# Comparisons

## Ocular Focusers

**Comparison Photographs of Ocular Focusers**
**for the Newtonian Reflectors within the WOLF TELESCOPES Collection**


**Hinged lid case**
**FRE1 SECRETAN, c. 1890**

**Sliding lid case**
**TRE16 FoucaultSECRETAN, c. 1858**

**No lid case**
**TRE17 SECRETAN, 1866**

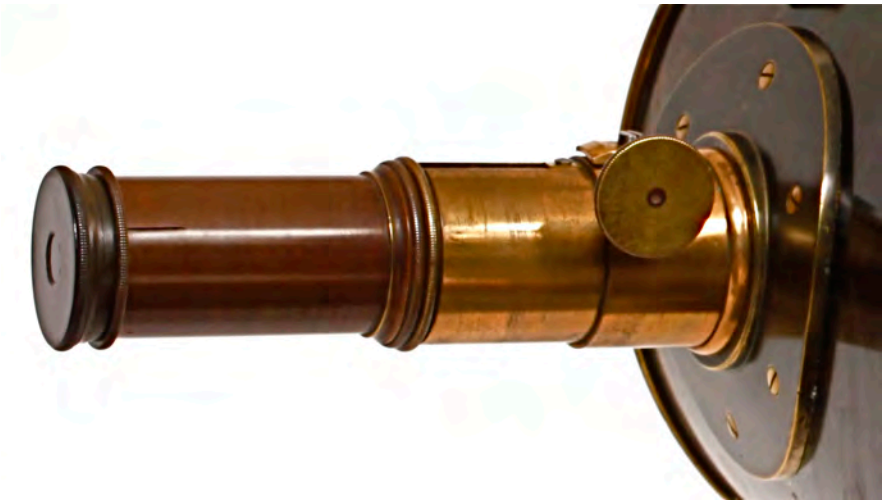
## Comparison Photographs of Oculars & Focusers
## for the Newtonian Reflectors within the WOLF TELESCOPES Collection

### TRE17 SECRETAN, 1866

**Ocular Case with No Lid**

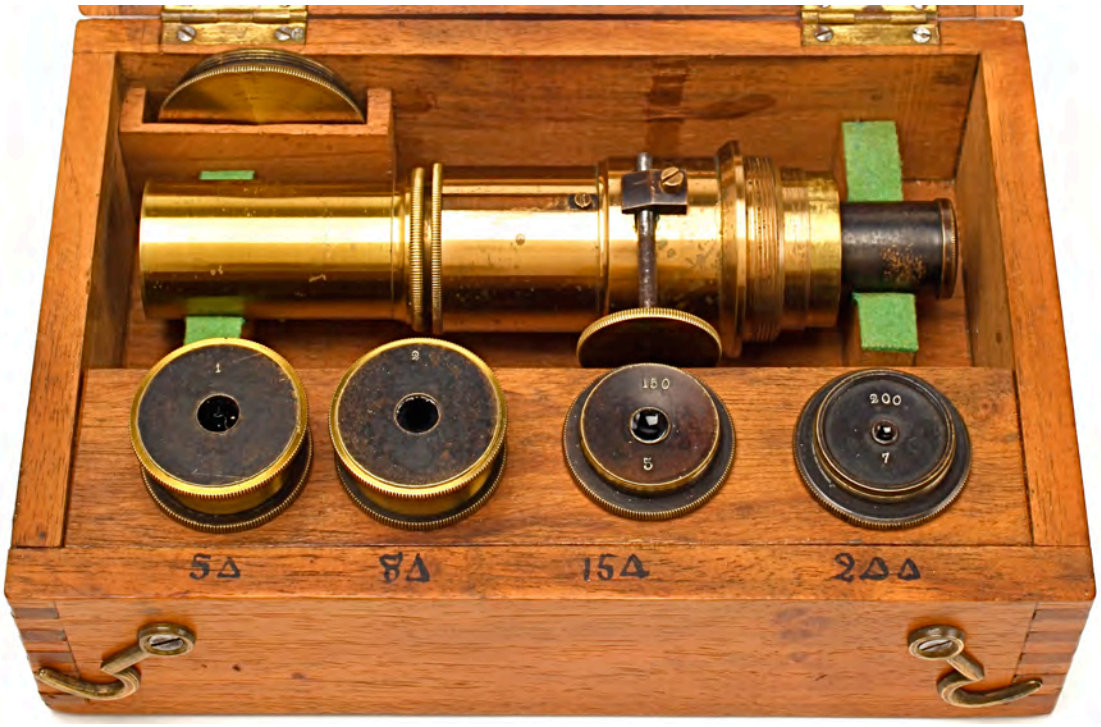
**There are 5 eyepiece lenses, 3 solar filters, and an ocular port cover.**

**Magnification is changed by changing the eyepiece.**



## Comparison Photographs of Oculars & Focusers
## for the Newtonian Reflectors within the WOLF TELESCOPES Collection

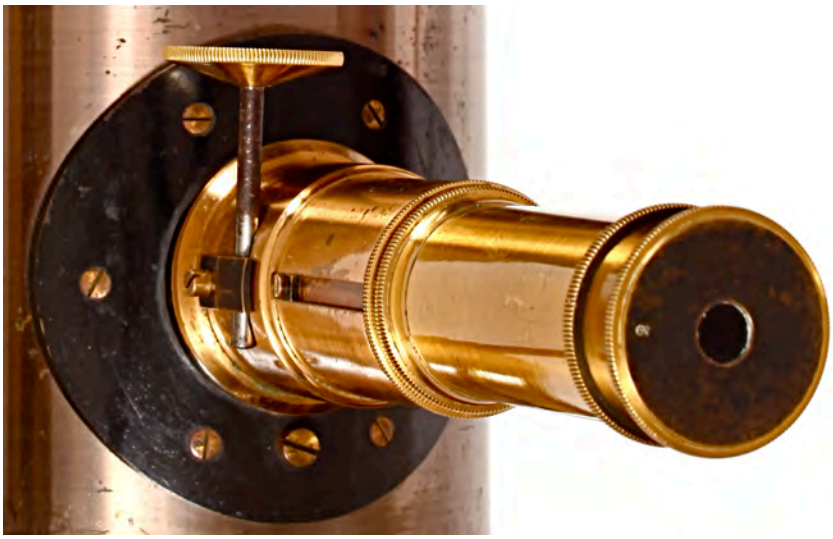
### FRE1 SECRETAN, c. 1890




**Ocular Case with Hinged Lid**

**There are 4 eyepiece lenses (one eyepiece is missing a L3 lens),
2 solar filters, and an ocular port cover.**

**Magnification is changed by changing the eyepiece.**



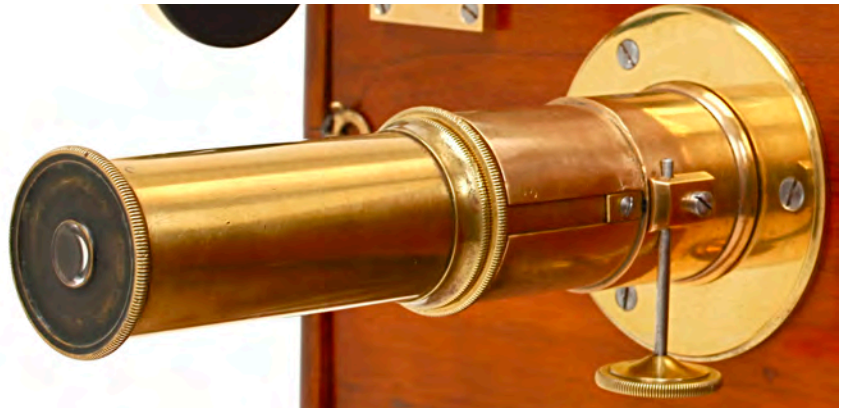
## Comparison Photographs of Oculars & Focusers
## for the Newtonian Reflectors within the WOLF TELESCOPES Collection

**TRE16 FoucaultSECRETAN, c. 1858**

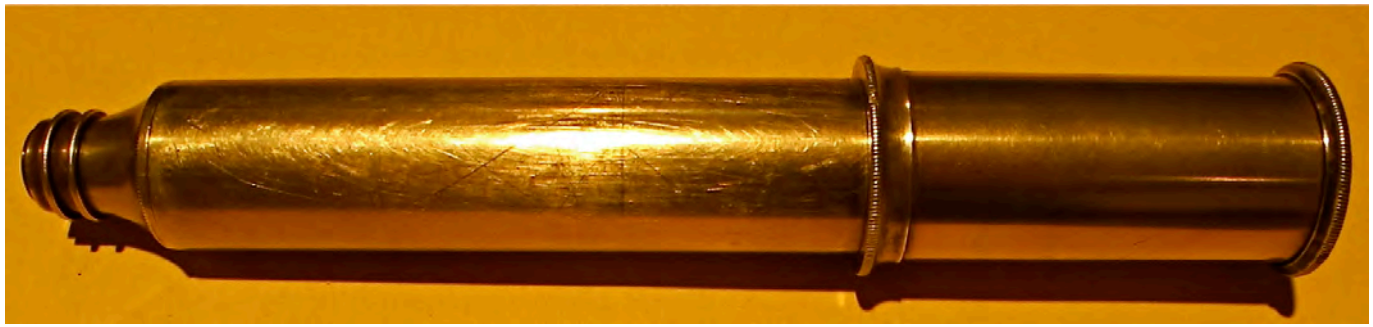
**Ocular Case with Sliding Lid**

**There are 2 microscope-type objectives; one mounted on the conical nosepiece of the ocular, and one stored in the slot just in front of the ocular on the left. There is only one eyepiece. The long brass rod holds the telescope to the telescope base. The fixture in lower left hand corner is a fine screw-adjustor for changing the altitude of the telescope.**

**Magnification is changed by changing the objective.**



## Ocular for Wolf Telescopes TRE16 FoucaultSECRETAN Newtonian Reflecting Telescope, c. 1858



Photograph of Ocular is sized to be 1:1 when displayed or printed at 11x8.5.

N1 N2 (<----nosepiece lenses) (eyepiece lenses and aperture---->) L3 A1 L4

Above: Lens dimensions and separations are not illustrated to scale nor proper proportions. Orientation & approximate locations for the (all) plano convex lenses are as shown.

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Below: Spacing information is believed to be accurate to precision indicated. Errors for lens dimensions estimated to be ≠ 0.5mm. Errors for large spacing and focal lengths estimated to be ≠ 1mm. Air gap estimated error ≠ 0.2mm

A1, Aperture diam. = 12.5mm

|<>| 3.8mm

|<---26.5mm--->|

|<----------134.4mm----------->|<----------40.6mm--------->|

|<----------175.0mm----------->|

| N1 | N2 | | L3 | L4 |
|---|---|---|---|---|
| DN1 = 9.0mm (7.80) | DN2 = 9.0mm (7.75mm) | <---- (brass cell aperture) | DL3 = 21.0mm | DL4 = 9.4mm |
| TN1 = 2.27mm | TN2 = 2.78mm | | TL3 = 2.40mm | TL4 = 1.77mm |
| FN1 = 21mm | FN2 = 32mm | | FL3 = 41mm | FL4 = 21mm |

FN1N2 = FN2N1 =13.3mm
N1 N2 air gap = 1.95mm
N2 N1 air gap = 0.70mm

D = Diameter; T = Thickness; F = Focal distance

# Optical Ray Traces for the Field Limits of TRE16 Ocular

**Ray traces by Dr. William Tobin, Vannes, France, using PostScript programming. He assumes 1) thin lenses, 2) uses the simple lens equation (1/u + 1/v = 1/f), 3) non-deviation of the ray through the optical centre to set positions of object and image, and 4) ignores aberrations. So the results are only approximate with no information concerning aberrations.**

**The attached plots (Fig.1 & Fig.2) show two bundles of 3 rays for what he has determined to be the approximate limits of the field. The stop A1 limits the field to a diameter of 1.9 mm in the entry focal plane of the microscope assembly. (See Fig.1) With the mirror 533 mm away that corresponds to a 0.20 deg diameter FoV on the sky, translated to a 29.2 deg diameter FoV in the eyepiece and a magnification of 143.**

**The aperture A1 is far from its optimum field-limiting location where the rays cross near L4, but what the ray trace shows is how narrow the bundle is. So really, it is not very important where the stop is placed, and the edge of the field will be quite sharp even though A1 is removed from the optimal point. Presumably, there is better suppression of stray light, internal reflections etc. with A1 where it is. There's good eye-relief. The exit pupil is very small, hardly more than a millimetre in radius, which makes things like floaters in the eye very apparent. Opening up the beam to about f/3, such as might have been encountered if the whole assembly had been designed for use in a microscope, and looking at what the optics would allow if A1 was removed, does not make the exit pupil enormously bigger (see Fig.2).**

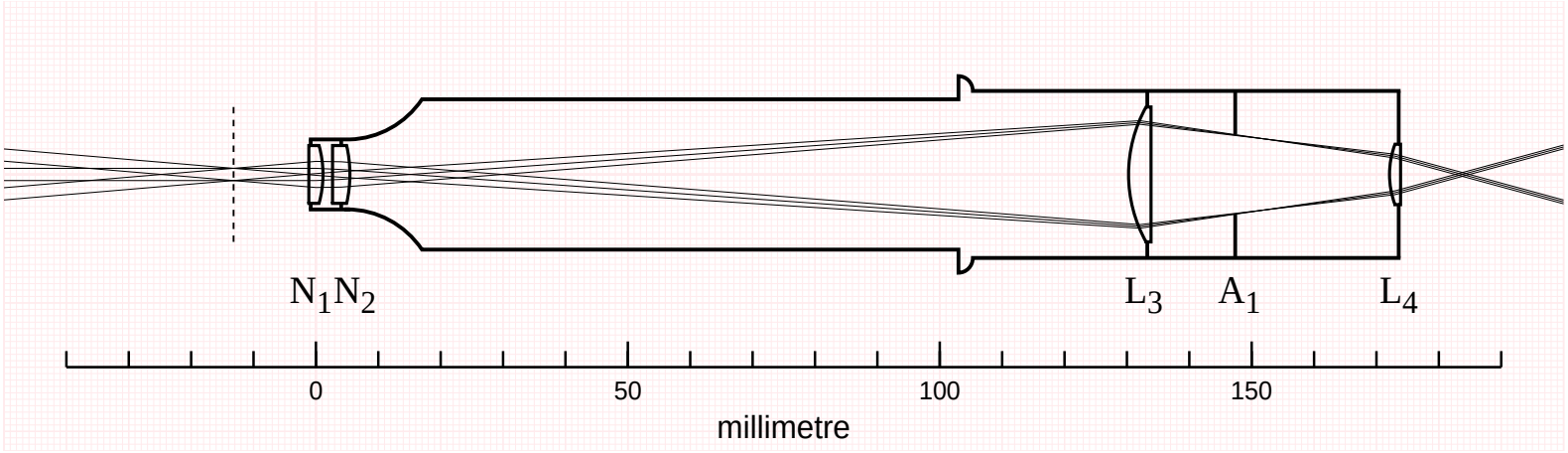



**Fig. 1**

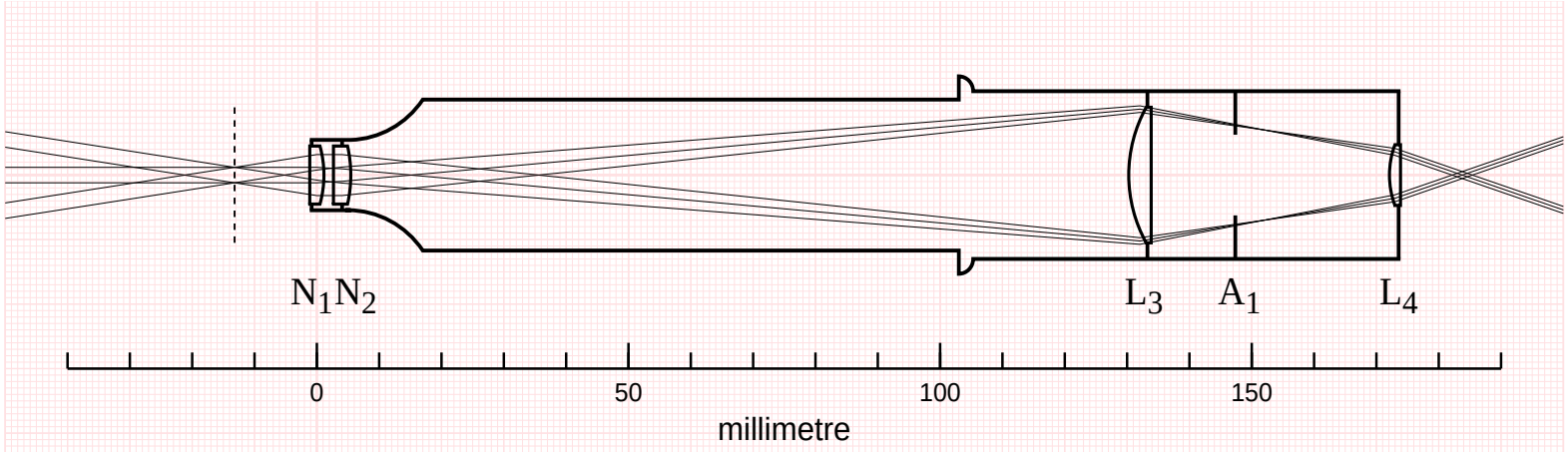



**Fig. 2**

**The TRE16 ocular is believed to be based on the Lerebours et Secretan microscope at the time of the Leon Foucault and Marc Secretan collaborations, which produced the first Newtonian reflecting telescopes employing silvered glass mirrors.**

**With 2 objectives, N1 and N2 there are 4 combinations possible: N1, N2, N1N2, and N2N1**

**N2N1 Objective** **N1 Objective** **N2 and/or N1 nosepiece**

*The author believe TRE16 was originally equipped with three(stacked) objectives N1, N2, and N3, thereby providing 18 different combinations with magnifications from approximately 25 to 480x (see the 1850 Secretan offering below for similar, but earlier microscope objectives).*

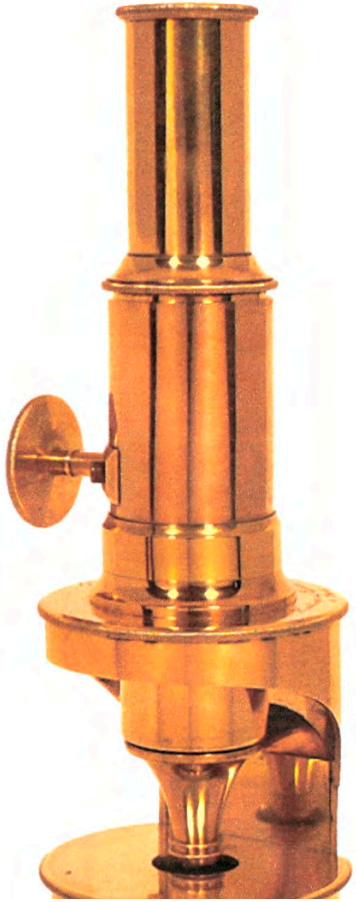
**1850 Microscope "achromatique simplifié" de N.-P. Lerebours**

Les objectifs sont numérotés 1, 2 et 3. Le plus faible est susceptible d'être monté sur le cône intérieur ou sur le cône extérieur, les deux autres ne devant être montés que sur le cône extérieur. Dans la troisième édition de son livre, "INSTRUCTION PRATIQUE SUR LES MICROSCOPES", Noël-Paymal LEREBOURS justifie, par la présence d'un oculaire "faible" et d'un oculaire "fort" accompagnant les trois objectifs et les deux cônes, 18 amplifications allant de 25 à 480 fois. ***Photo credit: http://www.lecompendium.com***

**The TRE16 ocular is believed to be based on the Lerebours et Secretan microscope at the time of the Leon Foucault and Marc Secretan collaborations, which produced the first Newtonian reflecting telescopes employing silvered glass mirrors.**

**Similarities of TRE16 Ocular with Secretan Microscopes**

**Wolf TRE16 FoucaultSECRETAN Ocular**
**c. 1858**



**1850 Lerebours et Secretan Microscope**
*Photo credit: http://www.lecompendium.com*

**Similarities of TRE16 Nose Piece with Secretan Microscopes (with stacked objectives)**

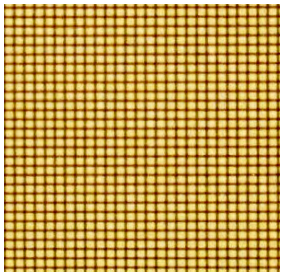
**Wolf TRE16 FoucaultSECRETAN Nose Piece**
**c. 1858**

**Secretan Solar Microscope, c. 1865**
*Photo credit: http://www.antique-microscopes.com*

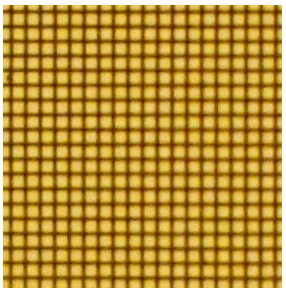
## Relative Magnifications of TRE16, TRE17, and FRE1 Ocular Assemblies

**TRE17 and FRE1 are essentially parfocal (PF) while TRE16 is not.**
**Photographed in transmitted yellow light. Magnification is calculated using the specimen image, which is a tungsten 1000-mesh; grid lines are on 25.4 ! m centers, a built-in resolution standard.**

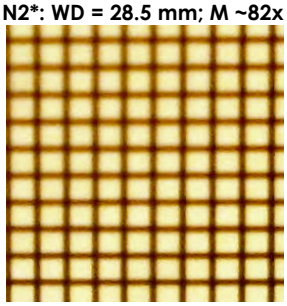
**TRE16: WD@ variable (~3x)**
**Eyepieces not labeled**



**N1*: WD = 46.0 mm; M ~54x**



**N2*: WD = 28.5 mm; M ~82x**



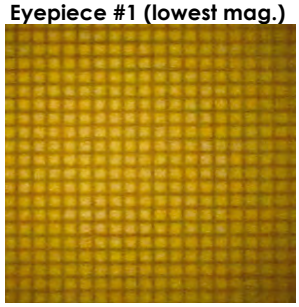
**N1N2*: WD = 14.0 mm; M ~152x**

@ WD = working dist. all oculars Dist. of specimen to 1st lens.
* Objectives designation by author. it is believed that one nosepiece "objective", N3, was lost in the past.

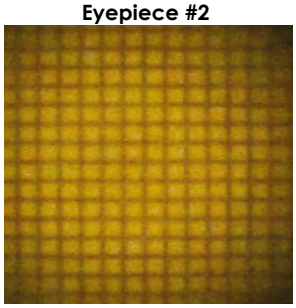
1) The camera "sees" a different light-cone angle from each eyepiece, thereby creating different image field sizes.
2) All photos were processed in the same manner. Care was taken to crop all images in the same proportions to retain accurate relative magnifications for each of the objectives (TRE16) and eyepieces (TRE17 and FRE1) as well inter-ocular photos.

**TRE17: WD (~PF) = ~ 9.0 mm**
**Eyepieces not labeled**

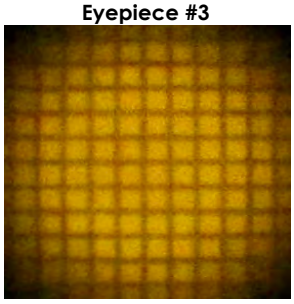
**Eyepiece #1 (lowest mag.)**



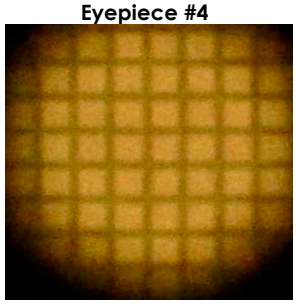
**Eyepiece #2**



**Eyepiece #3**

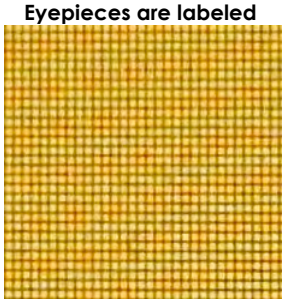


**Eyepiece #4**



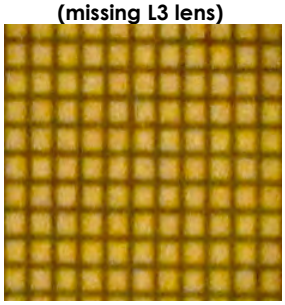
**Eyepiece #5 (highest mag.)**

**FRE1: WD (~PF) = ~ 5 mm**
**Eyepieces are labeled**

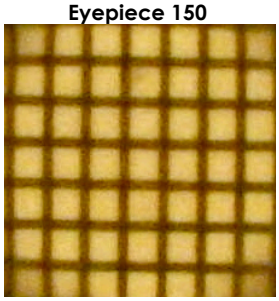


**Eyepiece 50 M~46x**

**Eyepiece 80**
**(missing L3 lens)**



**Eyepiece 150**



**Eyepiece 200 M ~205x**

**Improvised Test Platform for measuring the Optical Performance of TRE16, TRE17, and FRE1 Oculars.**

**Microscope tripod base and rack-and-pinion focus system-J. Parkes and Son, Birmingham, c. 1850, Left photo shows the TRE16 ocular mounted on the microscope frame with a mm-ruler mounted on the specimen holder. Right photo shows a 1000-mesh tungsten grid held taunt by a mounting ring, which is taped at the edges to a microscope slide. Grid was backlighted by reflecting light off the yellow paper. Therefore, the photos shown on previous page were all backlighted or shadow images with a yellow background.**

**Note: there is ~ 30% pancratic gain in magnification when the eyepiece (L3L4) is retracted to its maximum. The blue arrow represents this variable magnification adjustment.**