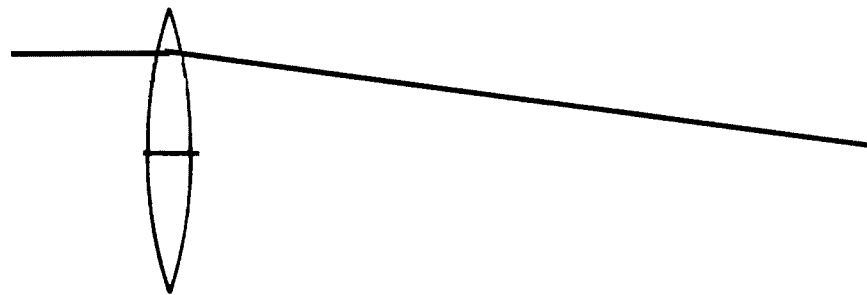


PHOTOGRAPHIC OBJECTIVES #2: TELEPHOTOGRAPHIC LENSES

The longer the focal length, the larger the image for a given object distance, and this property can be used to make far away objects seem closer. For instance, a 1000mm focal length lens would magnify the image of an object 20X as compared to a normal 50mm lens, but that would mean the single element would have to be 1 meter away from the film plane when focussed at infinity, and moved further away for closer objects, making an unwieldy device having to be tripod mounted. Even a 200 mm focal length lens would have to be placed that far away, and racked out to 220 mm for the typical head and shoulders 1/8 magnification portrait.

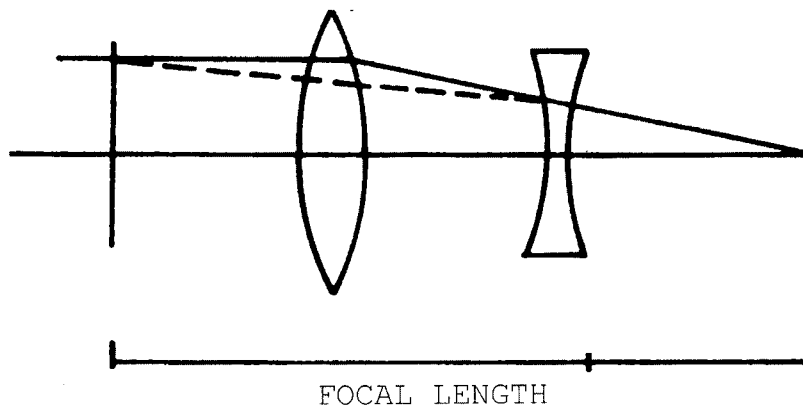
A telephotographic lens, or telephoto for short, is a special optical design that is physically shorter than a single lens of the equivalent focal length. The engineering trick is here. illustrated

The focal positive lengthened addition of lens



length of a lens is by the a negative

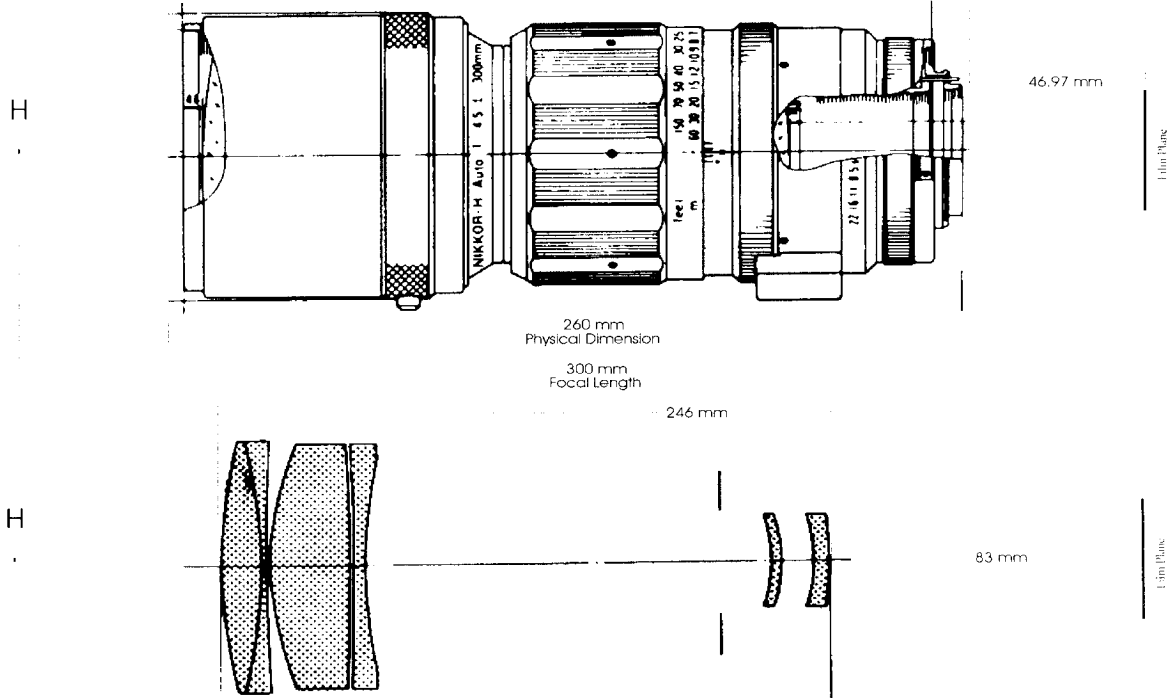
SINGLE ELEMENT ABOVE
TELEPHOTOGRAPHIC EQUIVALENT BELOW

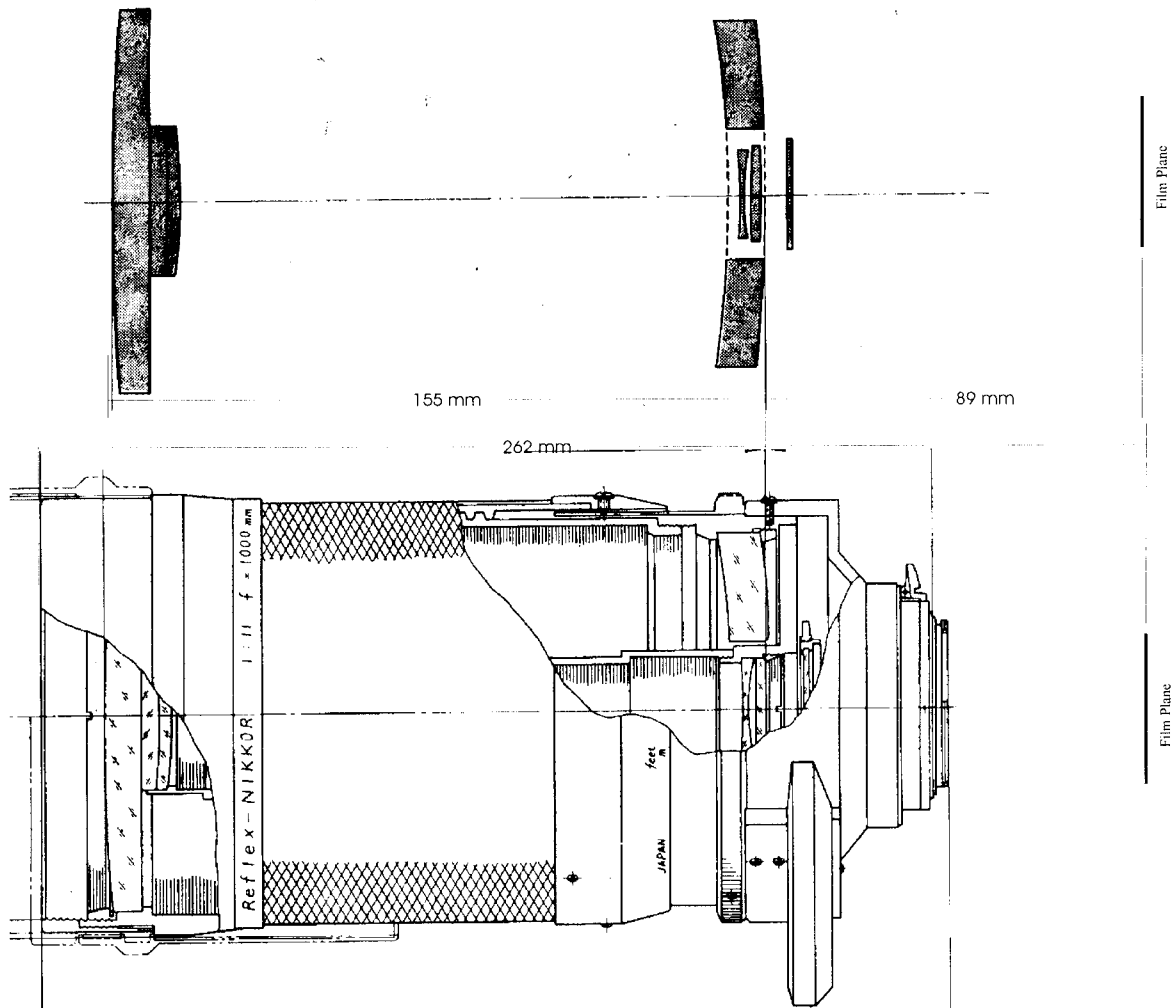


downstream. As the converging rays of the positive lens travel through the negative lens, they are refracted outward from the optical axis. The bending power of this second lens is not so strong to not allow the rays to come to a real focus, just enough to

extend its position. This lens prescription is similar to that of an achromat, but with the negative element distant from the first lens and not in contact like the achromat.

Here is a diagram of a decently long telephoto lens for a 35 mm camera. Notice that the actual length of the package is less than the equivalent focal length!



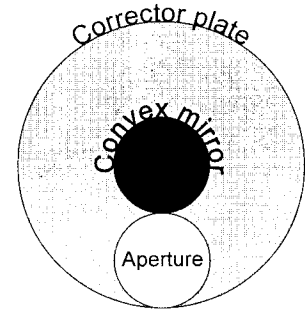


1000 mm f/11 Reflex Optic

The light first passes through the front corrector plate and starts converging, then is reflected forward by the concave reflector, then back again off a convex reflector glued to the inside of the corrector plate, through a hole in the middle of the concave reflector where a negative followed by a positive lenses live, through one of the filters on the filter wheel¹, and thence onto the film.

¹ Because a filter that screws on the front of the lens would have to be 115 mm in diameter a kit of the most commonly used filters (UV skylight, red, orange and yellow for deepening skies and lightening flesh tone in black and white work) would be extremely expensive. Smaller filters are installed inside of the lens unit (keeping them nice and clean!) and are rotated into position before use. Because their thickness can introduce some spherical aberration into the system and shift the focal plane, the lens is engineered to always have some filter, even if it's only a skylight filter in the optical path.

These lenses are never stopped down; there is no iris diaphragm in the center of the lens because of the convex mirror in the center of the corrector plate. To attenuate the incoming light an off-center circular aperture placed in front of the corrector plate would do the job along with increase depth of field. Usually these lenses are of moderate to slow speed anyhow, but the long focal length yields very little depth of field.



Front of Reflex Lens

Another peculiarity of this design with the center of the lens having an obstruction is that out of focus highlights will photograph as donuts! This fingerprint is a sure way to identify pictures taken with this type of lens.

TELE-EXTENDERS:

Since a telephoto lens is made by following a positive lens with a negative one, it is possible to extend the focal length of any photographic objective by adding a negative lens behind it.

Tele-extendors are usually designed to double the focal length of the prime objective, and are negative lenses of the proper focal length positioned appropriately so that the focusing scale of the original lens remains accurate.

Adding more glass to an optical path may introduce new aberrations, but the big drawback is that the new working f/number of the combination is also doubled, but means only 1/4th the light is reaching the film plane. But these are small prices to pay compared to the cost of a new lens!