Minolta Technical Bulletin C

The Making Of A Rokkor Lens

Minolta is one of the two companies in Japan and one of the few in the world that manufactures its own optical glass and lenses for its own cameras. This is the only way to assure the proper matching of optical and mechanical design.

Correcting Aberrations

Lens making, which is one of the most complex manufacturing skills, requires time, technology and no compromise with perfection. Because any material, no matter how seemingly transparent, placed in a normally straight light path will automatically alter that path, the manufacture of a quality lens involves far more than the simple combination of pieces of glass. Each lens actually represents the end result in a long series of computations and tests, all aimed at eliminating the various aberrations which interfere with theoretically perfect lens performance. The first step is the calculation and design of a Minolta lens. These calculations, based on proven Minolta designs and the potentials of new high-index optical glasses and configurations, have the primary objective of minimizing flare, vignetting and various optical aberrations in accordance with the limitations of visible light wave lengths.

Minolta engineers attack these problems in many different ways, at every step and with each component part of a lens. Among other things, they carefully examine the spacing of lens elements, the diameter of those elements, the curvature of the elements and the kind of glass used. For instance, lens elements may be separated by air, this space acting as an element in itself. One or more components can be eliminated while correction is still achieved. Curvature of field, which is the natural tendency of a lens to form a curved image, is a function of the glass refractive indexes of the glass and focal lengths of the individual lens elements. Minolta lens designers, therefore, must calculate these factors and come up with the answer in terms of the proper type of glass formulation and the proper shape of lens elements. In the case of astigmatism, the designer must choose radii, refractive index and thickness of glass to reduce this effect. To really appreciate the achievement inherent in your Minolta Rokkor lens, you should be aware of the many procedures that are necessary for its manufacture.

Even Crucibles Are Specially Designed

In a special Minolta factory, all types of optical glass are manufactured to rigid specifications. Even the crucibles or pots in which the glass is made are produced by skilled Minolta workmen using the most modern automated methods.

PREPARING THE CRUCIBLES

Very pure Kaolin and other ceramic substances are finely ground and then mixed with water to form a light gray, cement-like substance. This is poured into molds and allowed to stand until all air escapes and the material hardens. The formed pot is then placed in an electrically heated oven for further hardening. Even at this stage Minolta is concerned about stray cinders or soot contaminating the containers for its optical glass. Some of these pots can hold a ton of glass mix and their walls must be uniformly thick to take the strain. For optical glasses of specially high purity, crucibles of platinum are used to avoid contamination. Once the pot is ready, a long list of ingredients is weighed and blended. This "recipe" is carefully determined by a special research staff including 200 Minolta engineers. Their job is to determine what balance of ingredients will produce optical glass of a specific refractive index and without color-cast.

The Basic Ingredients Of A Quality Lens

Materials used may include Silica, Sodium Carbonate, Barium Nitrate, Barium Carbonate, Alumina and Potassium Carbonate. In addition, certain rare earth elements such as Lanthanum, Thorium and Zirconium may be added to the precisely controlled mix to produce the unique, high refractive glasses that make Rokkor lenses possible. This mixture is fed through small windows of the melting furnace into the heated pot and then brought to temperatures as high as 1800°F. The mix is periodically stirred to make sure that all ingredients are melted. After one week of "cooking", the heavy crucible is placed in a cooling tank and gradually brought down to room temperature. The length of time involved in preparing and cooling the "melt" is as important as the determination of the ingredients in the glass. The molten glass must be stirred slowly and evenly so that air bubbles will not be trapped in the mixture. Cooling too is carried out under rigidly controlled temperatures, permitting any gasses dissolved in the mix to be expelled. When crystalline substances such as glass are rapidly cooled, stresses set in which can alter the strength and light transmission of the material. For this reason, great care is taken to lower the "melt" temperature very slowly.

RAW GLASS: THE FIRST STAGE

Raw Glass Is Only The First Step

The glass is now ready to be broken up into easily handled fragments. The pot, which itself is the result of careful workmanship, is shattered in order to remove its solid contents. For every batch of glass produced a new crucible must be made.

Glass lumps of high quality are hand picked while the inferior pieces with strains or bubbles are rejected. The selected glass lumps are then re-melted in fire-proof, square clay molds.

Technicians now use transmitted light to inspect the resulting blocks for bubbles, strains and other imperfections; these are marked for removal. Those passed are now put into an annealing oven for another week of temperature treatment. The annealing oven maintains a set temperature designed to allow any distortions and stresses to dissipate. As a result, the glass is tougher and optically more perfect. So far, the glass has been in "production" for over two weeks.

A final stress and strain check is conducted by passing light through the annealed blocks and observing the pattern projected on a screen. If there are dark areas or bright spots, that block is now rejected. The remaining glass is checked for conformity to a specific refractive index on a spectrometer. (Refractive Index is the ratio of the speed of light in air to its speed in a different medium, e.g., glass.)

Precision Grinding

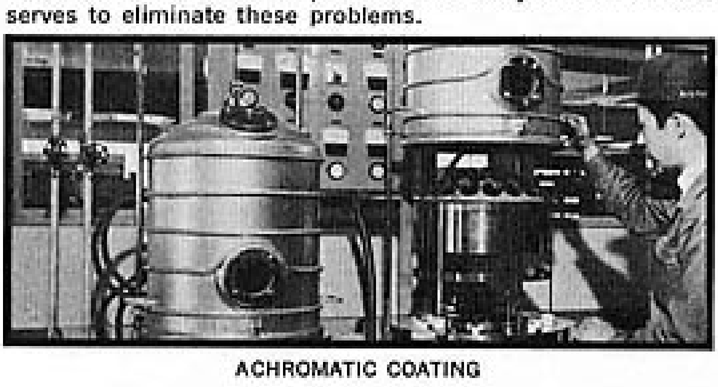
Minolta has an entirely separate manufacturing complex to which is sent the annealed glass in molded form, suitable for grinding and polishing. It should be mentioned here that this factory is provided with complete temperature and dust control systems to minimize dimensional changes in glass components. These rounded disks are given a rough polish and shaping on a curve generator machine. This complex machine grinds the radius of the curve, or amount of convexity or concavity determined by Minolta's optical engineers. Carborundum and diamond dust are the materials used to cut these curves. The rough-finished lens elements are now passed along through a series of mechanized polishers that gradually, and after many hours, produce a precision final finish.

GRINDING AND POLISHING

The lens elements so formed must now be inspected for a common optical and physical axis. This is checked on a special centering machine which will "edge-round" the element until both axes are the same.

Cementing The Lens Elements

After a final cleaning and inspection, the lens components are ready for cementing and coating. Cementing or joining lenses is a highly complex technique. The cement itself must be able to withstand extremes of heat and cold without separating. It should show no change in transparency or strength with age. It must even be resistant to fungus in highly humid and hot climates. Minolta's techniques and use of synthetic cements serves to eliminate these problems.



ACHROMATIC COATING

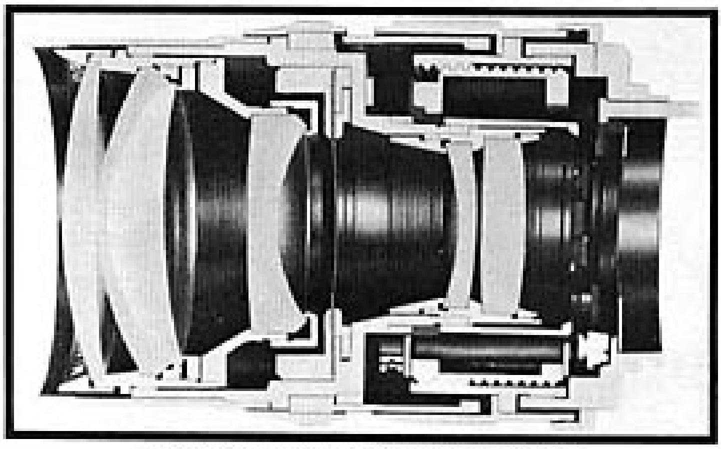
Exclusive Achromatic Coating

Lens coating is a very important step to the end user as well as the designer. It helps to prevent flare and ghost images and cuts down on light loss through reflection. This latter result is very helpful to the optical designer when working on a complex lens. If he can restrict the light loss by means of coating, he has more freedom to use additional elements for better performance.

These extremely fine coatings are applied to the glass in a vacuum and are precisely controlled to the proper thickness.

The basic coating material is magnesium fluoride. For purposes of color correction, a special technique has been developed by Minolta called "Achromatic Coating." It utilizes a double coating of fluorides plus other special ingredients to give superior color rendition as well as an even higher rate of light transmission.

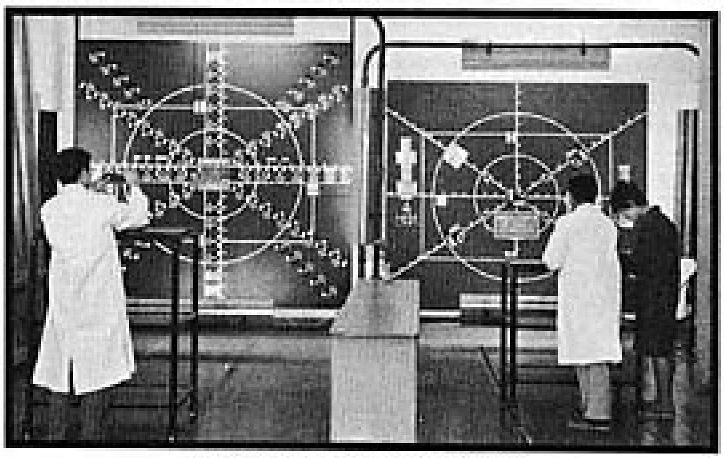
Our Minolta Rokkor lens has now traveled through many skilled hands and requires only a few more but very important operations. The cemented and coated elements must be accurately placed in a precision focusing mount. Each cell must be spaced at a specific distance from its neighbor, with surfaces exactly parallel. The machining of these mounts to extremely fine tolerances is essential for the high standards of optical performance set for Minolta Rokkor lenses.



A PRECISION FOCUSING MOUNT IS VITAL

The Lens Mount

The Minolta mount is not a "universal" type and for good reason. The slightest variation in tolerances, especially in lens seating, will degrade the sharpness of your negative. Its quality must therefore match the standards of the body with which it is used. Each lens is now mated to a camera and individually tested. This test is perhaps the toughest of all to pass. Actual exposures of a large test chart are made at every aperture to check for sharpness and accuracy of focus.



INDIVIDUAL BENCH-CHECKING

The films are carefully processed under controlled conditions and compared with a "standard". This final performance check is a practical test, one meant to insure professional performance based on Minolta's latest photo-optical developments.

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