Canon
FL-F LENSES

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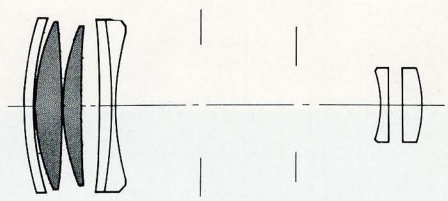
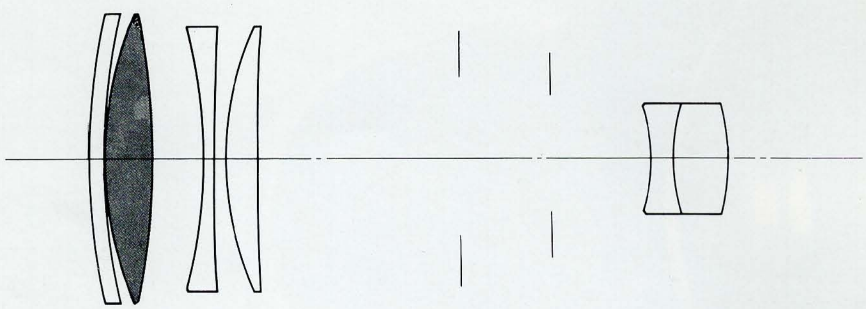


FL-F 300mm F5.6



FL-F 500mm F5.6

Canon, through its vast technological resources, has succeeded in manufacturing large-size artificial fluorite (CaF_2) crystals for the commercial production of apochromatic lenses. This technical break-through promises a new future in the further development of telephoto and high magnification zoom lenses.

Telephoto lenses in the past have been characterized by weak delineation power because of chromatic aberration. Additionally, their necessary size and weight have made them cumbersome to handle and to transport. These disadvantages have now been overcome by Canon through the practical application of the artificial fluorite (CaF_2) crystal in the development of two revolutionary, high performance and compact telephoto lenses : the FL-F 300mm F5.6 and the FL-F 500mm F5.6.

The use of natural fluorite in combination with optical glass to produce apochromatic lenses was first discovered by Ernst Abbe in the 1880's. However, as the supply of large pieces of natural fluorite has been extremely limited, its use for apochromatic lenses has been restricted to such small-size lenses as those used in the objective lenses of microscopes.

Optical Features of Fluorite (CaF_2)

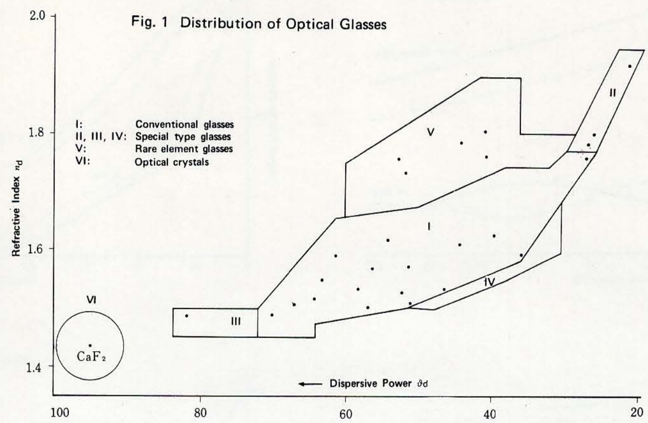
CaF_2 is a crystal with unique optical features. Its dispersion quality and refractive index are not obtainable in ordinary optical glass. It is therefore especially effective in providing chromatic aberration compensation in photographic lenses (see Fig. 1). The fluorite crystal has a low refractive index and a low dispersive power. Because of its unique partial dispersion quality, CaF_2, when combined properly with other optical glasses, can be used to make apochromatic lenses in which the secndary spectrum is eliminated.

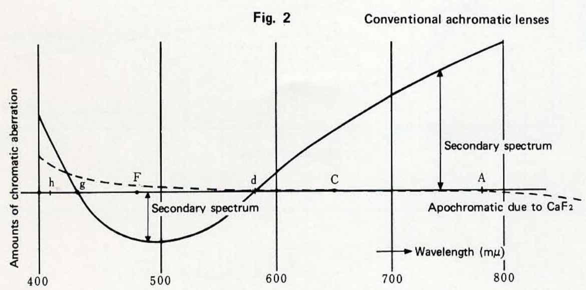
Unique Features of Photographic Lenses Using CaF_2

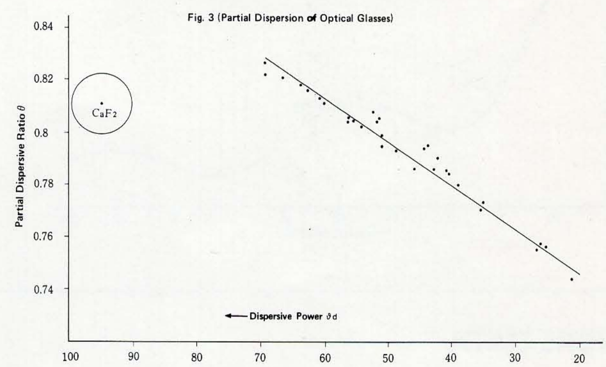
1. High Resolution, High Contrast

Telephoto lenses with conventional materials have the disadvantages of low resolving power and low contrast because of chromatic aberration. In ordinary achromatic lenses, the chromatic aberation is eliminated in only two specific wavelengths of light. If another wavelength has extensive chromatic aberration, there is very little achromatic effect. The chromatic aberration that appears as a result of this residual chromatic aberration is called the secondary spectrum. The longer the facal length of the optical system, the greater will be the effect of the residual chromatic aberration which reduces the quality of the picture produced. A good apochromatic lens therefore should be one which has a small secondary spectrum.

The diagram (Fig. 2) shows two specific wavelengths of light in which the chromatic aberration is eliminated. It illustrates the difference of achromatism between a conventional type of apochromatic lens and one in which the residual chromatic aberration has been eliminated.







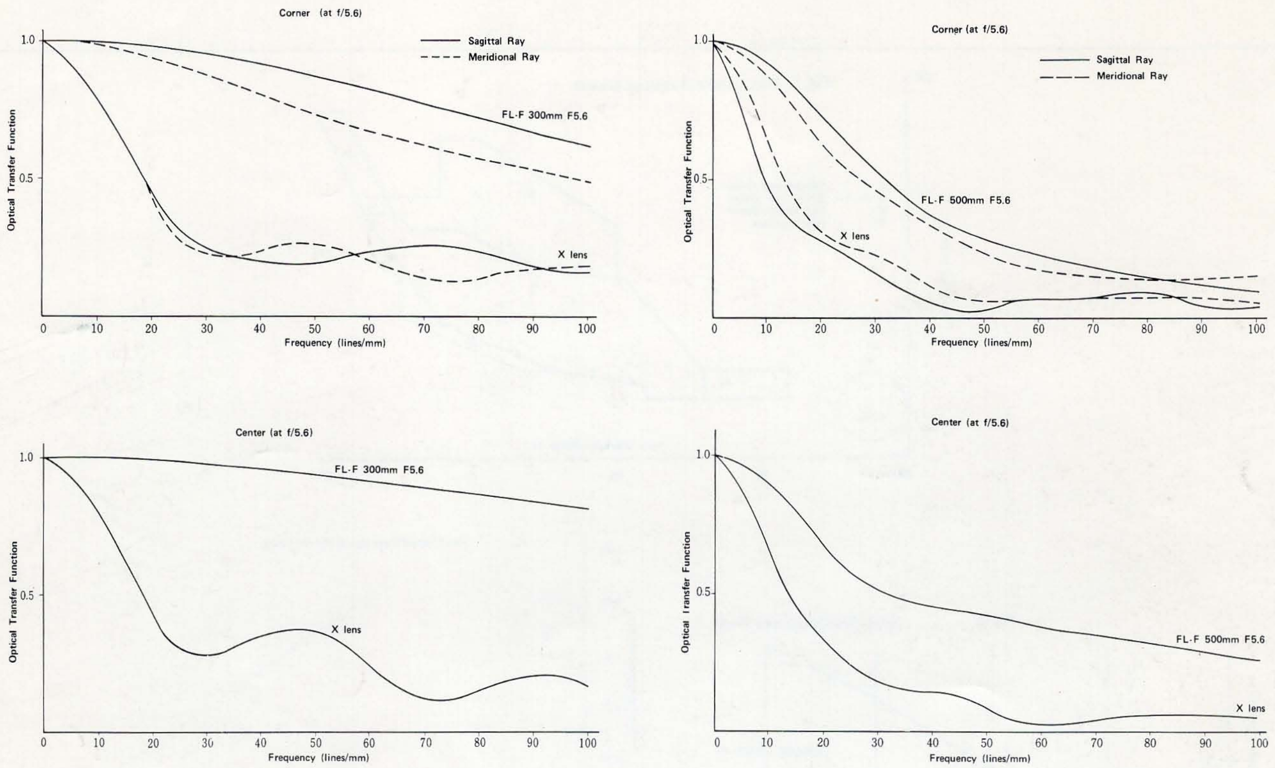
Generally speaking, chromatic aberration occurs when the lens material disperses the light. Dispersion is due to the variation of the refractive index with wavelength. Usually the Abbe number (νd) is used to indicate this difference. However, when the secondary spectrum is taken into consideration, in order to make it an apochromatic lens, the concept of partial dispersive ratio, say, the second order of dispersion, is used to indicate the amount of dispersion. This is a ratio of the dispersive powers and assumes a different value with different wavelengths.

When the relationship between the partial dispersive ratio (θ) and the Abbe number (νd) of various optical glasses is plotted, the relation of θ and ν, in the case of ordinary glass, becomes almost a straight line relationship, as shown in Figure 3. So long as glasses having this relationship are used together, theretically the secondary spectrum cannot be eliminated. It theoretically the secondary spectrum cannot be eliminated. It therefore becomes necessary to use a crystal which produces a marked deviation from this straight line relationship. The artificial crystal CaF_2 fills this requirement, making it possible to produce superior apochromatic lenses by combining CaF_2 with the proper optical glass. Additionally, since there is virtually no secondary spectrum in the range close to the infrared, the image delineation in the range close to infrared photography is incomparably better than that of conventional lenses. With the FL-F 300mm F5.6 lens, there is no need for focal point compensation in the range of photography close to infrared.

2. Compact Size

Telephoto lenses in the past, having long focal lengths, were, of necessity, heavy and burdensome to carry for the following reasons : If the overall length (distance from apex of first plane in the lens system to the focal point) of the optical system of a telephoto lens is much shorter than its focal length (telephoto ratio), then the power of each component comprising the lens inevitably becomes stronger. Due to the short overall length, the Petzval sum is minus, the curvature of the image plane becomes over-compensated, and spool-type distortion becomes greater. Furthermore, the chromatic aberration is extremely pronounced because of the increased secondary spectrum. These have been the restrictive factors that have prevented production of very small telephoto lenses. This restriction has now been successfully overcome by Canon with the creation of proper power distribution and the use of CaF_2. With respect to the curvature of the image plane, the Petzval sum has been reduced through proper power distribution. The problem of distortion has also been solved by proper distribution and shape. The low refractive index of CaF_2 has been exploited to compensate for image plane curvature. This advantage of CaF_2 has made possible a telephoto ratio for the FL-F 300mm F5.6 of 0.69 and of 0.66 for the FL-F 500mm F5.6 lenses. The very small telephoto ratios that Canon has developed are readily apparent when compared with the 0.95 - 1.0 telephoto ratios of conventional optical systems.

Appraisal by Optical Transfer Function



TECHNICAL DATA

	FL-F 300mm F5.6	FL-F 500mm F5.6
Mount :	FL breech-lock bayonet mount	FL breech-lock bayonet mount
Focal Length :	300mm	500mm
f/Stops :	f/5.6 - f/22	f/5.6 - f/22
Number of Elements :	6 components, 7 elements (including 2 fluorites and 2 rare earth glasses)	5 components, 6 elements (including 1 fluorite and 2 rare earth glasses)
Angle of View (diagonal) :	8°	5°
Coating :	Magenta	Amber
Distance Scale :	ft 13 - 200 ∞ m 4 - 50	ft 33 - 600 ∞ "R" for infrared photography. m 10 - 200
Aperture System :	Pre-set automatically, releasing possible with A-M ring	Pre-set automatically, releasing possible with depth-of-field check button
Telephoto Ratio :	0.69	0.66
Lens Hood :	Built-in	Built-in
Outer Diameter :	60mm	106mm
Inner Diameter :	58mm	95mm
Overall Size :	72mm ϕ x 168mm long (2-7/8" ϕ x 6-5/8" long)	106mm ϕ x 300mm long (4-1/8" ϕ x 11-7/8" long)
Weight :	850g (1 lb. 14 oz.)	2700g (5 lb. 15-1/4 oz.)

Subject to alterations.

Canon

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