Early symmetrical lenses

Lens Design OPTI 517
Singlet/doublet lens solutions

Plano-convex (Studied by Airy)

Wollaston’s meniscus 1812

Chevalier’s or French landscape lens early 1800’s

Grubb’s “aplanat” 1857
French landscape lens

Daguerre’s camera using a Chevalier lens.

*Photography*, R. Hunt, 1853.
The doublet solutions

- Four cemented
- More un-cemented
- How do you find them?

Crown in front

Flint in front

Prof. Jose Sasian
Chevalier double lens 1840

Prof. Jose Sasian
Petzval lens use of doublets
Early symmetrical lenses
(Symmetrical about the stop)

- Stenheil, periskop 1865
- Rapid rectilinear, Dallmeyer 1866, Steinheil 1866

- Use of the symmetrical principle
- Odd aberrations cancel
- “Doubling of a lens” principle
- F/16
Rapid rectilinear lens

- Intermediate lens at f/8
- A great design
- ~70 years life span
- 1866
- John Dallmeyer
- Hugo Steinheil
- Glass selection is key

Dallmeyer

Steinheil
Comparison I

24 deg @ f/8

BK7-F2

F=100 mm

10 mm spacing

Weight 5 on axis

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Comparison II

24 deg @ f/8

F2-BK7

F=100 mm

10 mm spacing
Comparison III

24 deg @ f/8

F2-BK7
F2 to v=51
F=100 mm
10 mm spacing

Weight 5 on axis
V1=51
V2=64

Prof. Jose Sasian
Ross concentric lens

Ross concentric (Schroeder) lens 1889
(two new achromats)
Thick and thin meniscus

- Thick meniscus lens corrects field curvature of the thin meniscus
- Thick meniscus is afocal
- Thick lens likely unconventional prior to 1890
Time table

1812 Wollaston landscape lens; 30 deg @ f/15
1839 Photography was disclosed by Daguerre
1839 Chevalier lens
1840 Petzval (Hungarian) portrait lens; 15 deg @ f/3.7
1841 Gauss, cardinal points
1856 Seidel theory
1865 Periskop, Steinheil
1866 Normal glasses: soda-lime-silica and lead oxide
1866 Rapid rectilinear, Dallmeyer (England) and Steinheil (Germany),
   40-year span; 20 deg @ f/8
1873 Piazzi Smyth field-flattener
1885 before this year the field was artificially flattened by astigmatism
1885 E. Abbe and O. Schott new glasses; barium in place of lead;
   ‘Jena’ glass; new achromat;
1889 Ross concentric lens
Fabrication issues

- Easy to make
- Same radius of curvature or flat
- Glass to air interfaces
- Ghost images
- Lens volume
- Back focal length (Packaging)
- Negative thickness. Razor blade edge.
- Lenses too thick, too thin
- Concentric meniscus centering vs. alignment
Conclusions

- Symmetrical lenses
- Doublet lens combinations
- Fabrication issues