apochromatic correction

Like a prism, a single lens element also disperses white light into its spectral components. Thus images formed by a single element show distinct colour fringes. The reason for this co-called chromatic aberration is that the lens refracts light rays of different wavelengths to different degrees. Blue is refracted more than green or red.

An ideal lens should refract all wavelengths of light involved in photography with absolutely the same focal length. Lens designers approach this goal by combining different glass types and lens curvatures in such a way that light rays of two selected wavelengths are refracted to the same degree. The deviations for the residual colours are then sufficiently low.

Particularly elaborate lens designs, usually involving expensive glasses of special optical characteristics, permit apochromatic correction. The imaging characteristics of such top-quality lenses are largely independent of the wavelength.

In an enlarger, apochromatic lenses offer various advantages – especially improved detail contrast which is noticeable in black-and-white as well as colour enlargements. They also improve image definition by virtually eliminating all colour fringing and so resolve fine texture better.

The exceptionally sharp rendering of an apochromatic-type lens is visible even when you focus using large apertures. The lens meets top quality standards with minimum stopping down.

Image definition

The quality of an enlargement depends greatly on how sharp it looks. Visual sharpness also involves contrast; it is an old black-and-white enlarging trick to make slightly unsharp negatives appear sharper by printing them on a more contrasty paper grade. The optical transfer steps necessarily affect contrast rendering. Hence the camera lens, the film and the enlarging lens all control sharpness in the print.

Many photographers like to use fast variable-focus and zoom camera lenses for convenience and versatility in pictorial photography. Such lenses however yield lower contrast transfer which impairs edge definition – especially noticeable at high reductions and at full aperture.

Light scatter within the film emulsion also affects contrast and hence sharpness. While colour negative films can render detail down to 0.05 mm with enhanced contrast or at least without loss of contrast, 0.012 mm detail shows only 45% of the original contrast. Printing to a given picture size requires less magnification from large-format films than from smaller formats. These lower magnifications do not require as fine detail in the negative. That is also why image definition depends on reproduction scale.

To approach the performance of large-format view camera negatives with smaller film sizes such as 6 x 7 cm or even 24 x 36 mm, the enlarging lens must project the negative with virtually no loss of contrast or sharpness. The more detail contrast is reduced on the film, the more even slightly better contrast of an enlarging lens improves the final image definition.

That also explains why many 35 mm and medium-size enlargers are equipped with the APO-RODAGON lens.

Rodenstock lenses for all applications

Rodenstock currently offers eight different enlarging lens types – a range for every quality requirement, including a number of special lenses for particular applications.

As we have specialised in developing and producing high-quality lenses (in photography that includes not only enlarging lenses but also view camera and process optics), users can be sure of topmost performance. Thanks to intensive research, using a computer system designed specifically for scientific needs, the product range is always fully up to date and usually marks the latest state of the art.

Consistency

Of special importance is a "simulation program" developed by Rodenstock. This method reduces the inevitable spread in production tolerances to an exceptionally low level. To achieve it, lens characteristics are studied from the design stage on. Tolerances are then specified to permit economic production with the maximum quality possible. At certain development stages the design data of all optical and mechanical components are fed into the computer together with every individual production tolerance. The effect of these tolerances on series production quality is simulated statistically. That permits specific modifications both of the design and of component tolerances to optimize the quality of the final product.

In view of Rodenstock's extensive experience in controlling highly precise production operations, this procedure maintains exceptionally consistent product quality.

The basic types

TRINAR
Focal lengths: 50 and 75 mm
Film sizes: 24 x 36 mm and 6 x 6 cm (2¼ x 2¼ in.)
A very economically priced quality lens for the beginner.

ROGONAR-S
Focal lengths: 25 to 210 mm
Film sizes: 13 x 17 mm to 13 x 18 cm or 5 x 7 in.
A high-quality lens for more advanced standards.

RODAGON
Focal lengths: 28 to 360 mm
Film sizes: 18 x 24 mm to 24 x 30 cm (10 x 12 in.)
A proven top-quality lens for professional applications.

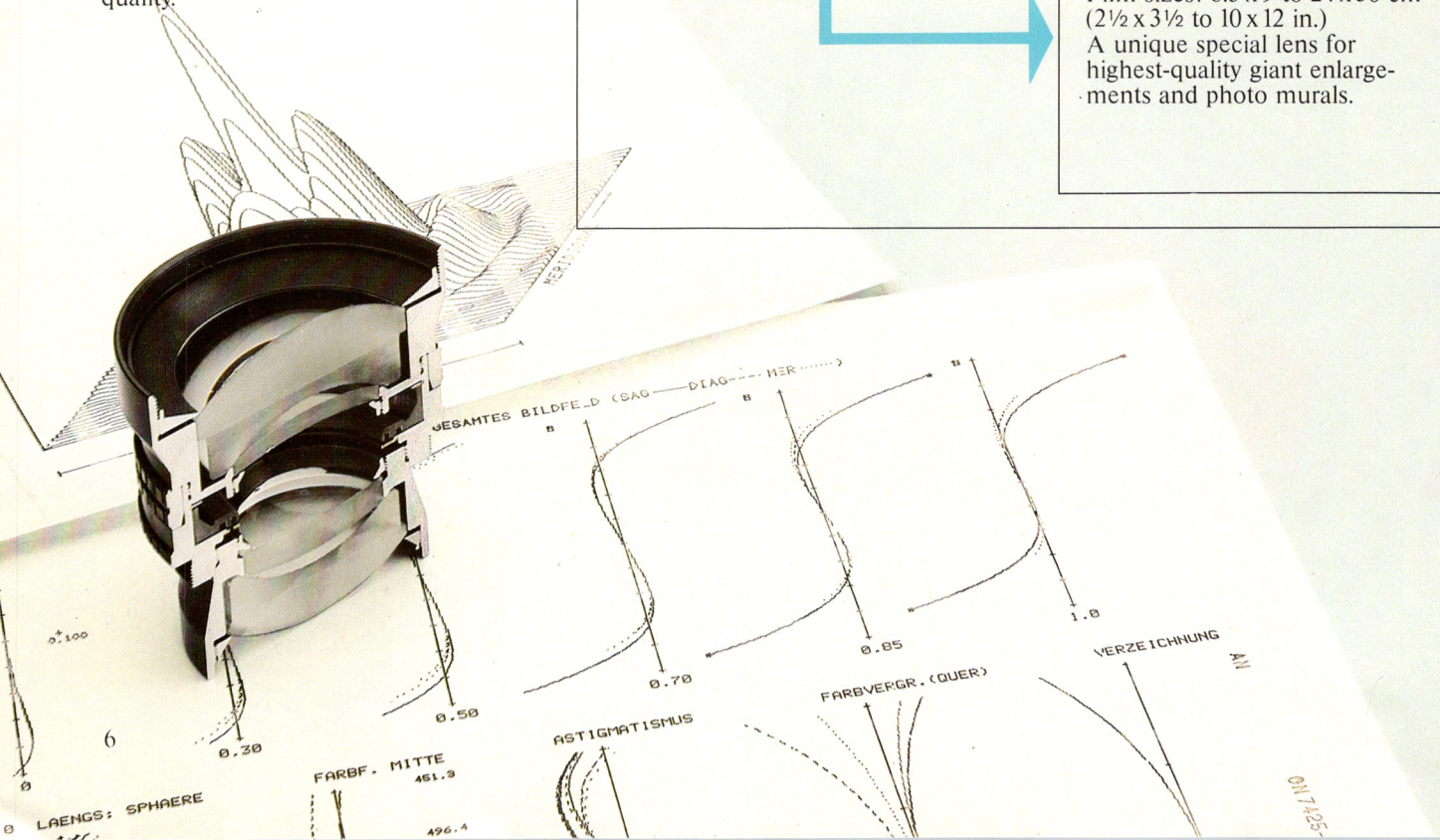
Special systems

ROGONAR
Focal length: 50 mm
Film size: 24 x 36 mm
Similar to the TRINAR but with a larger maximum aperture of f/2.8.

RODAGON-WA
Focal lengths: 40 to 120 mm
Film sizes: 24 x 36 mm up to 9 x 12 cm and 4 x 5 in.
The wide-angle RODAGON: With its shorter focal length this lens type can in a given setup yield up to 30 % higher magnification than normal lenses.

APO-RODAGON
Focal lengths: 50 and 90 mm
Film sizes: 24 x 36 mm and 6 x 7 cm (2¼ x 2¾ in.)
A high-performance lens for top-level exhibition quality.

RODAGON-G
Focal lengths: 105 to 480 mm
Film sizes: 6.5 x 9 to 24 x 30 cm (2½ x 3½ to 10 x 12 in.)
A unique special lens for highest-quality giant enlargements and photo murals.



Lens mounts

The size 00 lens mount (32.5 mm) is used for the ROGONAR-S and RODAGON lenses of focal lengths below 50 mm. With an adapter (supplied with the lens) this compact mount with clear click stops at single-stop intervals can also fit in lens boards with Leica thread (39 mm).

The mount for the TRINAR and ROGONAR lenses has click stops and a clearly readable illuminated aperture scale for easy darkroom operation. The mount is of Macrolon and is particularly rigid and comfortable to handle.

The size 0 mount with preset apertures (39 mm) – a remarkable and practical innovation in Rodenstock enlarging lenses – simplifies darkroom operation and is used for a large number of lenses: ROGONAR-S of 50 mm to 105 mm, RODAGON of 50 mm to 135 mm, RODAGON-WA of 40 mm to 80 mm, APO-RODAGON of 50 mm to 90 mm.

There is a choice of three operating modes:

Click stops engaged

○ The usual way is to control the aperture by the click stops. The half-stop intervals permit accurate brightness control.

Click stops disengaged

○ Continuous aperture control is provided for work with colour analyzers: With a given exposure time the aperture is precisely adjustable for any enlargement.

Preset mode

○ The preset aperture control is useful for mass production of enlargements and for many cases where a given aperture (for instance the optimum f-stop) is to be used all the time. Here you turn the ring to full aperture to check sharpness and composition, then turn back to the previously selected working aperture to expose at the preset aperture. It couldn't be simpler.

The new lens mount makes handling more convenient in the amateur as well as the professional darkroom. The design provides a number of very useful features.

○ A small conveniently located lever permits quick switching between click stops and continuous aperture adjustment – without obstructing the mounting of an analyzer.

○ Presetting is simple: Pull the aperture ring downwards, turn it to the required f-stop and let go again.

○ The preselected aperture clearly engages and is not likely to be displaced even when turning the ring a little roughly.

○ The established illuminated aperture scale is highly visible: The aperture setting mark is enlarged and therefore easier to see. The distance between the aperture scale and mounting thread is greater, too, so that the illuminated scale is visible even in recessed lens boards.

Size 1, 2 and 3 lens mounts for the ROGONAR-S lenses of 135 mm and longer, RODAGON above 150 mm, the 120 mm RODAGON-WA and for RODAGON-G lenses from 105 mm upwards differ only in their size. All have in common features such as the proven illuminated aperture scale and click stops.

The technical size 0 mount has similar features to the ones listed above. It was developed, as an alternative to the standard mount of the same size, to allow equipment manufacturers to add further controls when needed – for instance for easier aperture setting in deeply recessed lens boards.

The size 0P mount is also a special version. Its small outside diameter fits in printers and similar units. A variety of supplementary lenses modify the subject/image distance for specific magnifications.

Size 2 and 3 mounts

Size 0 mount with preset aperture control

Size 00 lens mount

The ROGONAR and TRINAR

Many amateur enlargers are supplied complete with a 3-element lens. The 50 mm TRINAR f/3.5 for 24 x 36 mm films and the 75 mm TRINAR f/4.5 for the 6 x 6 cm (2 ¼ x 2 ¼ in.) size are the preferred optical systems for first home enlargements.

Thanks to their simpler optical design, both lenses are very economically priced.

The fast 50 mm ROGONAR f/2.8 offers further scope: A brilliant projected image that makes precise focusing easier – particularly useful with denser negatives.

Both lenses are optimised for comparatively low magnifications of around 4 x linear. With a 6 x 6 negative that still provides a print of about 23 x 23 cm or 9 x 9 in. The advanced lens design yields an image quality that meets even more advanced requirements – especially if the lens is stopped down by 3 steps after careful focusing at full aperture. Definition then remains good even at higher magnifications.

The ROGONAR-S

With the growing popularity of home enlarging, users expect higher performance in enlarging lenses, too. That applies especially when they get involved with bigger enlargements and cropping.

This calls for lens systems of at least four elements to maintain quality at reasonably large apertures. The correction of the ROGONAR-S easily provides this. Its wide use in professional as well as amateur darkrooms shows that this lens design has plenty of performance to spare.

The light falloff towards the picture edge is only very slight in the ROGONAR-S – another side of the high quality level correction of this design. The ROGONAR-S presents no problems even with difficult film originals.

The focal length range starts with 25 mm for the Disc, No. 110 pocket and Minox formats and extends to 210 mm for professional 13 x 18 cm or 5 x 7 in. films. In the longer focal lengths, the large maximum aperture of the ROGONAR-S also permits precise and reliable focusing even at high magnifications and with dense negatives.

The RODAGON

The RODAGON meets all requirements of a modern top-quality lens – regardless of the enlarger or process. The RODAGON has for many years proved its worth as a professional all-round lens in demanding darkroom operation.

The 6-element design of the RODAGON is derived from a classical lens configuration for top performance. The RODAGON offers not only exceptional even contrast over the whole image area but also excellent anastigmatic correction. Perfect results are easy even in difficult conditions.

Thanks to its professional quality and universal application the RODAGON is the ideal system for the quality-conscious darkroom operator. Its definition is largely independent of magnification, it yields top quality on only slight stopping down and offers exceptional performance at the optimum aperture.

The performance of the RODAGON even meets process photography requirements. This applies to all 15 versions of the RODAGON which cover all film sizes up to 24 x 30 cm or 10 x 12 in. sheet film negatives.

ROGONAR
1:2,8/f = 50 mm

TRINAR
1:4,5/f = 75 mm

ROGONAR-S
1:4,5/f = 90 mm

RODAGON
1:2,8/f = 50 mm

RODAGON
1:5,6/f = 240 mm

The APO-RODAGON

Yet another quality step up is the APO-RODAGON with apochromatic correction – a level of perfection unique to date. To meet extreme demands, more and more quality-conscious professional photofinishers are using this lens type.

The APO-RODAGON also has another growing user group: Advanced amateurs and professionals who in their own darkroom want to work to the highest possible performance limits. They strive for highest-quality results, especially when using new film materials that provide further improvements in resolution, outline sharpness and fine grain.

The APO-RODAGON offers significant advantages of efficiency, especially in difficult conditions: Where low paper speed or high magnifications involve long exposure times, the time with the APO-RODAGON is half that required with other lenses of similar maximum aperture. This is because other lenses reach a performance level comparable to the APO-RODAGON only when stopped down at least one stop further.

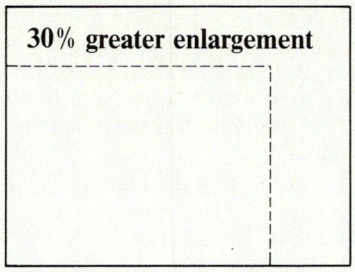
These features explain the popularity of the 50 mm APO-RODAGON f/2.8 for 24 x 36 mm negatives and the 90 mm APO-RODAGON f/4 for rollfilm sizes up to 6 x 7 cm (2¼ x 2¾ in.). With both lenses you are sure of utmost exhibition quality in the enlargement even when the going gets tough.

The RODAGON-WA

Advances in enlarger illumination – especially the shift from condenser systems to diffused lighting in colour enlargers – made the design of a new lens type possible. This is the RODAGON-WA wide-angle enlarging lens, derived from the EURYGON.

At first sight a focal length of 40 mm for 24 x 36 mm films or 120 mm for 9 x 12 cm or 4 x 5 in. negatives does not appear very short. But enlarging lenses correction requirements – for instance for flatness of field – are much higher than for camera lenses.

In practical use the RODAGON-WA offers significant advantages: At a given enlarger height it yields an almost 70 % larger projected image area than a standard focal length. Usually that means the next larger print size and in many cases avoids cumbersome projection on the floor or wall. Hence giant enlargements are an important application of the RODAGON-WA.



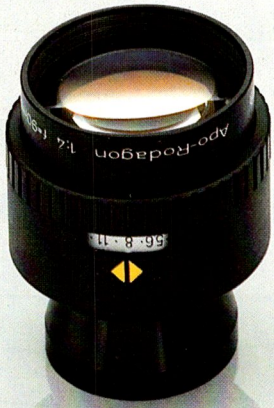
Normal enlargements also become easier with the RODAGON-WA. The reduced baseboard/enlarger head distance makes handling steps more convenient, such as exact positioning of the film in the negative carrier, focusing and filter settings. The image performance the RODAGON-WA is similar to that of the RODAGON. The lens is therefore recommended for all enlargements at magnifications appreciably beyond 10 x. The RODAGON-WA is ideal for enlarger setups in the advanced amateur and professional darkroom.

The RODAGON-G

The RODAGON-G is typical of Rodenstock's insistence on top-quality lenses for special applications even when only a small market is involved.

The RODAGON-G is ideally corrected for the special field of giant enlargements. That includes doing without extreme angles of field, optimum correction at 20 x magnification, even image definition over the whole field and highest performance on stopping down by only two stops.

The increased fine definition is particularly useful in mural enlargements because these are often viewed from much closer than they ought to be, relative to the image size. At such magnifications the RODAGON-G is superior to all previously available enlarging lenses. Even at 15 x magnification it shows distinct improvements over the RODAGON.



APO-RODAGON
1:4/f = 90 mm

RODAGON-WA
1:4/f = 60 mm

RODAGON-G
1:5,6/f = 240 mm

Demonstrating quality by MTF measurements

The modulation transfer function (MTF) enables us to describe the imaging characteristics of a lens objectively and informatively. For the darkroom operator elaborate description of the physical derivation of MTF is less relevant than the information the function conveys: Image detail (modulation) of different fineness is optically imaged (transferred) with reduced contrast which can be measured or calculated by computer. To achieve sharp images of high resolution, the contrast loss produced by the optical system – the lens – should be as small as possible.

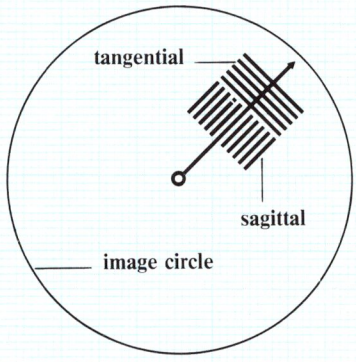
Even an ideally corrected lens shows some contrast loss. Hence this transfer can be assigned a theoretical limiting value which depends exclusively on the lens aperture, the wavelength of the light and the spatial frequency.

To determine the contrast loss in a real lens, subject detail is simulated by a target of black lines separated by white intervals. A black line and the white interval of the same width to the next black line make up a line pair. The spatial frequency in the subject is defined as the number of such line pairs per mm. When the lens images this target at a given scale, aperture and with specified lighting, it yields a spatial image frequency. This is the frequency quoted in MTF graphs. The MTF shows the decrease in contrast in the image compared with the contrast of the original. The contrast of the object line target is taken as 100%; the image contrast can then be read directly.

This test is carried out at different angles of view which are recalculated, for convenience, as half image diagonals.

The physical specification is the relative height (H_{rel}). This is based on the maximum distance of an image point (height) from the optical axis, taken as 1.0 or 100%. The distance of the other image points from the axis is expressed as a ratio or percentage of this maximum distance.

Outside the image centre the direction of the target lines becomes important. Certain aberrations lead to different contrast loss in sagittal and tangential image lines. The aberrations largely disappear when the lens is considerably stopped down. However, stopping down causes diffraction effects.



Even when only diffraction is considered, sagittal and tangential image lines are rendered differently in the field. This can be explained by the fact that the entrance pupil of the lens no longer appears circular at larger image angles. Hence increased image angles also create greater differences between the two parts of the curve.

These phenomena can be read off MTF curves in terms of diffraction-limited values. The right-hand axis, i.e. for the maximum diagonal, carries two different limiting values for sagittal and tangential lines. At the left, however, there is for a given spatial frequency only one diffraction limit for both types of line.

The different spatial frequences also differ in importance in terms of image quality.

In enlargements it is rarely possible to utilise 40 line pairs/mm. At this spatial frequency the camera lens and the film used already generate considerable contrast loss so that the image being enlarged shows noticeable shortcomings.

In negative films, for example, light scatter within the emulsion alone causes a contrast loss of around 50% at 40 line pairs/mm. Also, at normal re-enlarging magnifications the eye could not resolve such detail. Thus 40 line pairs/mm is significant as a limiting frequency only when using highly resolving films which are greatly enlarged, cropped enlargements or with giant enlargements to be viewed at near distances.

When looking at enlargements from a normal viewing distance, the eye requires a maximum resolution or limiting frequency of 4 to 5 line pairs/mm. Based on a normal enlargement scale this means that in the film the most important spatial frequencies are between 10 and 20 line pairs/mm.

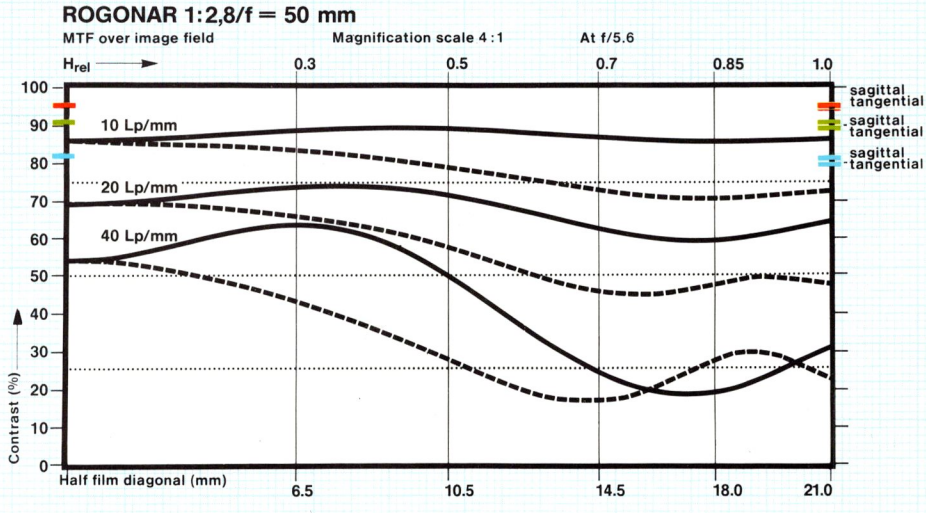
These frequences are indeed utilised and a contrast loss in transfer would appear as reduced image quality. On the other hand, the higher the contrast at these particular spatial frequences, the better the result in terms of sharpness and resolution.

To complete the picture, MTF also depends on the colour of the light. Different wavelengths yield different contrast transfer values. For a valid practical interpretation of MTF, the violet, blue, green and red spectral bands are weighted in such a way that they match the sensitisation of commercial colour films or black-and-white panchromatic film.

The MTF data published in this brochure are curves calculated and generated by a computer on the basis of design data of the individual types. As design dimensions of a lens are subject to production tolerances in mass production, the measured MTF of individual lenses may show slight deviations from the calculated values.

The MTF curve shown here is the contrast transfer of the 50 mm ROGONAR f/2.8 lens at 4x magnification and stopped down to f/5.6.

With a 4x magnification and minimum viewing distance of about 25 cm or 10 in., the eye no longer resolves 20 or 40 line pairs/mm. Hence contrast transfer values are more important at 10 line pairs/mm. The 50 mm ROGONAR f/2.8 yields outstanding values for a 3-element system: 85% contrast in the image centre and over 70% (tangential) or over 85% (sagittal) over the whole image.



Lens comparisons: Lenses for 24 x 36 mm films

The 24 x 36 mm miniature format today predominates among both amateurs and professional photographers. Rodenstock offers a wide range of enlarging lenses for this film size, from budget-priced 3-element systems up to high-performance 6-element units.

Apart from the 50 mm TRINAR f/3.5, the 50 mm ROGONAR f/2.8 deserves special mention as it offers a large maximum aperture and good performance at a very reasonable price.

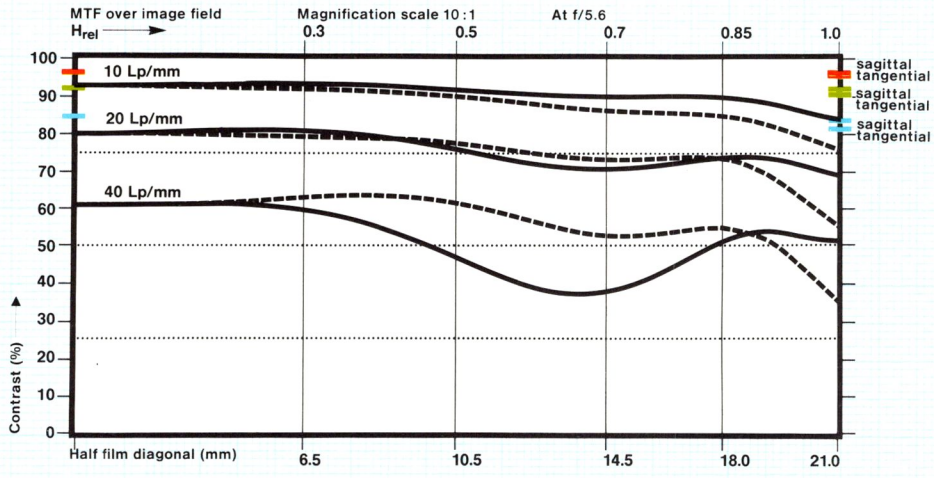
The 50 mm ROGONAR-S f/2.8 is acknowledged as an excellently corrected 4-element system. The MTF curves confirm that, too.

The 50 mm RODAGON f/2.8, the classical professional lens, reaches a quality level that can stand very critical assessment. Constant further development has thus yielded a lens to meet virtually all advanced enlarging requirements.

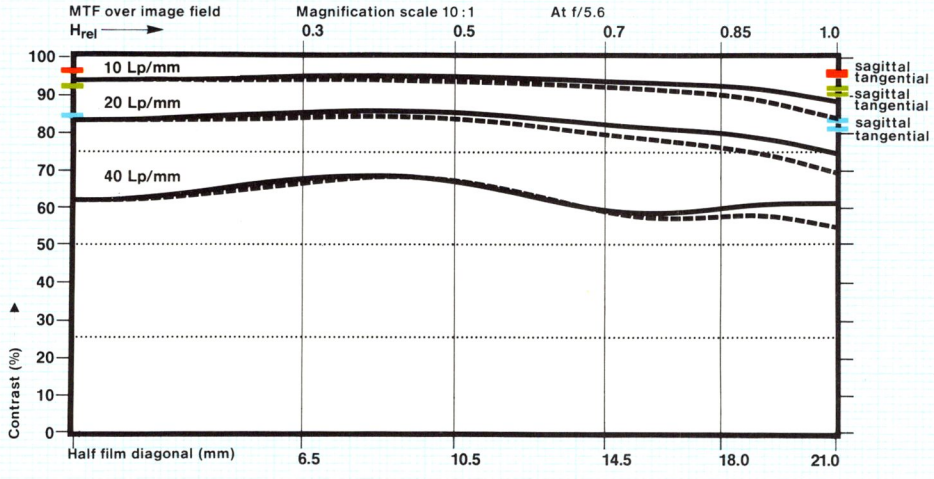
The 50 mm APO-RODAGON f/2.8 offers the highest image quality for the perfectionist. Its apochromatic correction also permits high-quality enlargements at larger apertures.

The 40 mm RODAGON-WA f/4 is a special lens whose shorter focal length – compared with the standard 50 mm focal length – yields up to 30% higher magnification at a given enlarger head height. As lens performance is uniform over a wide magnification range, this system yields perfect results even with giant enlargements.

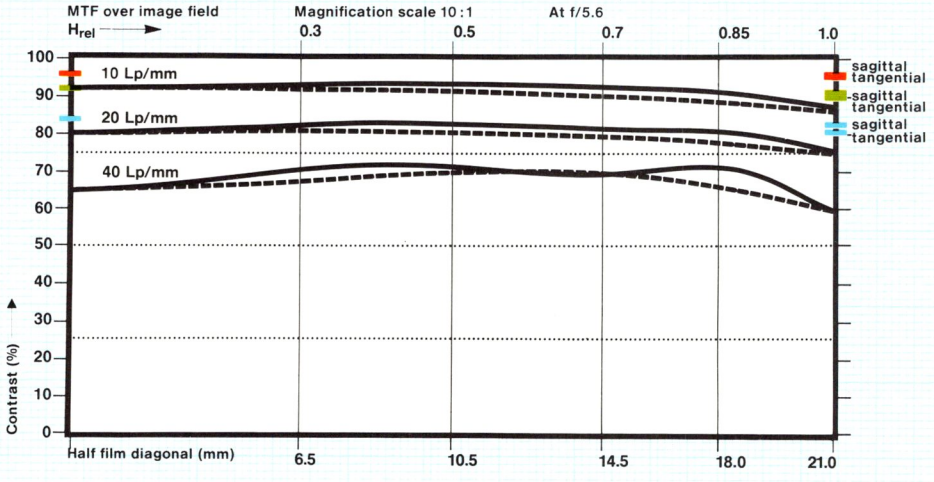
ROGONAR-S 1:2,8/f = 50 mm



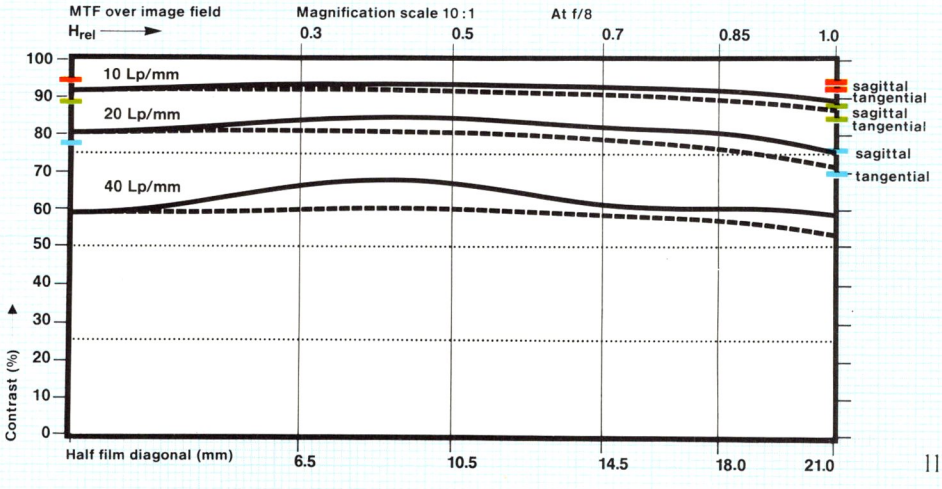
RODAGON 1:2,8/f = 50 mm



APO-RODAGON 1:2,8/f = 50 mm



RODAGON-WA 1:4,0/f = 40 mm



The 50 mm ROGONAR-S f/2.8 is a 4-element lens of exceptional value. At the significant spatial frequences of 10 and 20 line pairs/mm it yields high contrast up to the edge (0.85 H_{rel}).

The 50 mm RODAGON f/2.8 shows very little difference between sagittal and tangential contrast transfer and displays a very high overall contrast level.

The 50 mm APO-RODAGON f/2.8 shows the same characteristics; still higher contrast of fine detail (40 line pairs/mm) ensures maximum sharpness.

The 40 mm RODAGON-WA f/4 of smaller maximum aperture has a recommended working aperture of f/8. This results in less light fall off for a wide-angle lens but a somewhat lower diffraction limit and slightly lower contrast transfer.

sagittal

tangential

Theoretical diffraction limits at $H_{rel} = 0$ and $H_{rel} = 1.0$

10 lp/mm 20 lp/mm 40 lp/mm

Lens comparisons: Lenses for 6x7 cm films

The 6x6 and 6x7 cm (2¼x2¼ and 2¼x2¾ in.) rollfilm sizes are popular among amateurs, too, not only professionals. The relatively large film format yields high technical image quality while the comparatively compact camera outfit is very versatile. Enlarging lenses have to maintain this image quality level.

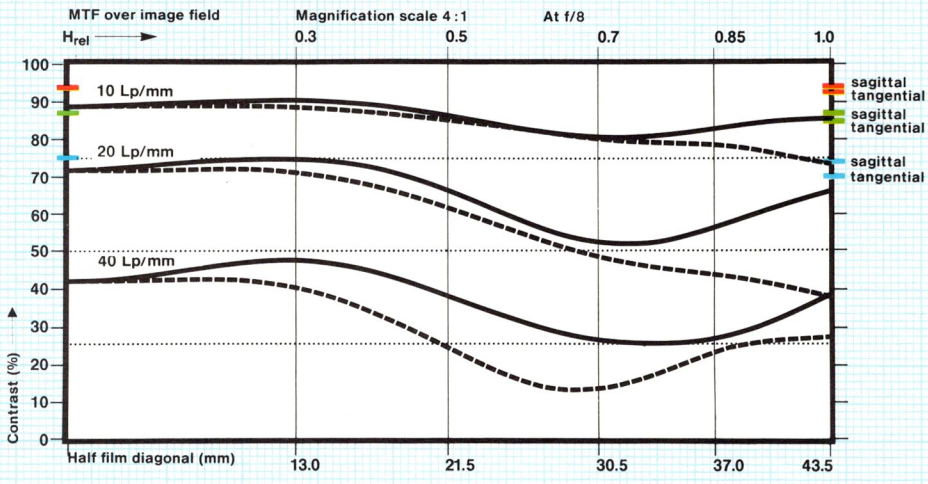
The 90 mm ROGONAR-S f/4.5 yields well balanced performance and offers excellent value.

The two 80 mm RODAGON lenses of f/4 and f/5.6 provide further improvements in optical quality with a slightly shorter focal length. In enlargements they render fine detail to the extreme edges in a way that satisfies the most fastidious professional.

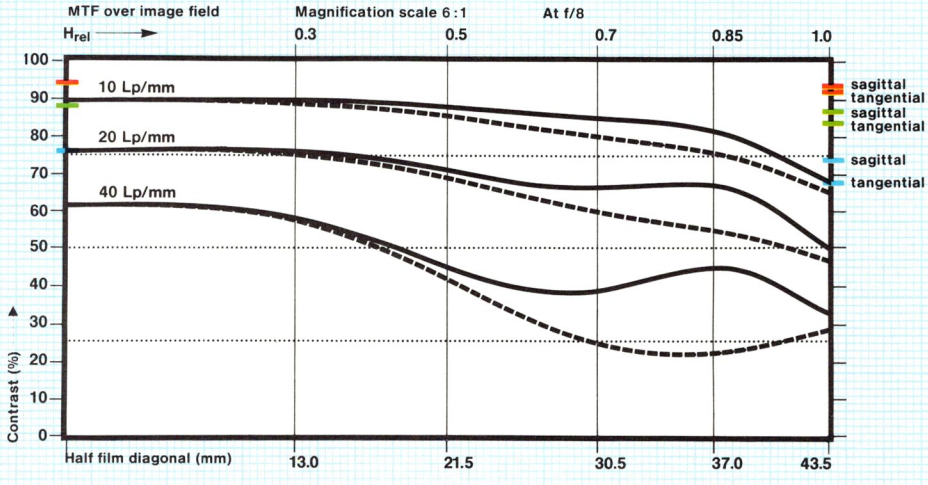
The 90 mm APO-RODAGON f/4 with a unique correction level for the rollfilm size, yields exhibition quality enlargements. Results are outstanding even at larger apertures.

The 80 mm RODAGON-WA f/4 covers the 6.5x9 cm (2½x3½ in.) film size. As the angle utilised is less than the full angle of view, the lens offers reserves in performance that ensure specially even image quality over the whole field.

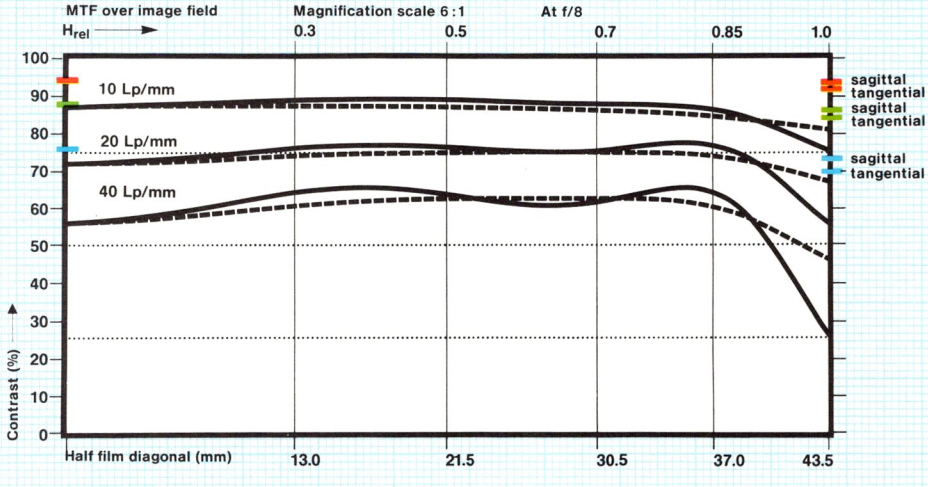
ROGONAR-S 1:4,5/f = 90 mm



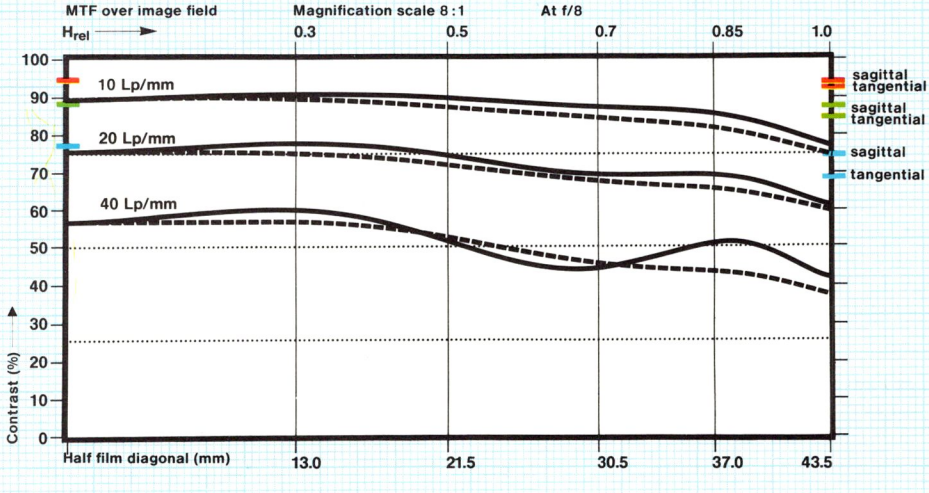
RODAGON 1:4,0/f = 80 mm



APO-RODAGON 1:4,0/f = 90 mm



RODAGON-WA 1:4,0/f = 80 mm



The 90 mm ROGONAR-S f/4.5 yields good results at 4x magnification: At 10 line pairs/mm on the film (2.5 line pairs/mm in the enlargement) – the eye cannot resolve much more, anyway. The contrast transfer of between 75% and 90% ensures very sharp enlargements.

The 80 mm RODAGON f/4 reproduces 10 lines pairs/mm and 20 line pairs/mm – significant detail at 6x magnification – with high and balanced contrast.

The 90 mm APO-RODAGON f/4 offers very high and even contrast transfer for extremely sharp enlargements. The range beyond 0.9 H_{rel} is rarely utilised, hence a slight drop is of no practical significance.

The 80 mm RODAGON-WA f/4, covering film sizes up 6.5x9 cm, yields very good contrast transfer and it is thus a useful alternative for the 6x6 or 6x7 cm formats.

sagittal

tangential

Theoretical diffraction limits at H_{rel} = 0 and H_{rel} = 1.0

10 Lp/mm 20 Lp/mm 40 Lp/mm

Lens comparisons: Lenses for 4 x 5 in. films

Enlargements from 9 x 12 cm and 4 x 5 in. sheet films are subject to substantially opposing requirements. On the one hand enlarging lenses must yield very high and even image quality, usually obtained with longer focal lengths. On the other, a short focal length is convenient as smaller distances between the enlarger head and baseboard make for more comfortable operation.

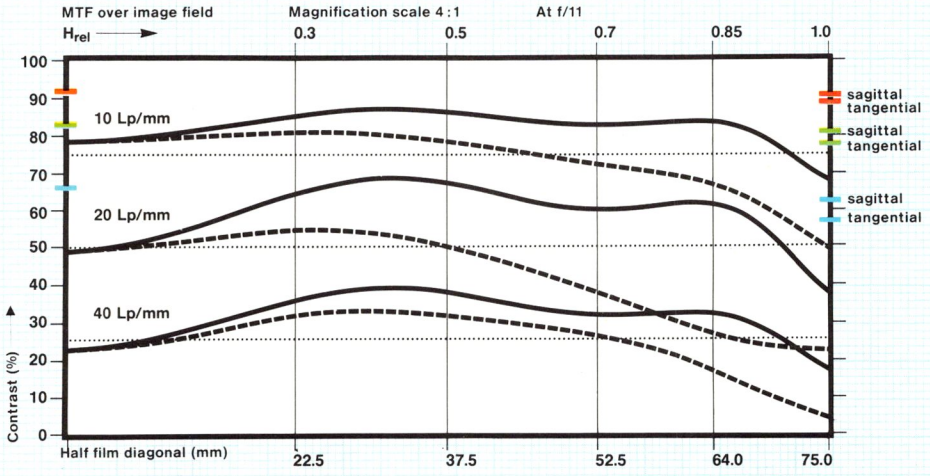
With six different lenses for this film format Rodenstock offers optimum performance for every application.

The 4-element ROGONAR-S and 6-element RODAGON lenses, each in focal lengths of 150 mm and 135 mm, are intended for universal application. The longer focal length is preferable when utilising the full 4 x 5 in. image area; both focal lengths are suitable for cropped enlargements and for the slightly smaller 9 x 12 cm (3½ x 4¾ in.) films.

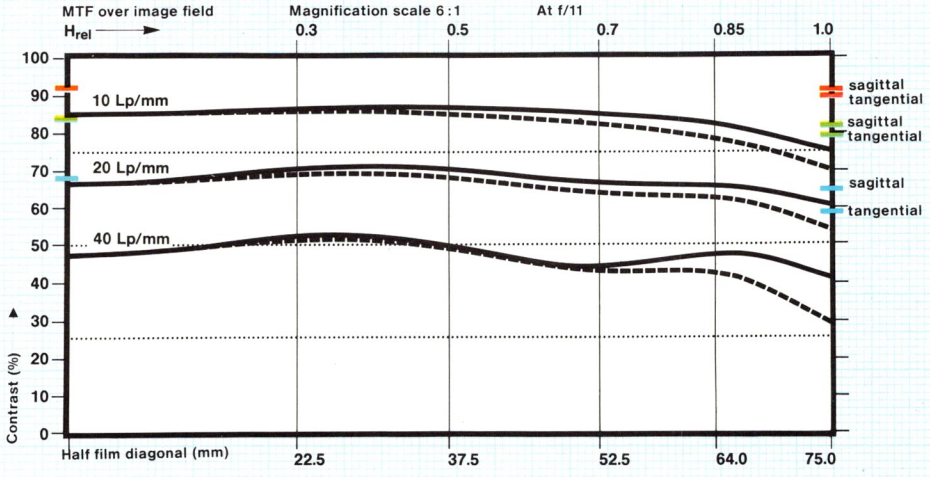
The 150 mm RODAGON-G f/5.6 is special lens for giant enlargements. It yields exceptional image definition at magnifications beyond 15 x.

The large angle of field of the 120 mm RODAGON-WA f/5.6 permits operation with the enlarger head about 20% lower than with a 150 mm lens. That simplifies handling at the usual magnifications and is particularly useful with giant enlargements and in cramped darkrooms.

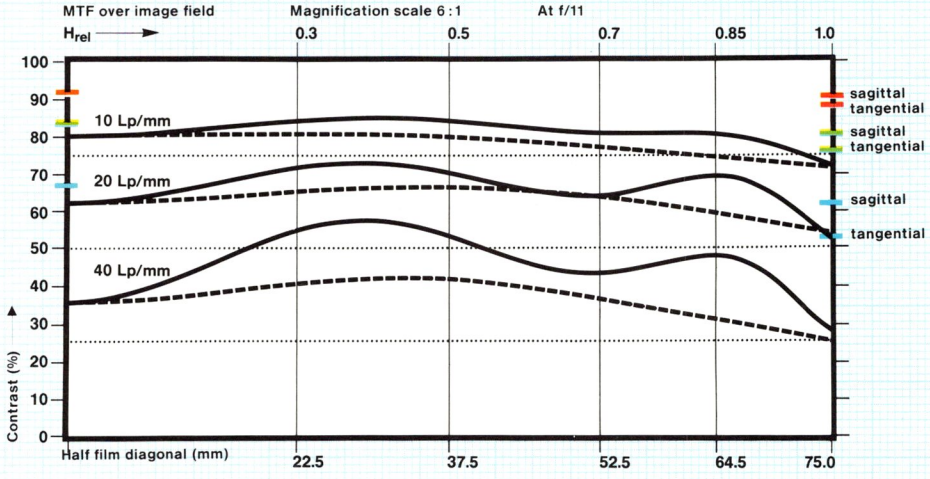
ROGONAR-S 1:4,5/f = 150 mm



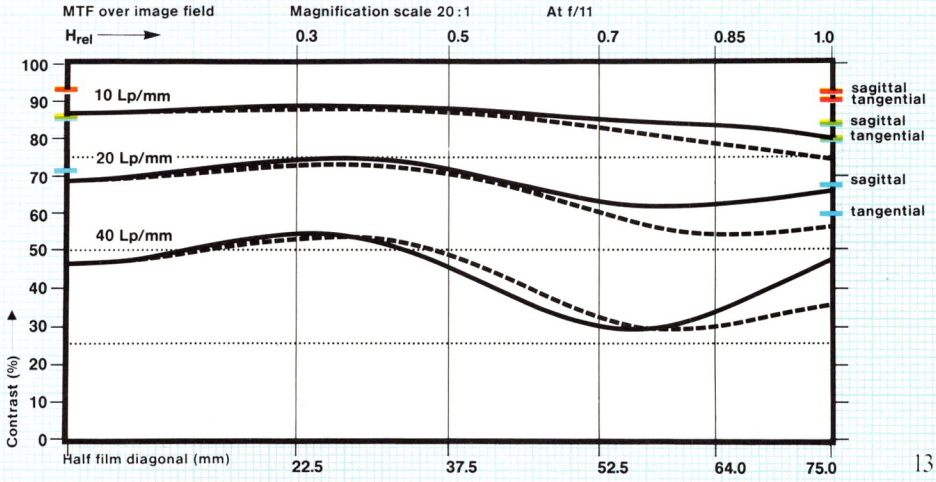
RODAGON 1:5,6/f = 150 mm



RODAGON-WA 1:5,6/f = 120 mm



RODAGON-G 1:5,6/f = 150 mm



The 150 mm ROGONAR-S reaches relatively high and even contrast transfer (to ensure sharp enlargements) at up to 10 line pairs/mm – the significant spatial frequency for large negatives. With a 9 x 12 cm film size and a 67 mm half diagonal, the contrast transfer actually utilised is over 70%.

The 150 mm RODAGON f/5.6 again confirms the performance characteristics of this lens type: Very high and even contrast transfer over the whole image area.

The 120 mm RODAGON-WA f/5.6 shows similar performance, especially at 10 and 20 line pairs/mm. The contrast transfer is very high for this shorter focal length.

The 150 mm RODAGON-G f/5.6 reaches a similar high contrast level at 20 x magnification as the RODAGON at 6 x. With that, the RODAGON-G yields giant enlargements of excellent contrast and definition.

sagittal

tangential

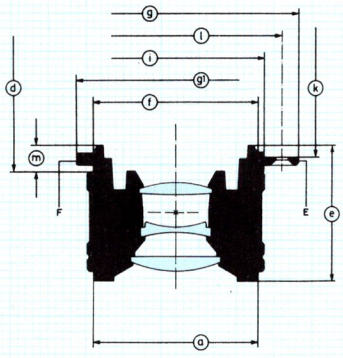
Theoretical diffraction limits at $H_{rel} = 0$ and $H_{rel} = 1,0$

10 lp/mm 20 lp/mm 40 lp/mm

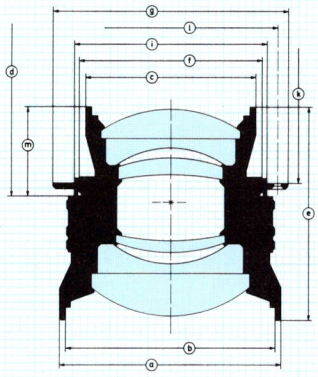
Technical data

The main optical and mechanical data of the enlarging lenses show their scope and applications, and facilitate specific selection. The sectional lens diagrams complete this information.

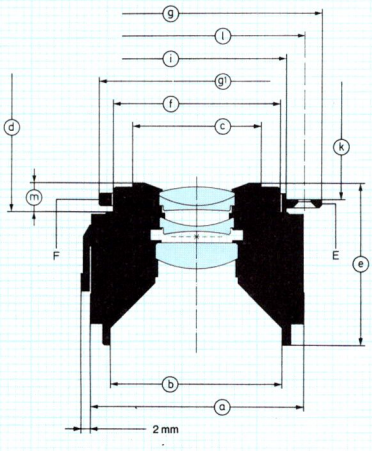
The tables do not include versions in the technical and the P mounts. The optical data are the same as for the standard mount; mount dimensions are available on request.



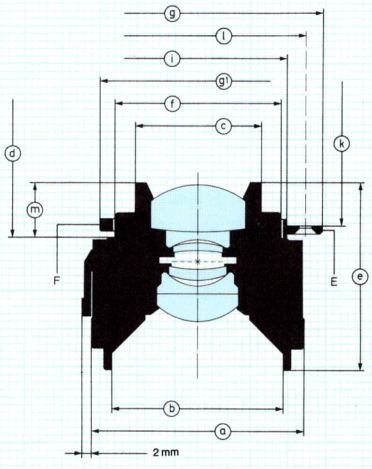
ROGONAR/TRINAR
50–75 mm



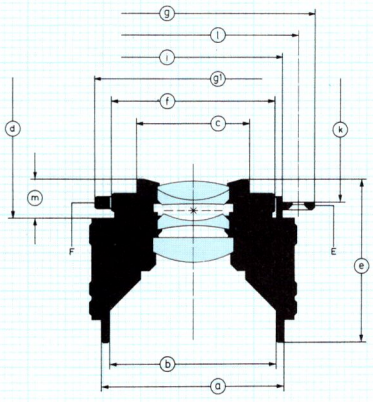
RODAGON 28–35 mm,
150–360 mm
RODAGON-WA 120 mm
RODAGON-G 105–480 mm



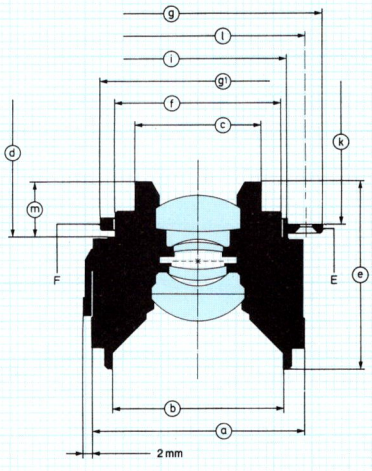
ROGONAR-S 50–105 mm



RODAGON 50–135 mm
APO-RODAGON 50–90 mm



ROGONAR-S 25–35 mm,
135–210 mm



RODAGON-WA 40–80 mm

Order No.	Max. aperture	Nominal focal length	Recommended film sizes	
ROGONAR/TRINAR*				
209.0051.001	f/2.8	50	24×36 mm	–
209.0050.001*	f/3.5	50	24×36 mm	–
209.0075.001*	f/4.5	75	6×6 cm	2¼″×2¼″
ROGONAR-S				
208.0025.001	f/4	25	13×17 mm	–
208.0035.001	f/4	35	18×24 mm	–
208.0050.001	f/2.8	50	24×36 mm	–
208.0060.001	f/4.5	60	4×4 cm	–
208.0075.001	f/4.5	75	6×6 cm	2¼″×2¼″
208.0090.001	f/4.5	90	6×7 cm	2¼″×2¾″
210.0105.001	f/4.5	105	6,5×9 cm	2½″×3½″
210.0135.001	f/4.5	135	9×12 cm	4″×5″
210.0150.001	f/4.5	150	9×12 cm	4″×5″
210.0210.001	f/4.5	210	13×18 cm	5″×7″
RODAGON				
270.0028.001	f/4	28	18×24 mm	–
270.0035.001	f/4	35	24×24 mm	–
270.0051.001	f/2.8	50	24×36 mm	–
270.0050.001	f/4	50	24×36 mm	–
270.0060.001	f/4	60	4×4 cm	–
270.0081.001	f/4	80	6×7 cm	2¼″×2¾″
270.0080.001	f/5.6	80	6×7 cm	2¼″×2¾″
271.0105.001	f/5.6	105	6.5×9 cm	2½″×3½″
271.0135.001	f/5.6	135	9×12 cm	4″×5″
271.0150.001	f/5.6	150	9×12 cm	4″×5″
271.0180.001	f/5.6	180	13×18 cm	5″×7″
271.0210.001	f/5.6	210	13×18 cm	5″×7″
271.0240.001	f/5.6	240	18×24 cm	8″×10″
271.0300.001	f/5.6	300	24×30 cm	8″×10″
271.0360.001	f/6.3	360	24×30 cm	10″×12″
RODAGON-WA				
277.0040.001	f/4	40	24×36 mm	–
277.0060.001	f/4	60	6×6 cm	2¼″×2¼″
277.0080.001	f/4	80	6.5×9 cm	2½″×3½″
277.0120.001	f/5.6	120	9×12 cm	4″×5″
APO-RODAGON				
275.0050.001	f/2.8	50	24×36 mm	–
275.0090.001	f/4	90	6×7 cm	2¼″×2¾″
RODAGON-G				
276.0105.001	f/5.6	105	6.5×9 cm	2½″×3½″
276.0150.001	f/5.6	150	9×12 cm	4″×5″
276.0210.001	f/5.6	210	13×18 cm	5″×7″
276.0240.001	f/5.6	240	13×18 cm	5″×7″
276.0300.001	f/5.6	300	18×24 cm	8″×10″
276.0360.001	f/6.8	360	18×24 cm	8″×10″
276.0480.001	f/8.4	480	24×30 cm	10″×12″

[1]) Available extra

Optimum magnification	Smallest aperture	Front (push-on) mount diameter a	Filter screw size b	Rear mount diameter c	Optical register for 1: ∞, without flange ring d	Overall length e	Maximum diameter	Screw mount f	Outside diameter of locking ring (F) g_1	When used with flange ring (E)				Distance from mounting flange to rear edge m
										Outside flange ring diameter g	Required centre hole size i	Optical register for 1: ∞ k	Hole diameter l	
4×	16	39.0	–	–	38.0	32.0	42.0	M 39×1/26″	45.5	–	–	–	–	6.5
4×	16	39.0	–	–	38.0	32.0	42.0	M 39×1/26″	45.5	–	–	–	–	6.5
4×	16	39.0	–	–	63.1	32.0	42.0	M 39×1/26″	45.5	–	–	–	–	6.5
20×	16	40.5	M 30.5×0.5	–	23.0	28.0	40.5	M 32.5×0.5	39.1	[1]) 51.0	37.2	20.3	45.0	4.5
20×	16	40.5	M 30.5×0.5	–	34.0	28.0	40.5	M 32.5×0.5	39.1	[1]) 51.0	37.2	31.3	45.0	4.5
10×	16	43.8	M 40.5×0.5	30.0	47.0	37.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	44.3	50.0	6.5
4×	22	43.8	M 40.5×0.5	–	52.5	36.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	49.8	50.0	5.9
4×	22	43.8	M 40.5×0.5	–	65.5	36.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	62.8	50.0	5.9
4×	22	43.8	M 40.5×0.5	–	80.0	36.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	77.3	50.0	5.9
4×	22	43.8	M 40.5×0.5	–	95.0	36.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	92.3	50.0	5.9
4×	32	57.0	M 52×0.75	37.5	129.5	38.0	60.0	M 50×0.75	[1]) 56.5	69.0	52.5	126.3	62.0	11.3
4×	32	57.0	M 52×0.75	37.5	138.0	36.8	60.0	M 50×0.75	[1]) 56.5	69.0	52.5	134.8	62.0	9.8
4×	32	60.0	M 55×0.75	60.0	201.0	53.8	79.0	M 72×1.0	–	98.0	75.0	195.5	88.0	16.2
20×	16	40.5	M 30.5×0.5	27.0	27.7	30.0	40.5	M 32.5×0.5	39.1	[1]) 51.0	37.2	25.0	45.0	6.7
20×	16	40.5	M 30.5×0.5	27.0	35.6	32.5	40.5	M 32.5×0.5	39.1	[1]) 51.0	37.2	25.0	45.0	9.0
10×	16	43.8	M 40.5×0.5	30.0	43.5	43.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	40.8	50.0	13.0
10×	16	43.8	M 40.5×0.5	30.0	43.5	43.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	40.8	50.0	13.0
10×	22	43.8	M 40.5×0.5	31.5	56.0	41.0	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	53.7	50.0	10.0
6×	22	43.8	M 40.5×0.5	30.0	74.7	44.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	72.0	50.0	13.5
6×	22	43.8	M 40.5×0.5	30.0	74.7	44.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	72.0	50.0	13.5
6×	32	43.8	M 40.5×0.5	31.5	99.5	41.0	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	96.8	50.0	10.5
6×	32	43.8	M 40.5×0.5	34.0	128.0	45.5	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	125.3	50.0	14.5
6×	45	57.0	M 52×0.75	40.5	146.0	49.8	60.0	M 50×0.75	[1]) 56.5	69.0	52.5	142.0	62.0	20.1
5×	45	60.0	M 58×0.75	45.0	177.0	59.8	60.0	M 50×0.75	[1]) 56.5	69.0	52.5	174.0	62.0	24.6
4×	45	70.0	M 67×0.75	54.0	201.0	67.2	70.0	M 58×0.75	–	74.5	62.7	198.0	67.5	28.1
4×	45	80.0	M 77×0.75	60.0	230.0	77.0	80.0	M 72×1	–	98.0	74.7	224.0	88.0	30.0
4×	45	90.0	M 86×1	70.0	283.0	93.0	90.0	M 72×1	–	98.0	74.7	277.0	88.0	37.2
2.5×	45	100.0	M 95×1	93.5	300.0	110.6	100.0	M 90×1	–	121.0	93.7	295.0	109.0	9.5
10×	22	43.8	M 40.5×0.5	31.5	36.5	37.2	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	33.8	50.0	6.5
8×	22	43.8	M 40.5×0.5	31.5	55.5	41.0	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	52.8	50.0	10.0
8×	22	43.8	M 40.5×0.5	32.7	77.0	44.0	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	74.3	50.0	13.0
6×	45	57.0	M 52×0.75	48.0	116.4	59.0	60.0	M 50×0.75	[1]) 56.5	69.0	52.5	113.2	62.0	26.6
10×	16	43.8	M 40.5×0.5	31.5	45.0	43.0	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	42.3	50.0	12.0
6×	22	43.8	M 40.5×0.5	37.0	87.8	61.0	50.0	M 39×1/26″	45.5	[1]) 58.1	41.7	85.3	50.0	24.0
20×	45	42.0	M 40.5×0.5	31.5	100.3	38.0	60.0	M 50×0.75	[1]) 56.5	69.0	52.5	97.1	62.0	14.3
20×	45	51.0	M 49×0.75	42.0	141.8	50.6	60.0	M 50×0.75	[1]) 56.5	69.0	52.5	138.6	62.0	20.5
20×	45	70.0	M 67×0.75	74.5	179.5	65.9	74.5	M 72×1	–	98.0	74.7	174.0	88.0	8.5
20×	45	80.0	M 77×0.75	70.0	230.6	76.9	80.0	M 72×1	–	98.0	74.7	225.1	88.0	32.2
20×	45	90.0	M 86×1	80.0	253.3	93.5	93.5	M 90×1	–	121.0	93.7	248.3	109.0	11.5
20×	45	110.0	M 105×1	80.0	304.2	116.5	110.0	M 90×1	–	121.0	93.7	299.2	109.0	12.2
20×	64	115.0	M 112×1.5	95.0	412.0	146.8	115.0	M 110×1	–	145.0	114.2	405.5	131.0	17.7

All dimensions not otherwise marked are mm.

Rodenstock sets objective standards – also for camera and process lenses.

For information on the complete line of Rodenstock products, please contact:

Optische Werke G. Rodenstock
Postfach 14 04 40
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Tel.: 0 89/72 02-0

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