

## Technical Note

# The Bolex Aspheron: A Super-Wide-Angle Adapter

By JOSEPH VASATA

News coverage in areas where often the available subject-to-camera distance is very limited is a challenge to the camera operator. The angle covered by standard wide-angle lenses is, in many cases, insufficient. This difficult problem has been solved, and a very efficient super-wide-angle attachment has been developed. It was especially computed to work in combination with the Switar 10mm Rx lens with preset diaphragm, which can be focused at extremely short distances.

The Bolex Aspheron wide-angle adapter for the 16mm format was first presented at the 1976 *photokina*. It is a negative optical element, designed for modifying the focal length and pick-up angle of a basic prime lens. The new optical formula used for the design of this adapter is based on the combination of the adapter with a basic prime lens which can be focused at an extremely short near distance.

The Aspheron, a single, multicoated negative element, is based on the retrofocus principle, a concept well known in the optical industry for a long time. In a retrofocus lens, the front group is divergent (negative) and the rear group is a convergent magnifier. This arrangement results in a wide angle of acceptance — a very important property, especially in SLR (single-lens reflex) motion-picture cameras, where a long back-focus distance is needed so that the rear end of the lens mount will not interfere mechanically with the moving mirror or with a fixed beamsplitter prism.

For use with the Aspheron, the basic Switar lens must be set at a rather large magnification,  $M$ , corresponding to a very close focusing distance. When the Aspheron, having a focal length  $F_D$ , is added to the basic lens with focal length  $F_B$ , their combined focal length,  $F_R$ , can be found from  $F_R = F_D \times M$ . The resulting focal length can thus be considered as a function of the focal length of the negative element and the magnification for which the basic lens has been set or focused. In this case, the resulting focal length,  $F_R$ , for the combined system equals 5.5 mm.

The unusually short minimum focusing distance of the Switar 10mm lens (practically a macro lens) is a prerequisite for the functioning of the Aspheron. With too long a near focusing range of the basic lens, a negative element with lesser optical power would have to be used with, of course, a lesser wide-angle increase.

Figure 1 shows the schematic ray path of the combination of prime lens and negative adapter. Points A and B are the conjugate

object and image points, respectively, on the optical axis for a given near-focus position and corresponding magnification of the prime lens. The dispersing element with focal length  $F_D$  is placed at the distance  $e$  from the equivalent principal plane of the basic prime lens with focal length  $F_B$ . At this distance, its virtual front focal point will coincide with the near conjugate point A, for which the prime lens is focused. As can be seen from the figure, this will refocus the combined optical system at infinity. At the same time, however, a greater back-focal distance is achieved, precisely because the shorter object distance  $x'$  needs a longer image distance  $x$ , with corresponding magnification  $M = x'/x$ . This, in essence, describes the retrofocus principle.

In other words, the refractive power of the lens attachment is calculated in such a way that the image of an object located at infinity falls in the same image-focusing plane as that of an object located at the dis-

tance of the nearest object focusing point of the prime lens alone, set at macro range. This assures a long back-focal distance. The diverging rays coming from the near object point A now appear to be coming from infinity along lines that are parallel to the optical axis. Simultaneously, the angle of incidence of oblique rays will increase considerably (Fig. 2). The total pick-up angle of the combination of prime lens and Aspheron is considerably wider than the pick-up angle of the prime lens alone. It is equivalent to the pick-up angle of a prime lens with a focal length of only about half the original focal length (5.5 mm instead of 10 mm).

When the pick-up angle becomes greater than  $80^\circ$ , problems relating to optical corrections become increasingly important. The distortions in many cases exceed acceptable standards if only spherical elements are used. For this reason, in many available wide-angle attachments the opti-

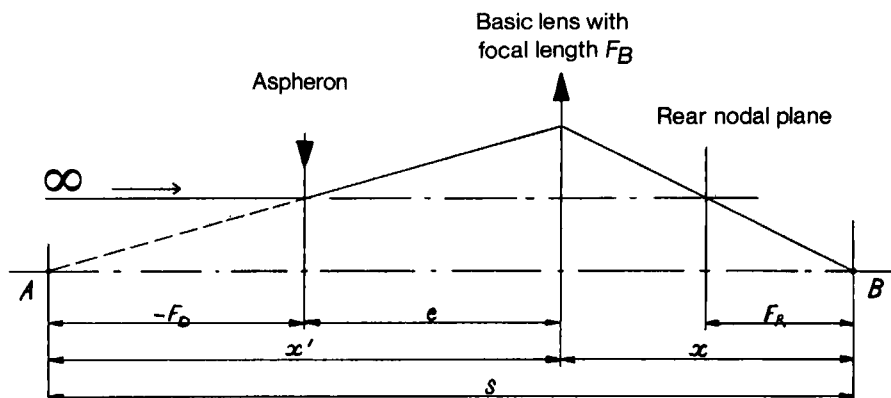


Fig. 1. Schematics of ray path through the Aspheron in combination with a Switar 10mm Rx lens.  $F_D$ : focal length of the Aspheron;  $F_B$ : focal length of the basic Switar lens;  $F_R$ : focal length of the combination of adapter and basic lens;  $e$ : distance between Aspheron and principal plane of the basic lens;  $x'$ : object distance at which the basic lens is focused;  $x$ : corresponding image distance of the basic lens;  $S$ : overall distance between conjugate points A (object point) and B (image point).

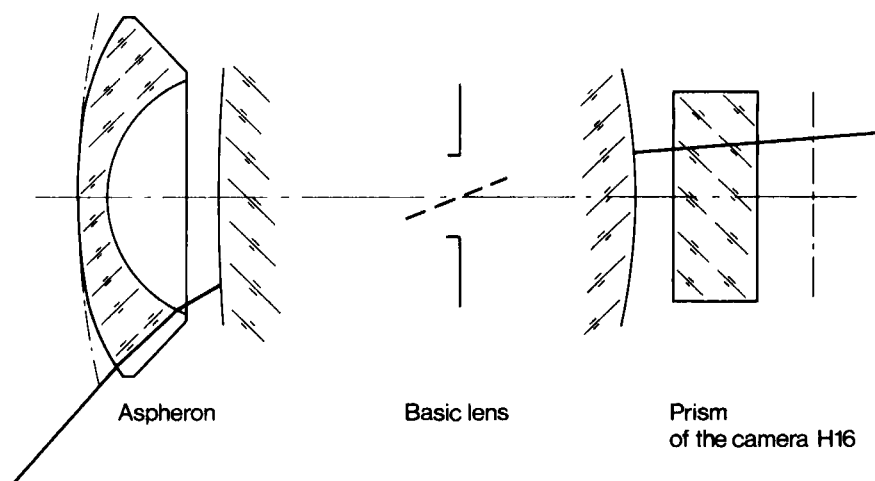


Fig. 2. Schematics of an oblique ray passing through the Aspheron/Switar combination to show increased entrance angle.

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cal performance corrections are customarily distributed over several elements. The Aspheron has only two refractive surfaces available for the correction of all optical aberrations. The Aspheron represents a new solution of this problem. The common, all-spherical design was abandoned and an aspherical convex surface was introduced, while keeping the concave surface spherical. This nontraditional design makes it possible to correct all aberrations of the adapter lens to an extent that achieves optimum perspective reproduction free of distortion.

When a supplementary optical element is attached to a basic lens, the number of glass-to-air surfaces is naturally increased, and this may create undesirable reflections and light losses. To avoid this, the Aspheron is multicoated. A special multilayer coating reduces unwanted light scattering and reflections to a minimum. Light transmission is at high efficiency, and picture quality, even in back-lighted situations, is free of flare.

The Aspheron has a refractive power of  $-28$  diopters. Because of its aspherical design, the bending of rays is slightly reduced



Fig. 3. The Bolex Aspheron and the associated Switar prime lens.

toward the edges of the lens to correct for spherical aberration. In addition to the almost complete absence of distortion and vir-

tually total transmission of the incident light to the prime lens, a large depth of field is obtained which extends at full maximum lens aperture from 100 cm (33 in) to infinity. By closing the diaphragm two or three  $f$ /stops, the depth of field will increase and range from as close as 2 in (5 cm) from the front element of the Aspheron-prime-lens combination to infinity. No corrections of the diaphragm settings of the prime lens are required.

The combination of the Switar 10mm Rx lens with the Aspheron attachment (Fig. 3) has been specifically designed for use with Bolex H-16 reflex cameras. If it is to be used on other 16mm reflex cameras, it is recommended that the diaphragm be closed to  $f/2.8$  or more. This is because the Switar 10mm Rx is intended for use with the Bolex reflex system, which uses a beamsplitter prism. This prism displaces the image plane a bit farther from the lens than where it would be without such a prism.

The 16mm camera has long been valued for its ability to work in tight quarters. With the Aspheron, this ability is enhanced to a very considerable degree.

## Removal of Hexacyanoferrate from Selected Photographic Process Effluents by Ion Exchange

By DONALD J. BRUGGER

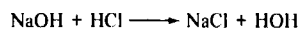
**An ion-exchange process has achieved almost complete removal of hexacyanoferrate anion  $\text{Fe}(\text{CN})_6$  from the bleach wash of Eastman color-print processes that use ferricyanide bleaches. A weak-base, gel-type resin column that has an adsorption capacity of approximately 50 g of  $\text{Fe}(\text{CN})_6$  per liter of wet resin was used. For resin regeneration, the hexacyanoferrate was eluted from the resin with sodium hydroxide, and the resulting solution was then oxidized for use as a bleach replenisher. This technique provides a route to complete recovery and recycling of the ferricyanide. Similar treatment was also applied to a final wash of Process K-14 for Kodachrome films, with equal success in removal of the hexacyanoferrate. However, reuse of the ferrocyanide recovered by this process is complicated by the presence of thiosulfate anion which is also removed from the effluent by the resin.**

Until recently, the collection of the ferricyanide bleach overflow for regeneration has been the only technique used to limit its loss to the sewer. Those who have employed this technique have realized savings in chemical costs. More recently, chemical precipitation has been used to recover additional ferrocyanide from contaminated reversal fixes. Squeegees have been added to reduce the carryover of the bleach into fixes and washes. By using these techniques, up to 90% of the hexacyanoferrate loss has been eliminated. The remaining hexacyanoferrate, that from the washes, was not considered to be easily removable by precipitation methods because of the large vol-

umes involved and the low concentration of the anion. Work done by Iwano, Shimamura and Abe<sup>1</sup> in Japan and by Avery and Fries<sup>2</sup> in this country has shown that weak-base, anion-exchange resins can be used to remove hexacyanoferrates from waste streams. This work has also shown that these resins are easily regenerable.

### Theoretical Basis

The ion-exchange process may be compared to a neutralization process. For example, if we neutralize sodium hydroxide with hydrochloric acid, the hydroxide part of the base (NaOH) exchanges for the chloride part of the acid (HCl).

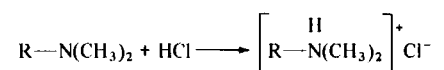


Here the final products are sodium chloride and water.

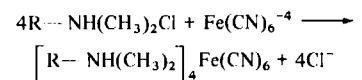
The ion-exchange process works in much the same way: with the exchange taking place between ions in solution (the solu-

ble species) and ions attached to a backbone or matrix (the insoluble species).

The backbone or matrix of most modern ion-exchange resins used for this purpose is some type of synthetic polymer. The ion-exchange resins of interest in the removal of hexacyanoferrates are of the weak-base type. These contain tertiary amine functional groups represented as  $\text{R}-\text{N}(\text{CH}_3)_2$ . (The "R" represents the polymer backbone.) The reaction for the preparation of this resin for ferrocyanide removal would then be as shown in Eq. 2 (converting it from the free base to the chloride form).



The reaction for the removal of hexacyanoferrates is represented in Eq. 3.



where the hexacyanoferrate anion, with its four negative charges, associates with four sites on the resin.

Iwano, Shimamura and Abe found that, by using the chloride form of a weak-base, anion-exchange resin as described above, they could remove ferri- and ferrocyanide from the bleach wash-tank overflow of a color-film-processing machine. They were also able to remove the same from the waste

Presented on 19 October 1977 at the Society's 119th Technical Conference in Los Angeles by Donald J. Brugger, Eastman Kodak Company, Photographic Technology Division, Kodak Park, Bldg. 69, Rochester, NY 14650. This paper was received on 21 December 1978. Copyright © 1979 by the Society of Motion Picture and Television Engineers, Inc.