

# ANTIQU & VINTAGE TELESCOPE COLLECTION

Chris Lord

"Collecting antique & vintage tripod mounted & hand held refractors"

I've been collecting and selling on antique & vintage hand held refractors since the late 1960's. In those days they could be found in junk shops for under a fiver. The most I ever paid was £17 for a '*Dolland*' (Benjamin & Joshua Martin) c1780 Day or Night, complete with leather sleeve case & shoulder strap. Nowadays they can be found on eBay and sites such as Fleaglass. Antique & vintage refractors are not only interesting instruments to collect, they can be a sound investment.

## THE COLLECTION SO FAR

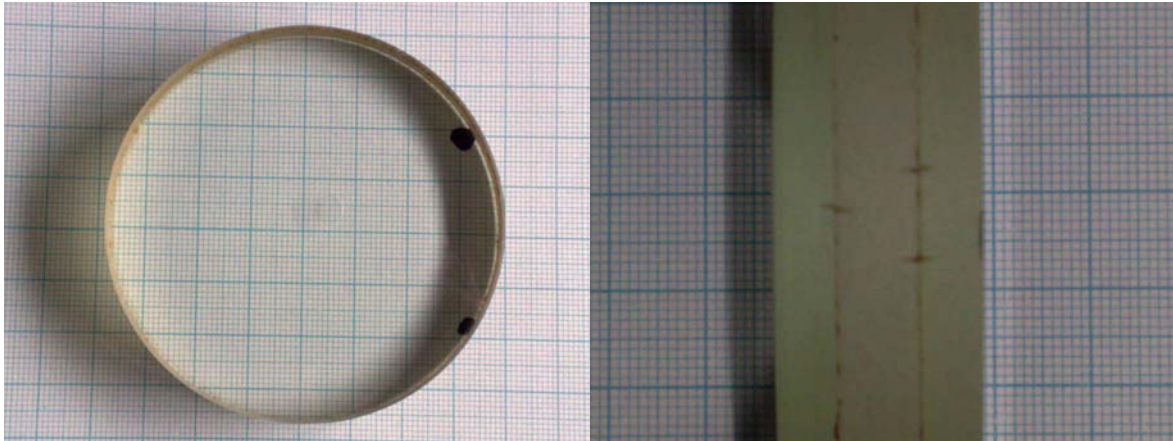
- 1) Ottway 3-inch f/13 achromatic c1955 + B.C. & Co.,Ltd. Pancratic eyepiece RAS (1" & 1/4-16TPI WHIT) c1910, with spare B.C. & Co.,Ltd. 3-inch f/13 achromatic OG in brass sleeve cell c1930.
- 2) Unsigned 3-inch f/12 achromatic, triplet OG c1960; refractor c1880 on teak tripod with brass altaz pillar.
- 3) Frodsham, Liverpool, Henry c1840 "Improved Telescope" - single draw marine, mahogany taper barrel - eyepiece missing.
- 4) J. Hughes, London, Day or Night c1800 single draw marine, leather bound barrel - OG cover slide missing.
- 5) Barton, London, Day or Night c1810 three draw, leather bound barrel - eyepiece cover slide missing.
- 6) J. Cetti, London, Day or Night c1820 two draw, mahogany barrel - with OG & eyepiece slide covers.
- 7) Aaronsberg, Manchester, William c1860 seven draw - OG missing - achromatic doublet substitution.
- 8) Unsigned c1830, mahogany barrel with enamelled tinplate sleeve case & post screw brass hex pillar.
- 9) Lennie, 46 Princes St, Edinburgh, c1890 six draw, leather bound barrel with leather sleeve case.
- 10) Eyepiece (simple Keplerian) in oxidized brass barrel & d'tube, c1740.
- 11) J. Casartelli, Garrett St, Oldham Rd, Manchester, c1870, brass theodolite in hardwood case.
- 12) Husbands, 8, St. Augustine's Parade, Bristol, Henry, 2-inch table top refractor, c1870 single draw x36, on pillar & claw stand, brass pillar, iron claw legs & altitude trunnion. Ironwork bronze gilt restored.
- 13) A. Clarkson & Co. Ltd. High Holborn, London, c1880 three draw with Pancratic eyepiece, x25-x40, with sliding leather barrel sleeve.
- 14) E.R. Watts & Son, Canada, Limited, c1945 three draw signalling refractor, leather covering removed.
- 15) Unsigned, c1900 three draw with leather bound barrel.
- 16) Watson & Sons, 343 High Holborn, London, c1920, six draw miniature pocket refractor, nickel plated, with leather sleeve case.
- 17) T. Cooke & Sons Ltd, London & York, c1915, 'Officer of the Watch' refractor, single draw, with leather bound barrel, marked No.2214, with Earl of Sandwich arrow, nickel plated.
- 18) Dollond, London, George c1800, large Huyghenian eyepiece, part of single draw Night telescope.
- 19) J.H. Steward, 457-406, Strand, 54, Cornhill, London, c1890 three draw signal refractor with leather bound barrel.
- 20) John Lilley & Gillie Ltd, North Shields, c1930 single draw marine, leather bound taper barrel, blued brasswork, with dust cap & glare shield. Supplied in hessian carrier with shoulder strap.
- 21) Unsigned, single draw marine, mahogany taper barrel, c1850, glare shield jammed, dust cap missing.
- 22) Unsigned, single draw, fruitwood taper barrel, c1740, simple stopped down OG, OG & eye lens cover slides.
- 23) Troughton & Simms, London, c1850 & Husbands & Sons, 8, St. Augustine's Parade, Bristol, rack & pinion focuser, c1890. 2 & 1/4-inch table top refractor, single draw, on all brass, braced pillar & claw stand, with altitude adjustment rack & pinion.
- 24) Tulley & Sons, Islington, London, c1830. 3 & 3/4-inch f/16 astronomical achromatic refractor on German Equatorial. 11-inch finder, rack & pinion focuser with RAS drawtube, and five Huyghenian eyepieces with Sun & Moon eyecaps, in mahogany case. Mahogany tripod.
- 25) G. Willson, London, c1820 three draw improved Day or Night, leather bound barrel, glare shield, OG cover slide missing.
- 26) Unsigned single draw, c1830, leather & rope bound barrel, achromatic OG.
- 27) Unsigned Dollond copy, table top 2 draw achromatic, mid-late C19th, mahogany barrel, wood folding tripod in pine case. Low & medium power Huyghenian eyepieces. Eye lens from low power missing.
- 28) Unsigned c1810 three draw, leather bound barrel, in RN blue pasteboard trunk marked "J.G." in gilt. (James Gardner fl 1791-1830)
- 29) Barton, London, Day or Night c1810 three draw, leather bound barrel.
- 30) Unsigned 3-draw, rope bound barrel.



3-inch  $f/12$  unsigned achromatic refractor, intended for both terrestrial and astronomical use. The barrel is red brass (62-38) c1880, and has 'season cracking'. The eyepiece is a Broadhurst, Clarkson & Co., Ltd., Pancratic c1910, RAS screw fitting. The original object glass which would have been very similar to a spare B.C. & Co., Ltd., 3"  $f/13$  achromatic doublet in my collection, dating from the 1910's, has been replaced with a Conrady design achromatic triplet c1960.



3-inch  $f/12$  unsigned achromatic refractor, dismantled and re-polished using the technique described in the article (see restoring & maintaining antique & vintage brass refractors). In order from top: the brass barrel, heavily dented; altaz trunnion; pinion saddle plate; rack & pinion; racktube flange; tripod pillar cap; tripod pillar (prior to filling with lead shot); racktube; drawtube & eyecap; pinion wheel; altaz tensioning collar; B.C. & Co., Ltd., Pancratic eyepiece.



3-inch  $f/12$  achromatic triplet object glass. Chips have been blacked out with acrylic paint. Note the alignment marks indicating clocking & the front surface. The OG is cemented, and judging by the diamond milling marks, must have been made during the 1950's or 1960's.

*OTTWAY ACHROMATIC DOUBLET  
3-inch f/12 in sleeve cell nickel plated brass  
c1955*



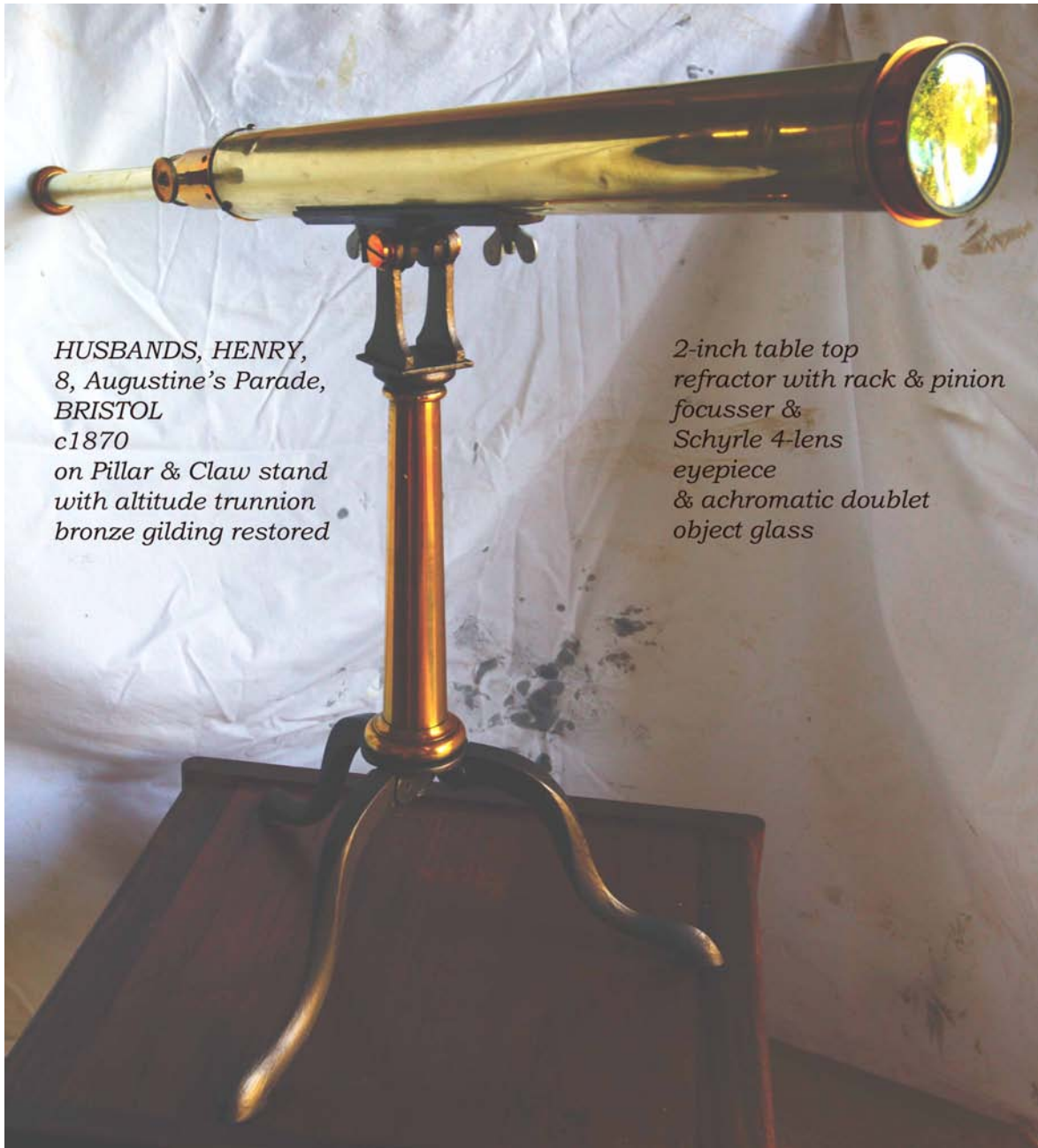
*TROUGHTON & SIMMS  
ACHROMATIC DOUBLET  
2.25-inch f/14  
screw-in cell  
c1850*



*HUSBANDS, HENRY,  
8, Augustine's Parade  
BRISTOL  
c1870  
on Pillar & Claw stand  
with altitude trunnion  
bronze gilding restored*

*2-inch table top  
refractor with  
rack & pinion  
focuser &  
Schyrle 4-lens  
eyepiece*

Table top 2-inch terrestrial refractor with Schyrle 4-lens eyepiece made by Henry Husbands, 8, Augustine's Parade, Bristol c1870. The brass barrel length is 20", extended 32&1.2", the drawtube OD 0".96. The OG clear aperture is 1".972.



*HUSBANDS, HENRY,  
8, Augustine's Parade,  
BRISTOL  
c1870  
on Pillar & Claw stand  
with altitude trunnion  
bronze gilding restored*

*2-inch table top  
refractor with rack & pinion  
focuser &  
Schyrle 4-lens  
eyepiece  
& achromatic doublet  
object glass*

Henry Husbands table top, pillar & claw stand of iron, restored bronze gilding to claw legs and trunnion.



Husbands signature on rack & pinion body.

HUSBANDS 2-inch achromatic OG, note the greenish tint to the crown element, unusual for a doublet of this date and indicating the use of crown window glass rather than Chance optical crown.



London Honourable Mention and Medal, 1851.

Melbourne Gold Medal, 1881.

Dundee Medal, 1882.



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CORNER OF DENMARK STREET,  
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W. BOWEN, Sr.  
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Henry Husbands and William Clarke had a scientific instrument making shop in Bristol, as partners between 1858 & 1870, following which Husbands operated the business alone and subsequently with his sons until he died in 1900. Three of Henry's sons maintained the Husbands & Sons' shop until 1910. The business was the

main supplier of instruments in Bristol in the latter half of the C19th. The shop still stands today, on the corner of Augustine's Parade & Denmark Street.



Unsigned 2 draw table top c1850-1900



Unsigned 3 draw c1810 in RN blue pasteboard trunk marked "J.G." in gilt.  
James Gardner, London, fl 1791-1830.



Four C19th refractors, two single draw, a 2-draw & a 3-draw.  
 Frodsham barrel length is 25&1/4", extended 38", barrel OD 2&1/2" tapering to 2&1/8". Draw OD 1".593 - 17swg  
 J. Cetti barrel length is 13&3/4", extended 34&1/8", barrel OD 2".45. Draw OD's 1".766 & 1".632 - 32swg, X12.5 Day, x10 Night  
 J. Hughes barrel length 18&1/4", extended 31&1/4", barrel OD 2".4. Draw OD 1".762 - 68thou, x13 Day, x4.5 Night  
 Barton barrel length 10&1/8", extended 32&1/4", barrel OD 2".43. Draw OD's 1".8, 1".625, 1".456 - 23swg



Frodsham - OG dia. 1.815/16" x 28"fl - split drawtube with Schyrle 4 lens eyepiece (original eyepiece missing)  
 J. Cetti - OG dia. 1.81/2" x 31.81/4"fl - 2 draw, Pancratic 4 lens eyepiece within 2nd draw.  
 J. Hughes - OG dia 1.81/2" x 17"fl - split drawtube with Schyrle 4 lens eyepiece.  
 Barton - OG dia. 1.81/4" missing - 3 draw with Schyrle 4 lens eyepiece within third draw.



Frodsham, J.Cetti, J. Hughes & Barton OG and cell arrangements.





Frodsham, J.Cetti, J. Hughes & Barton eyepiece systems.



Frodsham signature on eyepiece end of single draw.



J. Cetti signature on eyepiece drawtube.



J. Hughes signature on eyepiece end of single draw.



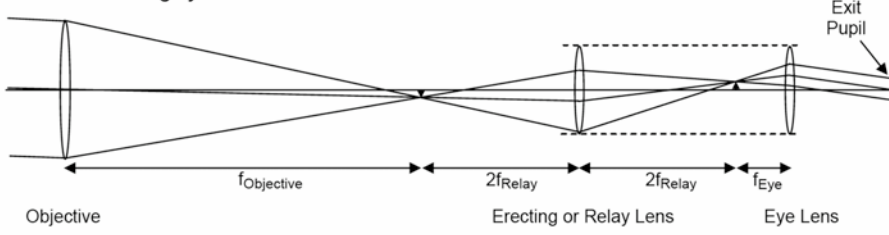
J. Hughes - badly worn Day or Night engraving



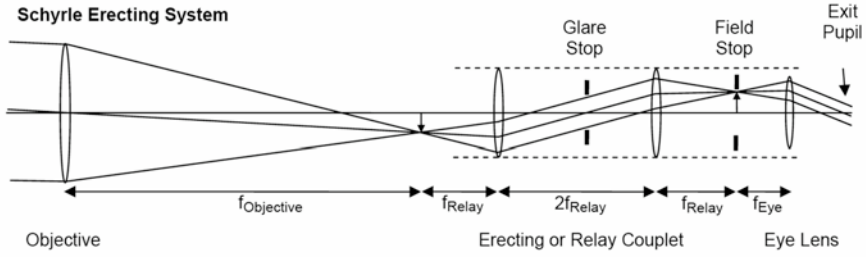
brass jobber's assembly marks on spring collars

## ANTIQUÉ BRASS REFRACTOR DESIGN

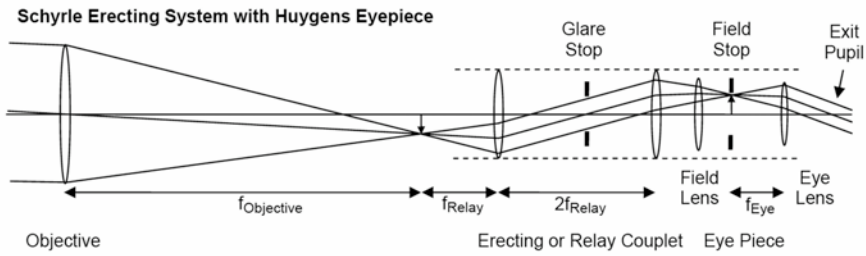
**Scheiner Erecting System**



**Schyrle Erecting System**

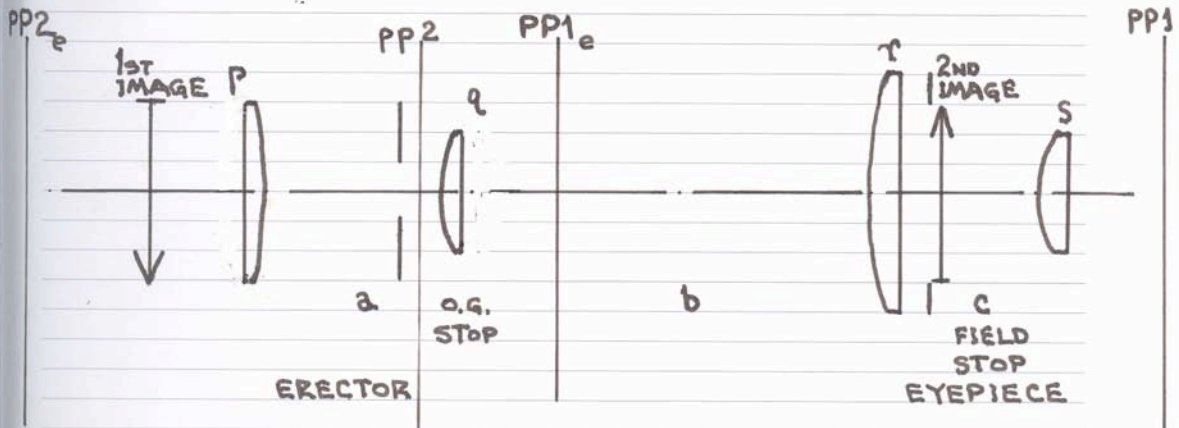


**Schyrle Erecting System with Huygens Eyepiece**



The evolution of the design of the terrestrial or relayed-Keplerian telescope. The separation between the elements in the erecting couplet was often twice the lens focal length, but this is not required. The Schyrle erecting system is often referred to as a three-lens eyepiece, and the Schyrle-Huygens erecting system as a four-lens eyepiece. In some telescopes, an additional field lens was inserted at or near the first intermediate image resulting in a five-lens eyepiece.  
 Ref: Proc. of SPIE Vol. 8129 812902-3 Fig.1

## SCHYRLE-HUYGENS ERECTOR



$p = 1st\ lens\ fl$      $q = 2nd\ lens\ fl$      $r = field\ lens\ fl$      $s = eye\ lens\ fl$

ERECTOR

$$EFL_e = \frac{p \cdot q}{p + q - a}$$

$$PP1_e = \frac{EFL \cdot a}{q}$$

$$PP2_e = \frac{EFL \cdot a}{p}$$

EYEPIECE

$$EFL = \frac{r \cdot s}{r + s - c}$$

$$PP1 = \frac{EFL \cdot c}{r}$$

$$PP2 = \frac{EFL \cdot c}{s}$$

ERECTOR AMPLIFICATION - PANCRATIC

$$M_e = \frac{B}{EFL_e} - 1$$

$$B = PP2_e + b + PP1 - EFL$$

TELESCOPE MAGNIFICATION

$$M = \frac{OG\ fl}{eyepiece\ efl} \cdot M_e$$

ERECTOR AMPLIFICATION - SCHYRLE / HUYGHENS

$$M_e = \frac{B}{EFL_e} + 1 \quad B = PP2_e + b + PP1 - EFL_e$$

TELESCOPE MAGNIFICATION

$$M = \frac{OG\ fl \cdot M_e}{erector\ efl}$$

The design and construction of antique and vintage refractors in some ways reflect the more primitive pasteboard multiple draw simple refractors of the C17th and early to mid C18th. But they also reflect advances in mechanical engineering, manufacturing and materials technology. The advent of precision brass tubing from the 1720's, thru' the late 1700's, both rolled and seam soldered, also hand and machine drawn, made it feasible to substitute pasteboard and vellum draws which were hygroscopic, and not trapped, with waterproof brass draws, which were trapped.



Pasteboard telescopes from the early to mid C18th:  
 (A) Paper covered pasteboard barrel and vellum covered draws, fittings made of horn. Length 33", barrel dia.  $2\frac{1}{4}$ " (Leonardo Semitecolo, Venice)  
 (B) Painted tin covered barrel and vellum covered draws, fittings made of wood. Length  $31\frac{7}{8}$ ", barrel dia.  $1\frac{7}{8}$ " (unsigned German)  
 (C) Painted paper covered pasteboard barrel and vellum covered draws, fittings made of horn. Length  $32\frac{1}{4}$ ", barrel dia.  $1\frac{5}{12}$ " (unsigned Italian)  
 (D) Leather covered pasteboard barrel and vellum covered draws, fittings made of horn. Length  $24\frac{13}{32}$ ", barrel dia.  $1\frac{3}{16}$ " (unsigned French)  
 Ref: Proc. of SPIE Vol. 8129 812902-5 Fig.5

The advances in material and mechanical engineering technologies arose from the English Industrial Revolution. The availability of high quality thin wall brass tubing, initially rolled or hammered sheet, subsequently hand and machine drawn seamless tubing, enabled stronger, and more rigid hand held refractors to be manufactured.



Single-draw pre-achromatic telescope with a wooden barrel and a Schyrle erecting system (unsigned c1740, English). The telescope has an overall length of  $22\frac{7}{16}$ ". The objective dia.  $1\frac{10}{128}$ " stopped down to  $1\frac{31}{256}$ ". Each segment of the draw contains one of the three lenses of the Schyrle erecting system.  
 Ref: Proc. of SPIE Vol. 8129 812902-4 Fig.3

The main tube that carried the object glass, the barrel, was usually made from either hardwood or fruitwood, typically Mahogany, or Applewood. The objective cell of brass, was fastened onto a turned register with small wood screws, likewise the first draw flange.

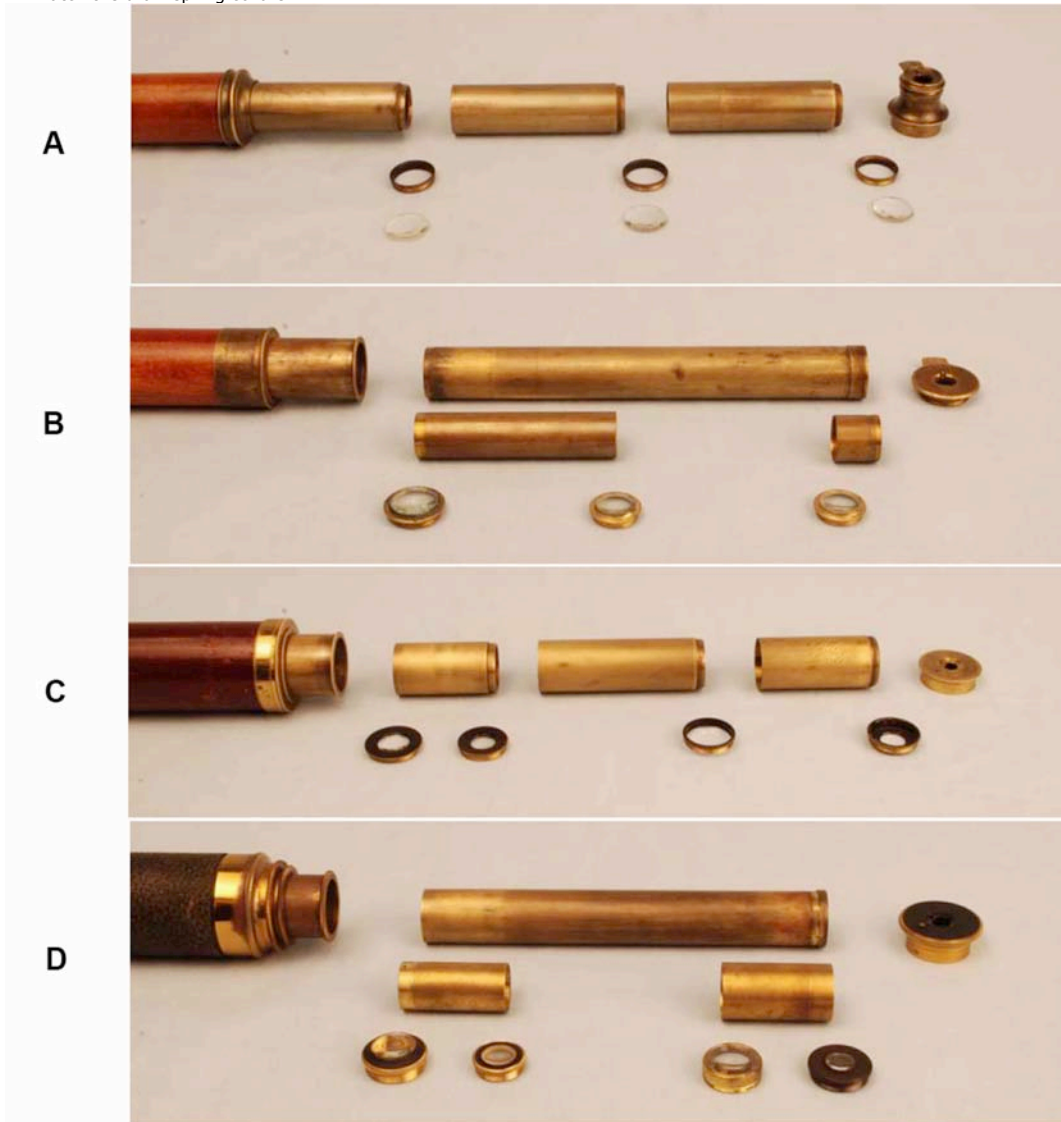
The wooden barrel was made by gluing strips fashioned with a spokeshave, around a paper lined former. The former could be either cylindrical, or slightly tapered. The reason for the preferred taper barrel was because it was easier to release from the former once the glue had set. The inside diameter was then turned out on a wood lathe using a long thin boring bar supported on a hand rest. The outside diameter was rubbed down using a rasp, and then sanded and polished. Some wooden barrels were made square, or octagonal.



Reverse taper octagonal telescope (unsigned c1750, English). The length of the telescope is  $42\frac{117}{128}$ ", the barrel dia.  $1\frac{3}{10}$ " at the objective end widening to  $1\frac{21}{32}$ " at the eyepiece end.  
 Ref: Proc. of SPIE Vol. 8129 812902-5 Fig.4

The earliest brass refractors c1750, had a single draw which contained the erecting, field and eye lenses. Sometimes this tube was split, and the erector could be removed, the tubes screwed together again, for use as an astronomical or night telescope. Hence the appellation, "Day or Night" or "Day & Night". Sometimes the single draw was split into three tubes, each carrying a lens, the first a Schyrlean single lens erector, the second the field lens and the third, the eyelens carried in the eyecup. Each lens was held in situ by retaining rings.

The brass tube at the time was not round enough for multiple draw refractors. That development came in 1782 when Benjamin Martin's son Joshua invented a tube drawing machine capable of drawing and plating brass or copper tube. Both Martin, Dollond & Ramsden used these machines, contravening the patent which was not enforced. All three makers introduced refractors having multiple draws, typically three or four. The tube drawing machine enabled precision thin wall seamless brass tubes to be produced to very close tolerances, to match the draw spring collars.



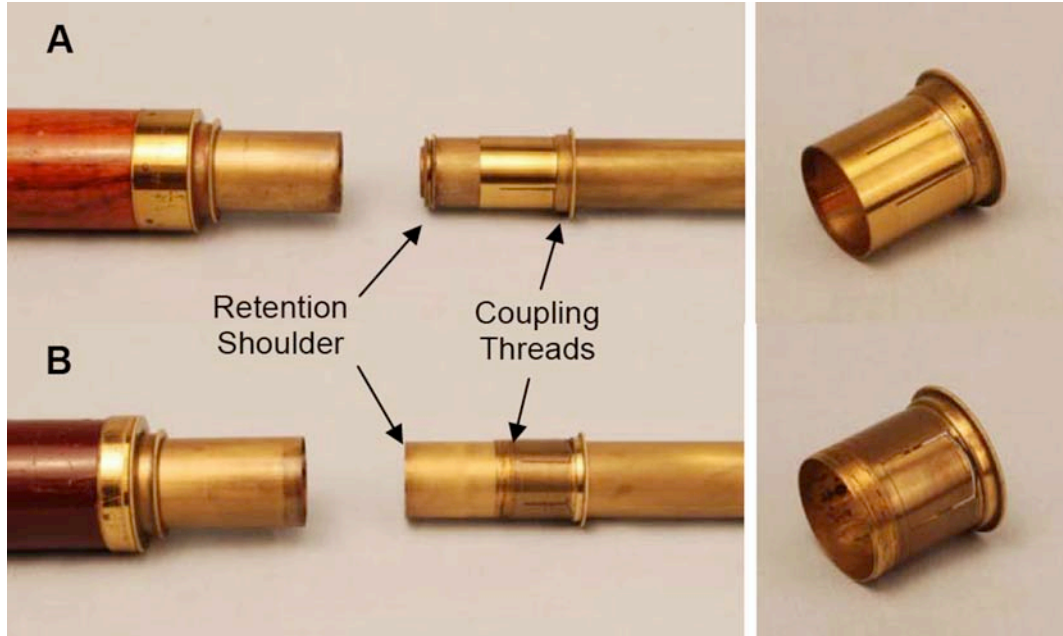
Eyepiece construction:  
 (A) Three-lens eyepiece with a segmented single draw (unsigned mid C18th, English)  
 (B) Three-lens eyepiece with a continuous single draw (unsigned c1800, English)  
 (C) Four-lens eyepiece with a segmented eyepiece draw (Dollond, London c1800)  
 (D) Four-lens eyepiece with a segmented eyepiece draw (unsigned late C19th, French)  
 Ref: Proc. of SPIE Vol. 8129 812902-7 Fig.6

With the introduction of multiple draw refractors, the 4 or 5 lens erector and eyepiece lenses were all carried in the final draw. The erector and eyepiece elements being held in separate shorter tubes. The erector being screwed into the end of the final draw had a rim that acted as a draw retainer, and the eyepiece, either Schyrlean or Huyghenian, slid into the end of the draw, trapped by the eyecup. Or the eyelens was screwed into the eyecup, and the eyecup onto the end of the final draw. Each lens of the erector - eyepiece system was mounted in its own cell.

Prior to 1758, the objective comprised a simple plano-convex or equi-convex lens. The aperture would be typically no more than 1&1/2 inches, and in some instances stopped down. Chromatic aberration was controlled by the Schyrlean erector - eyepiece system. Post 1758, when Dollond introduced the achromatic doublet (& more rarely an achromatic triplet), the tube length could be reduced, and the aperture increased. But due to the scarcity of optical quality flint glass, Day & Night refractors with simple objectives continued to be made into the C19th. Post 1830, most refractors were achromatics.

The brass collars used to connect the individual drawtubes, possessed spring tabs to provide tension on the

drawtube so they remained firmly in place whether extended or collapsed. The collars were fitted with soldered flanges with a knurled rim so they could be unscrewed by hand to permit easy dismantling for cleaning and polishing. At first the screw thread on the collar was up against the flange, so the female thread in the drawtube was right at the end and experienced the full cantilever load. It is not uncommon to find refractors with split drawtubes, damaged threads that have been crossed, so worn down that silk thread has been run in to provide a better fit. I have come across such refractors that when extended fall apart because the drawtube threads have failed. At the turn of C19th George Dollond amended the design, putting the thread at the end of the collar, turning a register at the head, and recessing the internal drawtube thread to match. This had the effect of distributing the cantilever load over the length of the collar, providing superior rigidity and strength. It is uncommon to come across a failed drawtube thread of this type. I have refractors made at the turn of C19th - C20th that feature the shouldered drawtube collar.



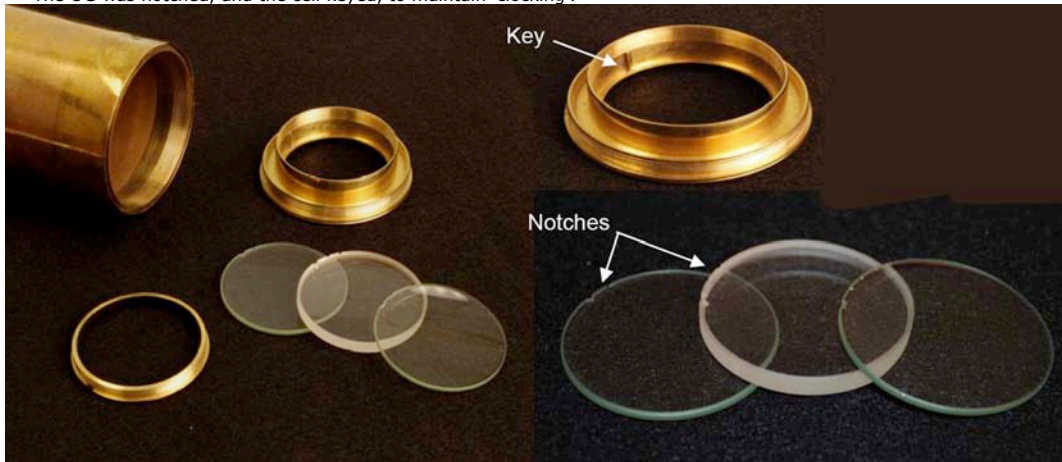
Couplings and retention:  
 (A) Coupling screws into the end of the draw. Draw retention is provided by the knurled shoulder of lens cell (Utzschneider & Fraunhofer, Munich, early C19th).  
 (B) Coupling screws into threads deep inside the draw. Draw retention is provided by a ring on end of the draw (Dollond, London, c1800)  
 Ref: Proc. of SPIE Vol. 8129 812902-8 Fig.7

The primitive simple pasteboard refractors of the C17th and early C18th did not have retained draws. However once brass tubing was used instead, it became common practice to fit or form a lip at the end of each drawtube, so the tube could not be withdrawn past the retaining spring collar. I have come across refractors where the lip has come unsoldered, but it is uncommon.



Objective lens mounting:  
 (A) Lens is mounted in a turned horn cell with a retaining ring. The retaining ring is on the front of the lens cell. (Leonardo Semitecolo, Venice, early - mid C18th)  
 (B) Lens is mounted in a turned wood cell with a wood retaining ring that screws into the rear of the cell (unsigned, German, early-mid C18th)  
 (C) Brass cell with an integral dust slide in front. The lens is held in place by a cap with a built-in aperture stop. (unsigned, mid C18th, English)  
 (D) Lenses are sealed together in a brass cell with a spun-over edge. (Dollond, London, c1800)  
 (E) Lenses are mounted in a brass cell with a retaining ring. (Thomas Harris & Son, London, mid C19th.)  
 Ref: Proc. of SPIE Vol. 8129 812909-3 Fig.8

Both simple and achromatic objectives were retained within a cell and either trapped by a retaining ring, or a screwed collar. The achromatic lens designs of the day were either Dollond (the name became a by-word for a refractor at the time) or Clairaut, or more rarely Herschel. Hand held refractors did not have achromatic objectives intended for astronomical observing. Achromatic doublets, and triplets, were air-spaced, typically edge contact, or Littrow style matched inner surfaces. Once edged and centred, the elements would be marked with a 'V' notch to ensure correct rotational and directional alignment. Sometimes the OG and cell were keyed. The OG was notched, and the cell keyed, to maintain 'clocking'.



Objective lens mount for a triplet objective. The lens mount has a key to maintain the lens element orientations. The lenses are notched for the key and for identification. The element dia. 1.811/16". Note the greenish cast of the early crown glass used for the first and third elements.  
(Dollond, London c1840)  
Ref: Proc. of SPIE Vol. 8129 812902-9 Fig.9

Vintage refractors in the aperture range up to 3 inches often have cemented achromatic objectives. Only the exposed outer surfaces are vulnerable.

Both objective and eyepiece eye lens were protected, at first using cover slides, retained with a small peg, later with a dust cap over the objective, and an eye-wink within the eyecup. These have a tendency to go walkabouts, the dust cap especially.

To prevent sunlight shining obliquely into the barrel, refractors were fitted with a retained glare shield, that could be extended over the objective. The earlier sliding OG cover would be screwed into the end of the glare shield. Latterly the glare shield would accommodate the dust cap, or be used as an excuse for not fitting one, so consequently such refractors often have scratched or chipped objectives.

Sometimes a refractor had a leather bound brass barrel instead of wood, or a barrel bound in platted rope. The reason wood, leather or rope, (sometimes Baleen) was used, was to protect the refractor from damage at sea. Marine telescopes tended to be single draw for that reason. Multiple draw refractors cease to function when the brass tubes are badly dented.

I mentioned that the draw retaining spring collars were deliberately designed to permit the drawtubes to be dismantled for cleaning and polishing. This was a task expected of the owner, but in practice neglected. Once the brass is allowed to tarnish and oxidise, it makes the draws very stiff, too stiff sometimes, to withdraw. Brass tubing made in the C18th and most of the C19th is 70-30 brass (actually 68%-32% copper & zinc). When it oxidises it turns red, hence it is commonly referred to as red brass. It also work hardens, so once the draws become stiff, the tubing develops "season cracking". It is not unusual to find a 200 year old refractor with numerous long thin cracks running along the length of each draw, especially the last. The fact of the matter is, these refractors were never designed to be operated in a heavily tarnished state. Antique collectors may blather on about a superb patina lending an aura of old age, but refractors were intended for use, not admiration behind a glass cabinet, and in any case, brass tarnishes to a dull reddish-brown or in the open air a dark greenish-black in a few years, and tarnishes no deeper, so is not indicative of old age, only neglect.

#### UNSIGNED SIMPLE SINGLE DRAW c1740



Single-draw pre-achromatic telescope with a taper fruitwood barrel and a Schyrle erecting system (unsigned c1740, English). The telescope has an barrel length 13&1/4", extended 21". The objective dia. 1".082 stopped down to 0".45.



Each segment of the draw contains one of the three lenses of the Schyrle erecting system. Magnification x8.

### HUSBANDS ACHROMATIC SINGLE DRAW c1870



HUSBANDS 2-INCH TABLE TOP ACHROMATIC c1870



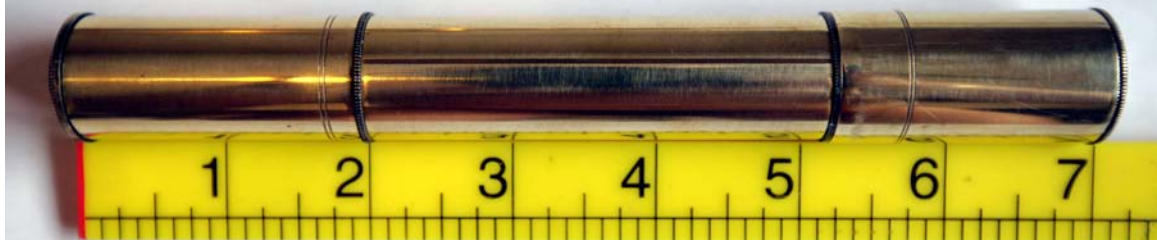
HUSBANDS 2-INCH TABLE TOP ACHROMATIC c1870



Note the greenish caste to the crown bi-convex

HUSBANDS 2-INCH TABLE TOP ACHROMATIC c1870

Schyrle 4-lens eyepiece in three sections - note copper joint along the length of the centre section



### COMPARISON of FRODSHAM & J. LILLEY & GILLIE SINGLE DRAW MARINE



HENRY FRODSHAM c1840 SINGLE DRAW MARINE  
lacquered brass & mahogany taper barrel - achromatic OG

J. LILLEY & GILLIE c1930 SINGLE DRAW MARINE  
blued brass & leather bound taper barrel - achromatic OG



The one thing that stands out in terms of design is how long manufacturing practices were maintained amongst the plethora of scientific instrument makers from the mid C17th thru' mid C20th. Just to illustrate my point, take two single draw marine refractors in my collection. The Henry Frodsham, Liverpool, was made sometime between 1835 & 1845. After 1845 Henry Frodsham signed his telescopes "H. Frodsham", after his brothers Charles & John started trading in London under their own names. The J. Lilley & Gillie dates from the 1930's, and the South Shields firm is still trading. They are remarkably similar in design and construction, if not in appearance.

#### UNSIGNED SINGLE DRAW MARINE



Unsigned single draw marine, taper mahogany barrel, barrel length 26&1/2", extended 45&1/4", Schyrle-Huyghens 4-lens eyepiece, x22.



This single draw marine is unsigned, and dates from the mid C19th. It bears a similarity to the Henry Frodsham c1840. It is the biggest hand held refractor in my collection. The object glass is achromatic, and the erector eyepiece a 4-lens Schyrle-Huyghens. The Huyghenian eyepiece eye lens is fitted within the eyecap. Unlike the Frodsham the drawtube is not split. The brass gauge is also heavy, 0"050 compared to 0".055. The taper tube construction is also similar. Magnification is x22, low for such a large telescope. The exit pupil is 7/64", giving a bright & clear image.

It may be an apprentice piece. To learn the instrument making profession, a boy had to be indentured to a master. The master housed and fed his apprentice, in return for training him. The apprenticeship in theory ran for 7 years. But the apprentice could only get out of his indenture by buying himself out. In order to pay his master the agreed sum (signed at the start), the master would have him make apprentice pieces for sale, identical to the master's instruments, but unsigned. Once the apprentice had earned his master sufficient, he had bought himself out, and was free to set up in business for himself. Except during the Victorian era, it was not easy to set up your own business. The master retained all the tools his apprentice used, and if the newly

freed apprentice could not raise the money to buy them, or find the money to rent suitable premises, or buy raw material &c, then he had no alternative but to become a journeyman employee of the master. Only about 1 in 7 apprentices were taken on after their indenture had been bought out. The masters had the whip hand, and it remained that way until the Great War.

**SIGNALLING & POCKET HAND HELD REFRACTORS**



**OFFICER of the WATCH TELESCOPE**



'Officer of the Watch' telescope, T. Cooke & Sons Ltd., London & York No.2214 c1915. Single-draw air-spaced contact achromatic telescope leather bound barrel and a Pancratic erecting system. The telescope has an barrel length 17 $\frac{3}{8}$ " , extended 24 $\frac{7}{8}$ ". The objective dia. 1 $\frac{1}{4}$ ". Nickel plated brass. Magnification x10.

'Officer of the Watch' telescopes were worn by officers of the Royal Navy as part of their ceremonial dress uniform. Each officer was expected to buy his own telescope, and most marine instrument makers supplied them to a standard design, hence the 'Earl of Sandwich's' arrow, & unique supply identification number. The abraded upper section of the barrel would be where the officer had fastened a platted lanyard.

## PILLAR & CLAW STANDS

Pillar & Claw stands were intended for desk or table top use. Patrick Moore was fond of reiterating that a Pillar & Claw stand was as steady as a blancmange. What he clearly failed to appreciate is that they are entirely unsuited to an astronomical refractor. Pillar & Claw stands were never intended for observing objects at more than about 40° elevation.



Ramsden, late C18th & Matthew Berge, London, early C19th - pillar & claw with pad feet & altitude adjustment. Matthew Berge apprenticed to Jesse Ramsden, his father or uncle, John Berge apprenticed to Peter Dollond.

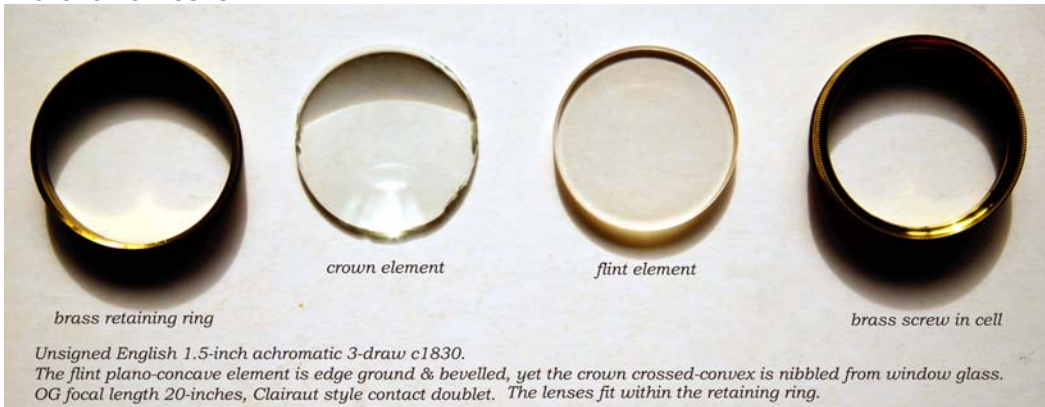
A Pillar & Claw stand is perfectly stable when the cabriolé leg hinge pins are properly tightened up, and the tripod feet are placed on a stable, hard, flat, level surface. If the brass pillar is hollow I add weight by filling it with lead shot. The extra weight lowers the centre of gravity and increases stability.

The cabriolé legs were either made of brass, lacquered to match the pillar and telescope, or iron. The iron work was normally bronzed with a patiniser, but occasionally it was gilded. The style of leg and the taper of the pillar varied with instrument maker, and evolved over 150 years or so from ornate to plain. Likewise the design of the feet. The pillar could be removed from the legs, and fitted to either a field tripod, or if there was a forged coach screw protruding from the base, into a fence post.



Husbands - claw legs - inverted & hinge boss - note centre punch marks used to assemble each leg & hinge pin correctly. Note also traces of lead chromate primer applied before the bronze gilding which had been rubbed off. New brass hinge pins were turned to suit, blackened with Selenium compound, and the cabriolé legs and hinge boss re-primed with lead chromate and gilded dark bronze.

### OBJECT GLASSES



The type of glass used in the objective differed over time too. Mid C18th objectives had lenses made of blown crown with iron contamination; the lens has a greenish hue. Achromatic objectives had water white flint & blown crown elements. After the 1850's English telescope makers bought their crown from Chance Bros. It was also water white. Some achromatics had cemented elements from as early as the mid C19th. This became the norm in the 1920's - 1930's.

### BUYING ANTIQUE & VINTAGE BRASS REFRACTORS

When I started collecting antique refractors in the mid-late 1960's they could be found in junk shops for under a fiver. The most I ever paid was £17. Junk shops became 'antique' shops, and the fancy name for what was in essence the same old junk shop, only with airs and graces, charged more, and pushed up prices, but not

necessarily value. Throughout the 1970's and early 80's the price of antique refractors remained flat, and even fell against inflation, which was then in the region of 20%. Vintage refractors fell in value. This situation changed dramatically in the late 1990's, and the price commanded at auction by the better names, such as Dollond, Ramsden & Adams, are now truly astronomical. Given the current low interest rate on banking investments or bonds, buying antique brass refractors with a view to selling them on in a decade or so, is a sound investment.

So where do you go, and what do you look for? Websites such as 'Fleaglass', and 'Antique & Scientific Instruments' & 'Scientific Collectables', offer fixed prices from private sellers or dealers. Dealers such as Russell, Philips, or local dealers such as Graham Marsh (Tockholes, Darwen, Lancashire), buy, sell & repair antique refractors. Auctioneers such as Bonhams, Philips, Christies, specialise in rare and fine antique refractors, requiring no restoration. The trading site eBayUK offers antique and vintage refractors either by auction, or at a fixed price. The way to make money in the long run, is to bid on refractors requiring some restoration; eBayUK 'Buy it Now' (BIN) listings will rarely provide a return even over ten years. I have followed numerous table top refractors on pillar & claw stands, listed as BIN, which have been rolled over for years, and still not found a buyer.

If you use eBayUK, look at not only <telescopes> or <antique telescopes> but also <scientific instruments> <military memorabilia> & <marine memorabilia>. Draw up a watch list and follow the bidding to get a feel for what certain types of refractor make. This provides a yardstick when bidding, so you are not tempted to overbid. When a choice refractor is listed, check out the fixed price and other auction sites to see what a similar refractor sold for, in order to gauge its worth. An antique refractor is only worth what a buyer is willing to pay, but if you pay too much, you may not get a return on your investment. You need to have a figure in mind when you start bidding. If the bidding goes beyond your guesstimate, let it go, don't be lured into a bidding frenzy.

Just remember, the best return is to be had on unusual listings in obscure places, listed by a seller who hasn't a clue what it is they are selling (yes it does happen!). Add the listing to your watch list and enter a low bid to keep it near or at the top. Decide the most you're prepared to pay, and match rival bidders to the close. Some bidders, especially private collectors, use auto-bidding software to place a high bid at the final second. The way around this is to put in your highest maximum bid in the last minute or so. If the rival bid is less, you win at a nominal increment above the rival bid, rather than your maximum, and if the rival bid exceeds your maximum, well that was the most you were prepared to pay anyway, so forget it, and move onto the next on your watch list.

One final word, please don't be fooled into buying a dreadful Indian replica. They maybe cheap, but if something looks to good to be true it inevitably is too good to be true. They may look like the real thing to the untutored eye, but they're awful; poorly designed, badly made, and most certainly not an investment. If you want a useful guide to authentic firms I can do better than refer you to Webster's Instrument Makers Database.

## CLEANING, RENOVATION & MAINTENANCE of ANTIQUE & VINTAGE BRASS REFRACTORS

Renovating antique and vintage refractors is not difficult. All it takes is a good deal of elbow grease, and some mechanical engineering nous.

The first task is to completely dismantle the telescope. Usually this is simply a matter of unscrewing the objective cell, glare shield and objective cover slide, if it has one; the drawtube retaining collars; withdrawing the drawtubes; unscrewing the erector and eyepiece tubes, and then unscrewing the lens cells. It is important to make a note of which lens cell screws into which end of which tube; a sketch proves invaluable. I make notes of the lens focal lengths and separations when a distant image is in sharp focus; the type of erector, i.e. whether it is a Schyrlean or Pancratic, and use the figures to calculate the power. A fob watch spherometer is a handy tool for determining lens focal lengths, otherwise project an image onto a white card on a sunny day, and measure the distance using a rule. Drawtubes and erector & eyepiece tubes &/or cells sometimes have jobber's marks scratched into them, that aid re-assembly.

Occasionally a cell or a collar is jammed. A handy pair of tools to try to force it to turn is either a jar lid opener, or a tape pipe wrench. If a spring retaining collar won't budge, soak the drawtube and it in paraffin overnight and try again. If it is still jammed try applying a modicum of local heat with a blow lamp, but don't get it too hot or the soldered flange on the spring retaining collar may come apart. Plunging the hot collar end into cold water is usually enough to make the thread unlock.

Sometimes threads are crossed. Nothing else for it but to force them apart and run a chaser down each thread to get rid of the burrs. Use a little #5 block grease applied to each thread when reassembling. The way to avoid crossing threads on reassembly is to turn the threaded part backwards (anticlockwise), keeping the gap even all round, until you feel a click where the thread starts. You can now turn it clockwise and if the thread hasn't crossed, there ought to be little resistance.

If the objective or any of the erector or eyepiece cells are jammed, you need to exercise care if using a lid opener. Sometimes it is best to leave well alone and work around the problem. Lenses usually require cleaning, but you don't necessarily have to unscrew the cell to gain access to either side. Lenses should be cleaned with a proprietary liquid lens cleaner, applied with a soft tissue or chamois cloth. Don't apply the liquid to the lens. Brush dust and dirt off first, and then apply the liquid to the tissue of cloth, and polish the lens that way. The objective can usually be removed from its cell for cleaning. Make a note of any edge marks, and ensure you note which way the elements face. Erector and eyepiece lenses tend to be spun into their respective cells, so cannot be removed. If a lens is loose within its spun cell, run around the lip with a polished round bar to peen it back over.

Once you have the refractor completely dismantled, you need to set about removing the tarnish and/or oxidation from the brass work. For this you need a set of emery paper grades from 240 thru' 2500. 'Axminster Tools' is a handy supplier of A4 emery paper packs, as is 'Alec Tiranti', 'Joseph Cornelian', and 'Meadows and Passmore'. You also need a Brasso rag, an old heavy dish cloth is most suitable, a buffing rag, and a polishing cloth. Also 'PreLim' brass polish and 'Renaissance Wax'. Polishing tools comprise a piece of old kitchen worktop, veneered on one side only, wooden dowels ranging from 1/8" thru' 1/2" diameter, emery impregnated buffing blocks, Selenium black copper & Haematite iron patinator, Shellac lacquer in various shades of yellow ranging from pale yellow through gold to deep bronze, lacquer brushes, Shellac varnish, fine steel wool, and Duraglit.

Drawtubes are polished using each grade of emery paper, dry, starting with 240 if the oxidation is heavy, or 400 if light. Each grade is used for as long as it takes to polish out the sleeks from the previous grade. I always use

whole A4 sheets (or A5), and rub along the length of the tubes. The grades run from 240; 400; 600; 800; 1000; 1200; 1500; 2000; 2500. By the time you get to 2500 grade your hands will be green, and the brass tube polished to a mirror finish. The tube is then polished against a flat cloth on the old piece of kitchen worktop, rough side up. Lay the cloth on the board flat down and pour on a little Brasso. Rub the tube over the polishing cloth holding it at either end, moving the tube to and fro at right angles to its length, steadily rotating it until you have completed three rotations. Move the tube to an area of the cloth that has no Brasso on it, to clean off the black residue, using the same motion. Then buff the tube longitudinally with the buffing rag. At this stage the tube should look pristine, without a sleek or a blemish, other than the odd dent. Next use a paper towel to apply PreLim, rubbing up and down the length of the tube. Buff off with a clean sheet of paper towel, and then rub down with Renaissance Wax.

The spring retaining collars need to have their flange faces and knurling buffed up and polished. Don't try to polish the springs or the screw threads.

The OG cell may require buffing. I use a kebab stick wrapped with a strip of emery paper to get into the profiling, and then finish off on the Brasso cloth using the edge of the board as a guide. Same applies to the eyecap.

The dustcap, or cover slide, spring collars, and eyecap need relacquering. Wash these polished parts in warm soapy water, and then thoroughly dry off using kitchen towel, and then place in a tepid oven on a baking tray to drive off any moisture. The lacquer has to be applied with a suitable brush, either Squirrel, Zorino, or Camel hair, so as not to leave brush marks. You only get one shot at this, so practice on a plain polished sheet first. The trick is not to go over what you've already painted, because the shade deepens where you do so. If you balls up, which if it's the first time is very likely, wash off the lacquer with Methylated spirit, dry in a tepid oven, and have another go. The easier alternative is to use nitro-cellulose lacquer, coloured with Irgalite dyes. Irgalite is a photo-stable dye.



Five shades of Irgalite dyed nitro-cellulose spray lacquers.

The shade you require depends on the age of the refractor. Mid C18th thru' late C18th refractors have a deep gold almost orange lacquer because of the red brass used. Early to mid C19th have a mid gold lacquer, and late C19th thru' early C20th a pale lemon yellow lacquer, because of the switch to Muntz brass, 60-40 composition.

Larger terrestrial or astronomical refractors usually have brass barrels, sometimes bearing the maker's signature. You have to do your best to avoid abrading the signature. This can prove a problem if the barrel has pitting corrosion. One of the principal causes of pitting corrosion is dew contaminated by nitrous, sulphurous or carbonic acid. The tell tale sign is pitting on the uppermost side of the tube, and little or none underneath. Soot or dirt particles on the tube act as nucleation points for condensates. The weak acid acts as an electrolyte producing galvanic action between the face centred cubic zinc and copper crystals in the brass alloy. The localised area becomes anodic, and the surrounding area cathodic. Zinc and the copper ions react at different

rates, producing either copper carbonate, sulphate or nitrate, around the nucleation point (examination of a pit with an eye loupe in a bright light will reveal the acid responsible; copper carbonate is greenish, copper sulphate bluish, and copper nitrate dark brown). Pitting is the most insidious type of corrosion, and dealing with it is problematic. Whichever renovation method you choose, none is ideal. If you are able, better to ignore it, and prevent further pitting by keeping the tube protected with Renaissance Wax.

Sometimes the pitting corrosion has only effected the lacquer coating and the outermost brass surface, being so shallow that vigorous buffing with a Brasso soaked paper towel will polish off both the lacquer and the black pits. It doesn't take long to discover if the corrosion is deeper. Count yourself fortunate if this is all it takes.

If the pitting is fairly shallow a technique I use is to clean the tube external surface with white spirit or turpentine substitute to remove any grease. I then bath the external surface in hot soapy water, and dry it thoroughly, taking care not to get water inside the tube. The signature is then covered with gaffer tape, and the usual polishing process gone through, until a mirror finish, free of sleeks, is obtained. The gaffer tape is then removed, and local retouching applied to each of the remaining pits. This is a tedious, protracted process, but well worth it. Be prepared to spend days re-polishing. Start with a fairly fine grade, such as 600 or 800. Finish with PreLim (use Brasso if you must but rinse afterwards). Treating the restored surface with Renaissance Wax, applied monthly, prevents further pitting corrosion.

Deep pitting has to be left because resurfacing would remove too much material. It is better to treat each pit with a weak alkali solution such as diluted bleach, applied with a cotton bud, and rinsing in warm water afterwards. If you try to polish the pits out all you will succeed in doing is emphasising them. Finish with PreLim and protect from further corrosion with Renaissance Wax.

There is another technique, but it involves re-lacquering the barrel, and you will need a nitro-cellulose spray lacquer, of a deeper gold shade than the original in all likelihood. Each pit is polished locally using fine emery paper tightly wrapped around a wooden skewer, then Brasso, followed by a rinse and dry. The brass is then degreased using white spirit, and left to air dry in a warm dry room, prior to spraying. The lacquer tends to fill up the pits, making them slightly less obvious.

Season cracking of alpha brass results from exposure to ammonia. This typically occurs in a rural environment where ammonium nitrate fertilizer is spread on surrounding fields. It is associated with stressed or work hardened brass, in this case hydraulically or mechanically drawn tube, or hammered and rolled seam soldered tube. Annealed red & cartridge brasses tend not to be effected by season cracking.

Brasso along with most commercial brass polishing liquids contains ammonia in solution (Ammonium Hydroxide). It is maintained by conservators that ammonia produces micro-crystalline cracking. Personally I have yet to see any such phenomenon. The secret is to remove all residues, which is why it is better to strip the telescope down to its component parts if feasible. Rinsing the brass in warm soapy water also neutralises the surface. The only reason brass cracks in the presence of ammonia is because it is stressed, and unless the telescope has been seriously damaged, there ought to be no internal strains. Red brass tubing is annealed at manufacture, and is strain free. [see footnote]

**EXAMPLES OF BEFORE & AFTER CLEANING & RENOVATION - see part 2**