Introduction

This document is a version of a conservation condition and treatment report, written
By Tim Hughes in 2013 as part of a West Dean College professional development project, abridged in 2023 for publication in Antiquarian Horology, the journal of the Antiquarian Horological Society.

A refracting telescope on a universal equatorial mount c.1741, signed *Hindley York*

T M Hughes and Matthew Read

Object Reference	BCF56, Burton Constable Foundation, East Yorkshire
Date Received	8th January 2013
Conservators	Tim Hughes, Matthew Read
Date Examined	8th January 2013

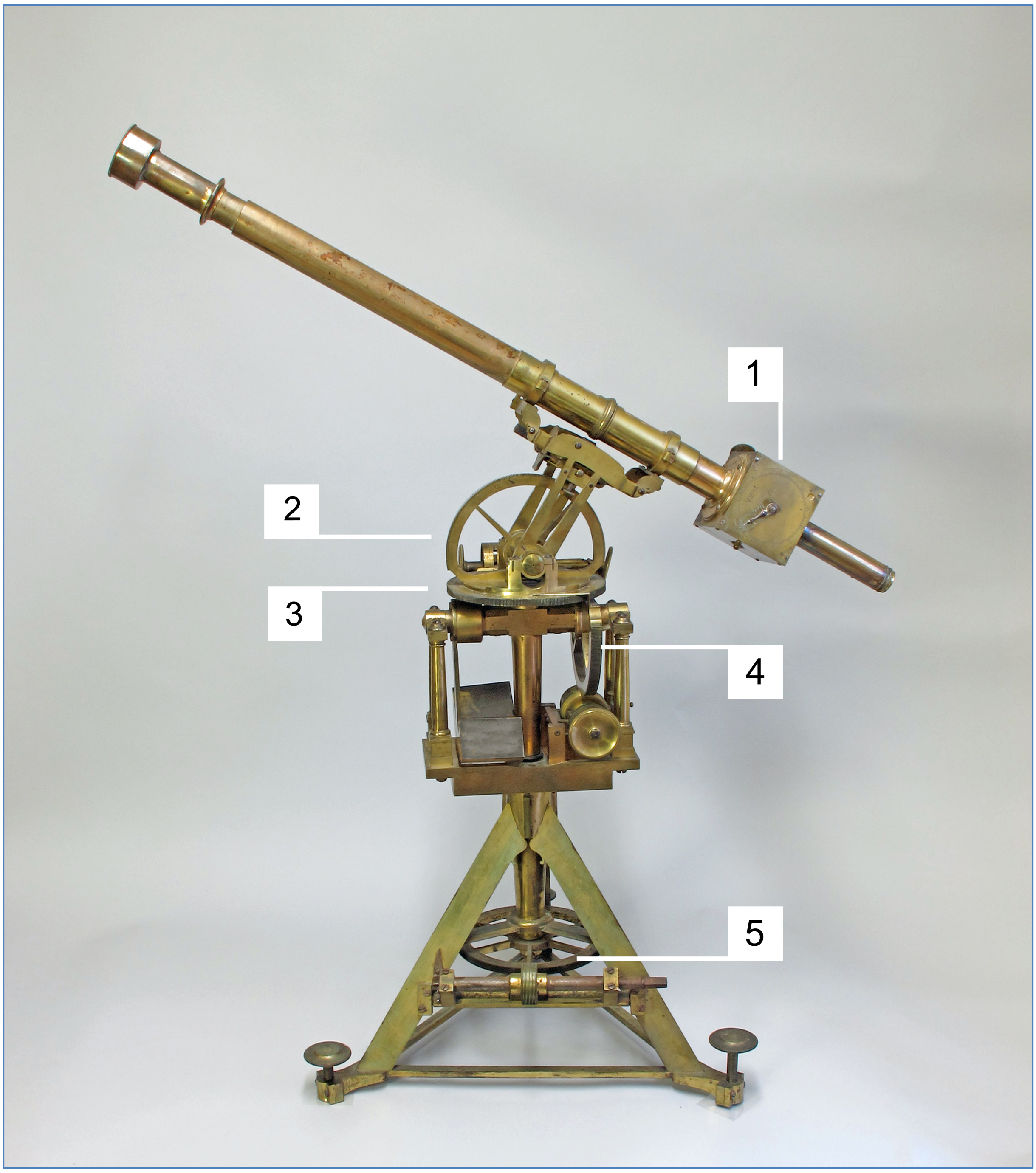

fig. 1 The telescope before treatment

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1	Micrometer box
2	Declination circle
3	Equatorial circle
4	Meridian circle
5	Setting circle

Contents

Description of the Instrument 3
Appraisal of the condition and proposed treatment 17
Description of the treatment 22
Observations 30

Appendix 1 Train count 35

Description of the instrument

Overall

The instrument comprises a brass refracting telescope tube with micrometer box on a brass universal equatorial mount with tripod base *(fig.1). The mount comprising an upper, declination circle over an equatorial circle above a meridian circle. The whole rotating about a vertical axis by a setting circle mounted between the tripod legs. The relative positioning of all four circles is via ground worm wheels engaging worm gears cut into the edges of the wheels. All the worm units are set in pivoted sprung frames that can be latched out of engagement for rapid setting.*

Object body

The 825mm long brass-bodied refracting telescope has a micrometer box towards the eyepiece end *(fig. 2)*. The telescope optics comprises four lenses, three of which are placed before the micrometer box.

fig. 2 The telescope tube with micrometer box. Overall length approximately 825mm.

Objective lens

The doublet objective lens is 46 mm diameter *(fig. 3)*.

Focusing is achieved by turning a wheel on the micrometer box.

fig. 3 Objective lens and dewshade

Eyepiece

The eyepiece has a sliding dust cover and the objective end has a dew shade and a push fit dust cover *(figs. 3 & 4)*.

fig. 4 Eyepiece assembly

Micrometer box

The cuboid micrometer box is approximately 80mm across flats with two winding wheels, one for focusing the telescope set on one of the box edges *(fig. 5)* and the other set in the centre of the face opposite the engraved scale for indexing the four reticle frames within the box. This wheel is geared to a blued steel indicator hand on one face of the box *(fig. 7)*, with an engraved graduated scale signed across the centre *Hindley YORK.*

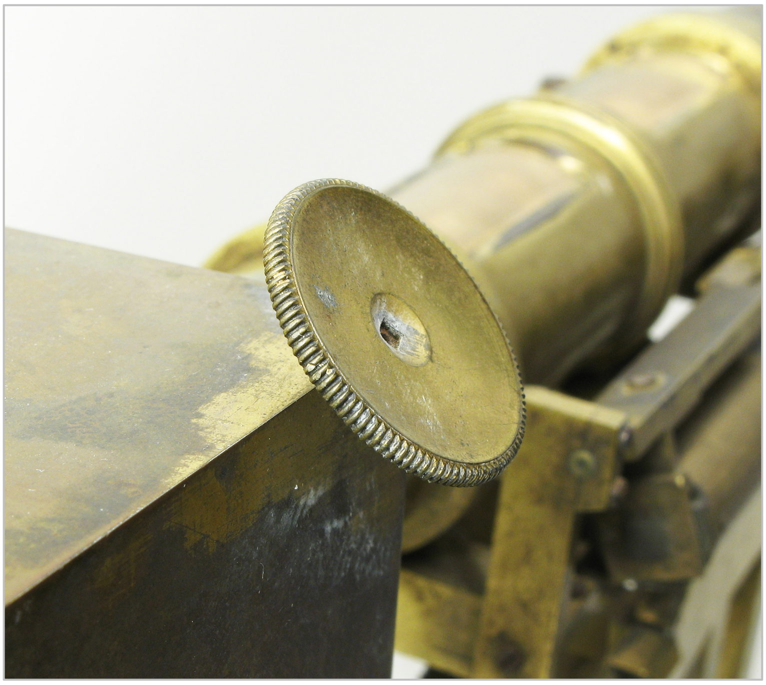

fig. 5 The micrometer box setting knob for focussing the instrument.

fig. 6 Indexing mechanism

The micrometer box scale is engraved from zero to 120 in increments of ten. A bevelled square aperture to one corner of the dial with a revolution counter graduated from 0 to 12, which indexes once for every full revolution of the hand *(fig. 7)*.

fig. 7 Micrometer box with engraved scale and signature

Within the box are four, 70mm diameter intermeshing contrate wheels. Each wheel is mounted on captive steel threaded arbor. When the wheels are rotated via the external setting knob, four brass reticle frames are drawn in and out *(fig. 8)*. The reticle wires measure approximately one tenth of a millimetre (0.1mm) in thickness and form a square in the field of the view in order to embrace the object being observed *(fig. 9)*. Stop work connected to one contrate wheel to ensures travel of the frames is restricted at both ends of their range *(fig. 10)*.

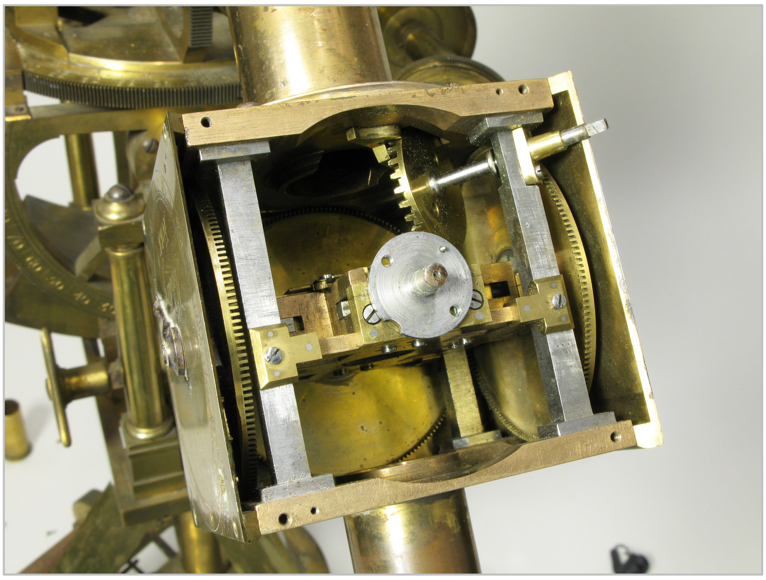

fig. 8 Micrometer box with cover plates removed

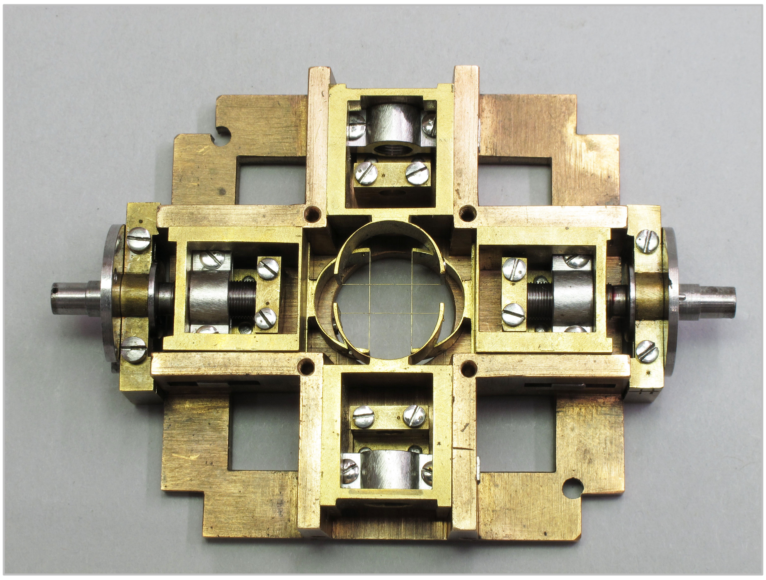

fig. 9 Reticle frame

fig.10 Stopwork comprising a wheel with two uncut tooth gaps and a friction spring.

Telescope mount including frame, worm gear and declination circle

The telescope is mounted in an open brass frame and retained by two split clamps allowing the telescope to be rotated about its longitudinal axis. The mounting frame incorporates a pivoted spirit bubble *(fig. 11)*.

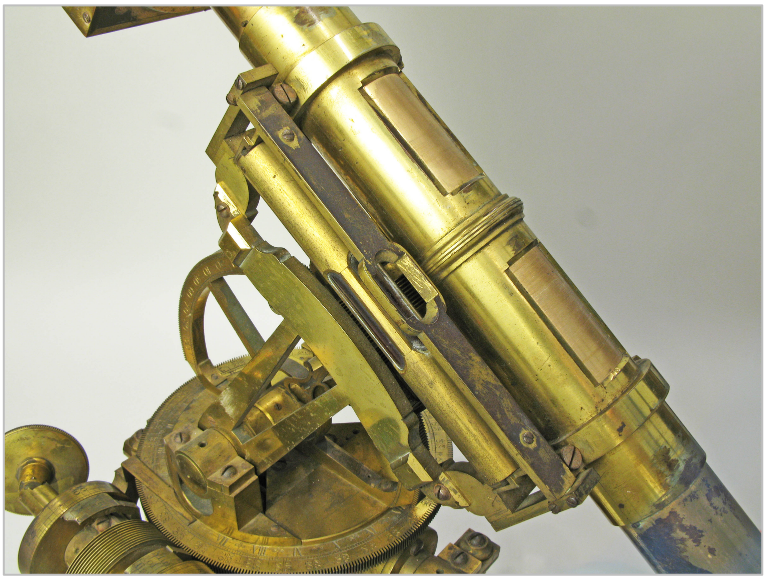

fig. 11 Telescope tube within the frame clamp with spirit bubble.

The frame with telescope tube and bubble pivots around the central axis of the declination circle. The circle has 181 teeth and is engraved plus and minus 90 degrees from the horizontal. The corresponding worm gear is single start and of 10 turns. Rotation of the worm is indicated on an engraved scale, 0 to 60 in increments of ten *(fig. 12)*.

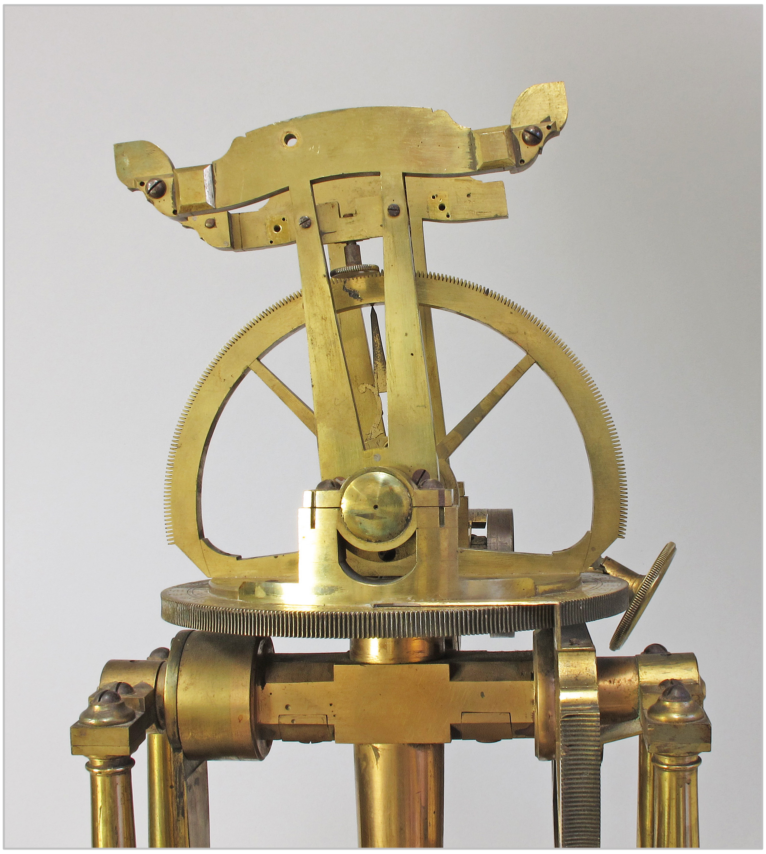

fig. 12 the telescope mounting frame pivots around the axis of the declination circle.

Equatorial circle and worm

The declination axis is mounted to the upper surface of the equatorial circle. The equatorial circle has 360 teeth and is engraved on the upper face in degrees and in hours of arc. The engraving comprises concentric rings and radial lines. Degrees are marked towards the inside. Hours are marked 1 to 12 twice in Roman numerals, 12 o'clock corresponds with the 360 and 180 degree marks. Half hours have fleur-de-lis markers at the end of the radial lines and quarter hours are marked by plain radial lines. See *figure 13*.

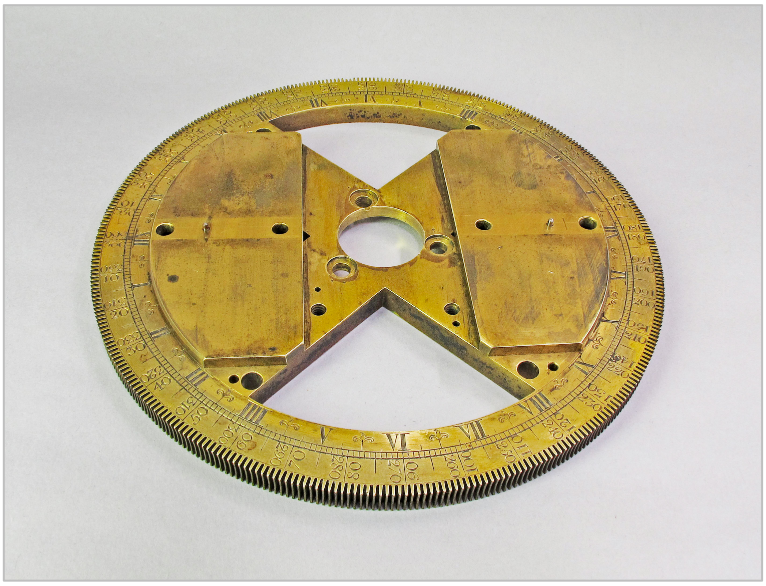

fig. 13 Equatorial Circle

The equatorial worm is single start of twelve turns. The worm is flanked by graduated scales, both having increments of 20, 40 and 60; the left dial is graduated in minutes and degrees of arc and the right for minutes of time. See *figure. 14*.

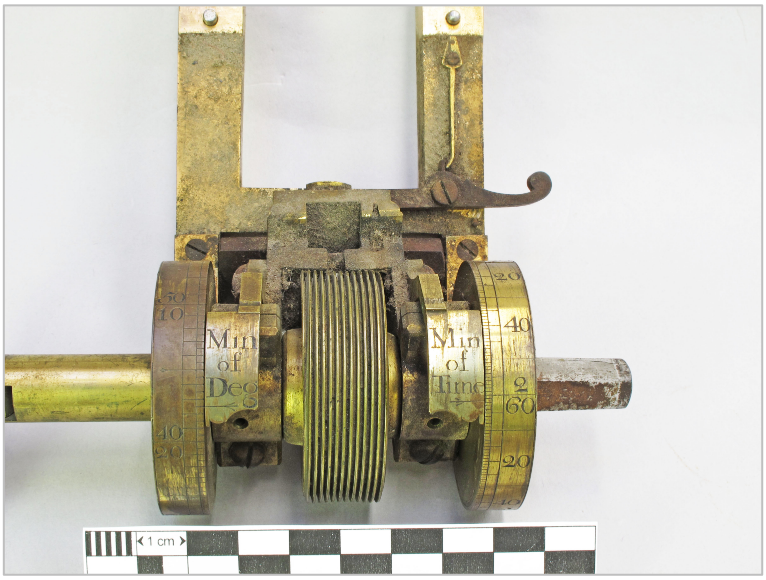

fig.14 Equatorial Worm and scale indicating minutes of degrees and minutes of time

The equatorial circle is mounted onto a steel spigot, which is 190mm in length and tapering from 25mm to 21mm, rotating within a matching brass tapered tube which is part of the large cast brass frame supporting all of the above *(fig. 15)*.

Fig.15 The equatorial Circle is mounted on tapered steel spigot. Seen here with the declination circle

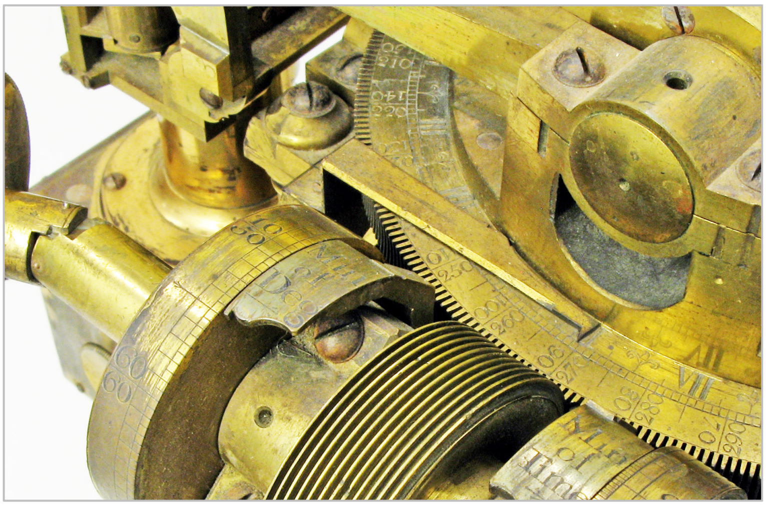

fig.16 Equatorial circle degree readings are taken from brass pointers mounted on the meridian circle and equatorial circle worm mounts

Meridian Circle and Counterpoise Weight

Below the equatorial circle is a pivoted mount, the axis for the meridian circle and counter-weight *(fig. 17)*.

The meridian circle has 194 teeth and is engraved plus and minus 90 degrees, indicated by a brass pointer mounted to the frame.

The brass cased lead weight is segment shaped and weighs 3.62kg, or approximately 8lbs *(fig. 18)*.

Fig. 17 Meridian circle and counter-weight

fig. 18

The pivoted meridian circle arbor is mounted between four tapering brass columns, which in turn are fixed to a cast brass chassis *(fig. 19)*, to which the meridian worm screw is mounted. The screw has 12 turns and a dial reading zero to 60 in increments of ten. This chassis has a tapering spigot made of brass, at the bottom of which the setting circle is mounted *(fig. 20)*. The spigot rotates within a tapered brass tube which forms part of the tripod frame *(fig. 21)*.

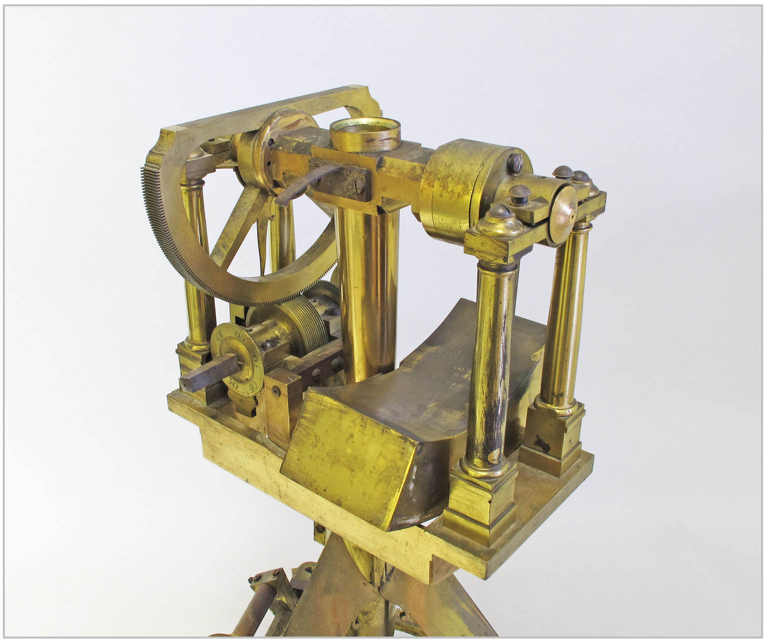

fig. 19 Meridian axis in its bearings

fig. 20 Setting circle spigot and support for the telescope. Enables the instrument to be rotated in the horizontal plane

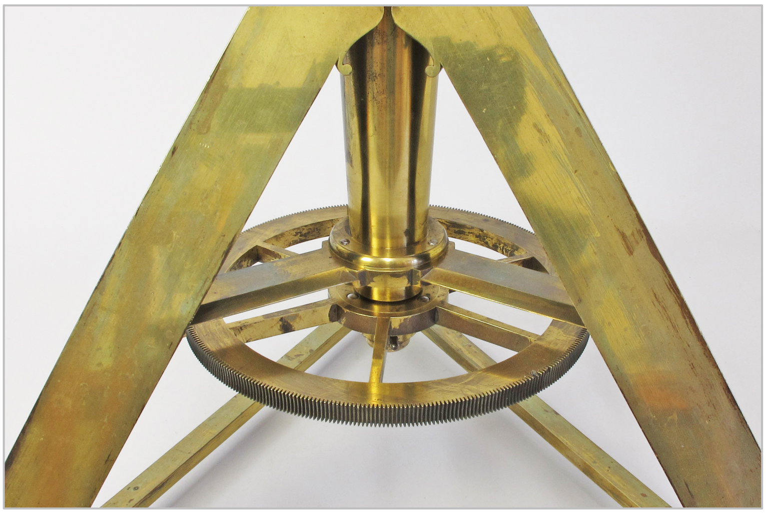

fig. 21 Setting circle within the tripod legs.

The setting circle is mounted to the bottom of the brass spigot and is unengraved. It is rotated by a worm screw. This is mounted to the base of the tripod *(fig. 22)*.

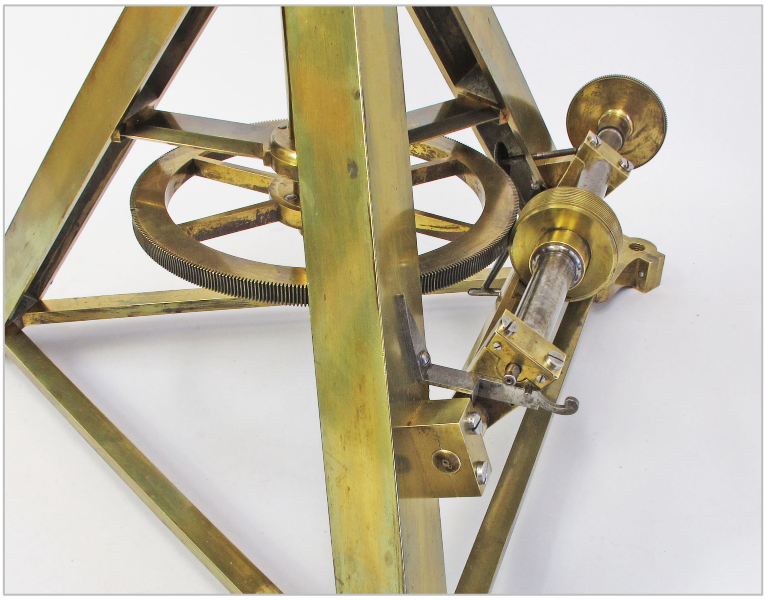

fig. 22 Setting circle worm and pivot blocks screwed to the tripod legs.

The tripod has three adjustable screw feet used for levelling of the instrument *(fig. 23)*.

fig. 23 One of the height-adjustable tripod feet and its split clamp

Appraisal of the condition and proposed treatment

Appraisal of the condition

1. Completeness

Overall the instrument appears to be broadly complete.

2. Losses

There is significant loss to the lacquered finish to the brass work *(fig. 24)*.

fig. 24 Telescope tube and micrometer box showing losses to the lacquered finish and variegated tarnished brass.

3. Corrosion

Where loss has occurred to the lacquered finish or where the lacquer has degraded and cracked the brass work has tarnished to a multitude of hues ranging from pale gold to almost black. There is considerable finger printing to the telescope tube *(fig. 25)*. Almost all of the exposed steel work shows light surface rusting *(fig. 26)*.


fig. 25


fig. 26

Many of the screw threads are corroded due to the presence of a cleaning/polishing agent.

4. Cleanliness

The instrument has a powdery and chalky white residue in almost all of the corners, engraving detail and screw threads etc *(fig. 27)*, which is restricting the free movement of many components, ie the worm screws and rotating components. The equatorial circle is locked into its current position. The instrument is superficially dusty and the optic lenses to the telescope are contaminated with organic material including what appears to be fungal growth and insect remains *(fig. 28)*.

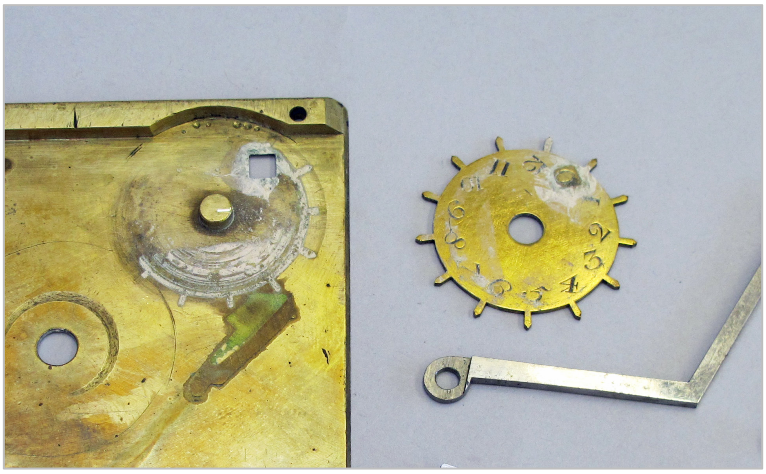

fig. 27

fig. 28

5. Broken Parts

The pointer to the meridian circle has broken away from one side of its mount *(fig. 29)*. One of the adjustable feet is broken and missing a portion of its threaded foot *(fig. 30)*.

fig. 29 Broken foot of the meridian circle pointer.

fig. 30 Three tripod levelling screws R. with fractured and lost threaded section.

Treatment proposal

1. Completely disassemble the telescope and mount. Wash all metal components by hand brushing and rinsing in L & R® No3 watch rinsing solution[1]

2. Loose surface corrosion to steel work is to be removed using 0000 grade steel wool soaked in microcrystalline wax.

3. Once cleaned all metal components are to be brushed with microcrystalline wax.

4. Bearings to be oiled as required using Moebius® synthetic lubricant.[2]

5. The cleaning of the optics is to be carried out by a ceramics conservator.

6. All components are to be measured, photographed and recorded throughout the treatment.

7. Repair the broken tripod levelling screw by letting in a new piece of brass and cutting a new thread to match existing.

[1] L&R (L&R Ultrasonics) is a registered trade mark of L&R Manufacturing Company.

[2] Moebius is a registered trade mark of www.moebius-lubricants.ch a company of the Swatch Group.

Description of the treatment

Cleaning

1. General

The instrument was dismantled in sections, washed and rinsed using L & R watch rinsing solution, corrosion to steel was removed using 0000 grade steel wool, all metal components were brushed with microcrystalline wax. All components were measured, photographed and recorded starting with the telescope tube and micrometer box.

2. Optics

The optics were cleaned by the West Dean College Ceramics Department *(fig. 31)* using a diluted solution of industrial methylated spirits. The objective lens, being a doublet (i.e. two lenses pressed together in one mount) was not removed from its mount as this was deemed to be too invasive and could present a potential high risk of damaging the lenses. Hence just the exterior of the two lenses was cleaned and as a result there is still light fogging between the two lenses *(fig. 32)*.

fig. 31 Cleaning the lenses. West Dean College

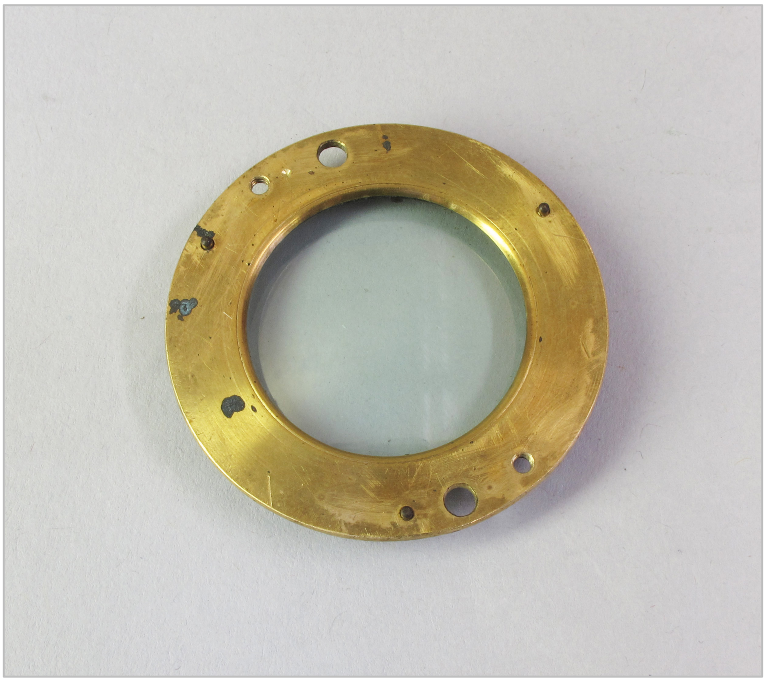

fig. 32

3. Micrometer box

The micrometer box *(fig. 33)* was dismantled, cleaned and recorded, including X-Ray Fluorescence (XRF) readings taken from some of the components.

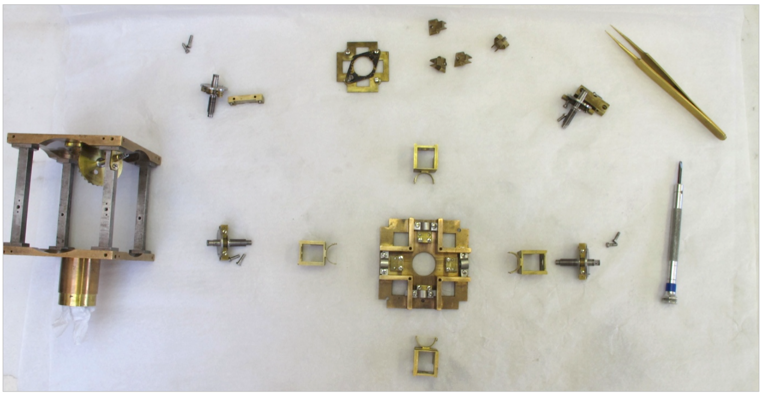

fig. 33

4. Steel Spigot

The steel spigot mounted to the equatorial circle, which was locked into one position, was removed and after soaking overnight in a releasing agent (PlusGas®)[3] and tapping free with a hide mallet. *(fig. 34)*.

[3] PlusGas is a registered trade mark of Saint Gobain Abrasives.

Fig. 34 Equatorial mounting spigot

5. Meridian circle pointer

The brass pointer to the meridian circle was repaired by fashioning a piece of cast brass to span the internal 90 degrees of the two broken pieces *(fig. 29 and fig. 35)*, which was then glued into position using 2020 Araldite® glue epoxy resin *(fig. 36)*.[4]


fig. 35 Broken Meridian pointer with a metal reinforcing 'glue block'

[44] Araldite is a registered trademark of Huntsman Advanced Materials.

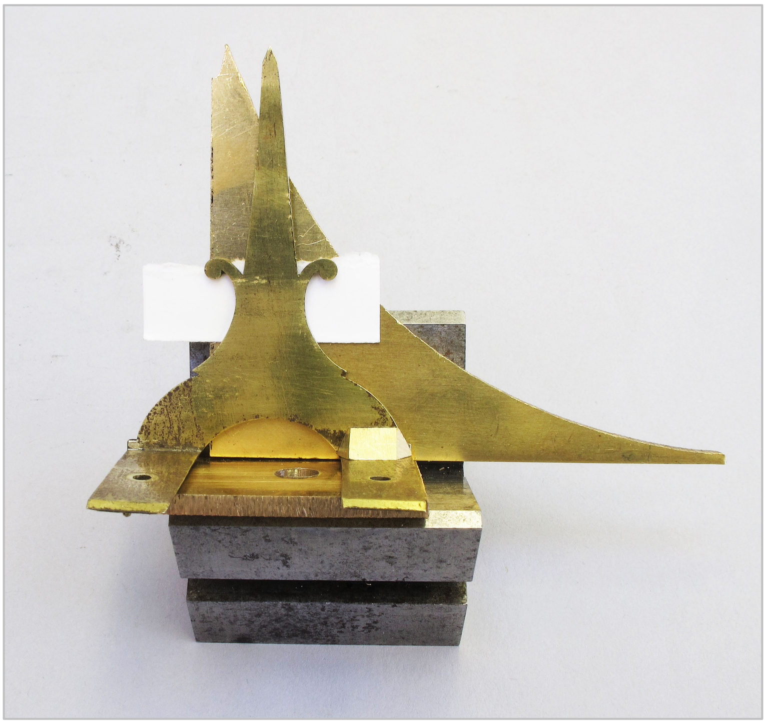

Fig. 36 The Meridian pointer during glueing

Some of the corroded steel components required cleaning and surface rust removal with 0000 grade steel wool. Before cleaning: *(fig. 37).* After cleaning: *(fig. 38)*.

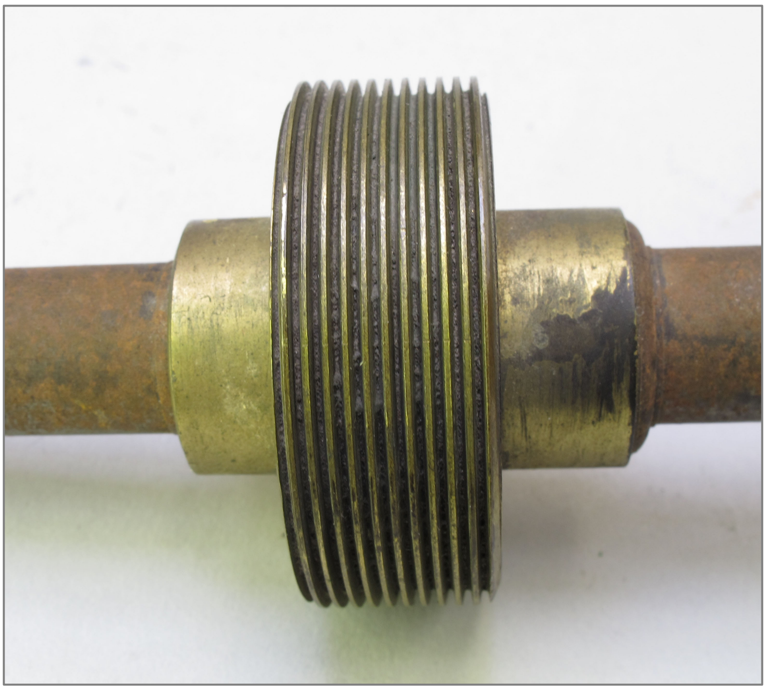

fig. 37 - before cleaning

fig. - 38 after cleaning and surface rust removal

Thread cutting for the adjustable foot

It was important to imitate the historical thread to the adjustable foot and to retain as much of the original component as possible.

A thread cutter was made from 4mm silver steel and turned in the lathe with a graver to the same profile as the historical thread.

A section of 60mm nylon bar was turned to hold the foot with the remaining thread, the broken end turned flat and a 6mm diameter hole was drilled 20mm into the end *(fig. 39)*.

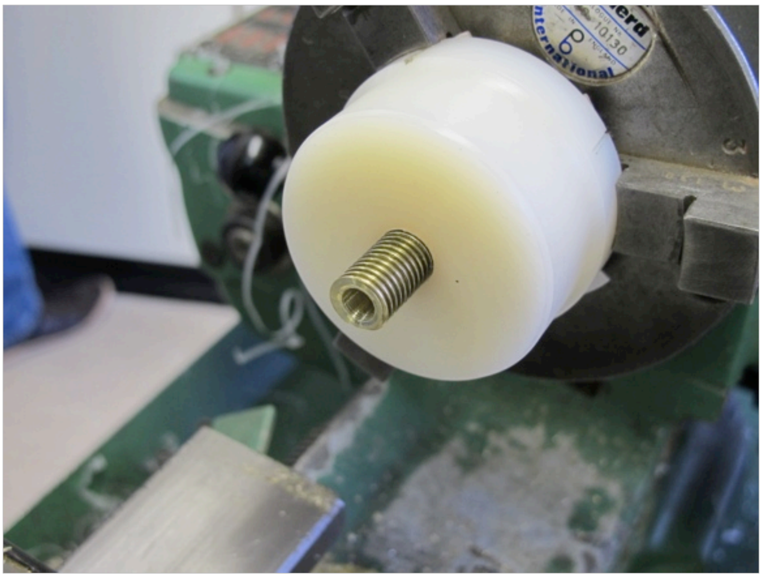

fig. 39

Cast brass bar was turned to a diameter of 10.3mm, ie the diameter of the crest of the historical thread, and then a plug was turned from cast brass to push fit into the hole in the stock. A small amount of Loctite was used to make sure the marriage of the components was stable *(fig. 40)*.

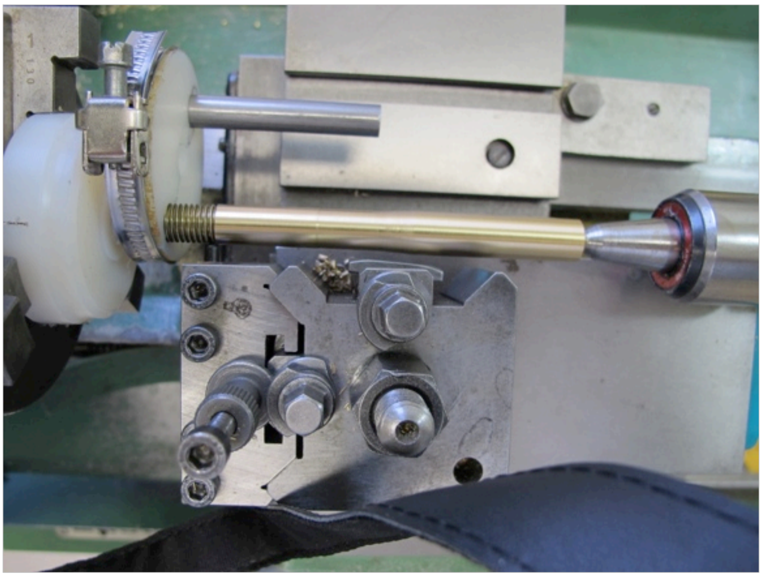

fig. 40

The lathe was turned using the hand crank and the thread was cut in 10mm long sections until the required length was achieved. It took five cuts with the thread cutter for each 10mm length *(fig. 42)*. Once enough lengths were created a mean average of the two remaining feet was taken. The new stock was parted to length and the foot was created with a graver *(fig. 41)*.

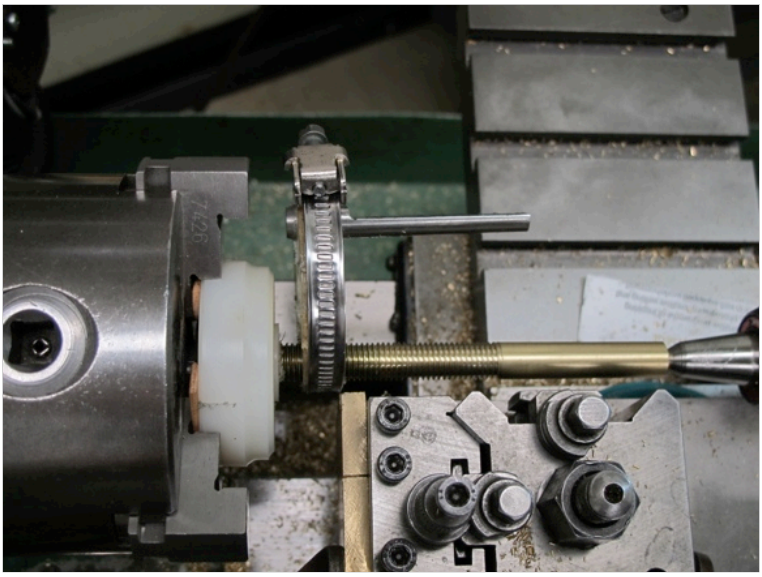

Fig. 41

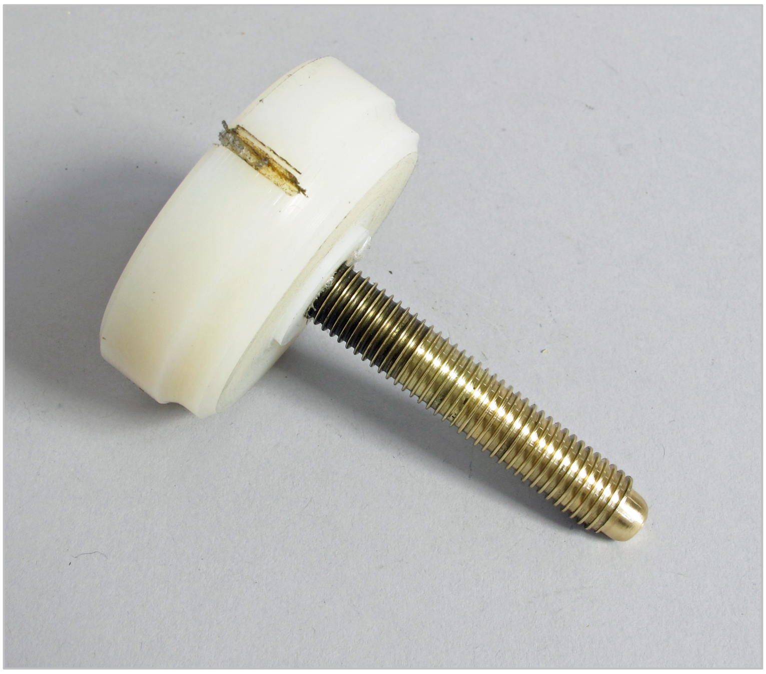

fig. 42

The thread was then polished with a fine pumice powder soaked into the string with oil *(fig. 43)*. The advantage of this method, albeit time consuming, was that a good continuation of the thread was achieved and theoretically good match to the pitch. The thread winds successfully through its existing clamp.

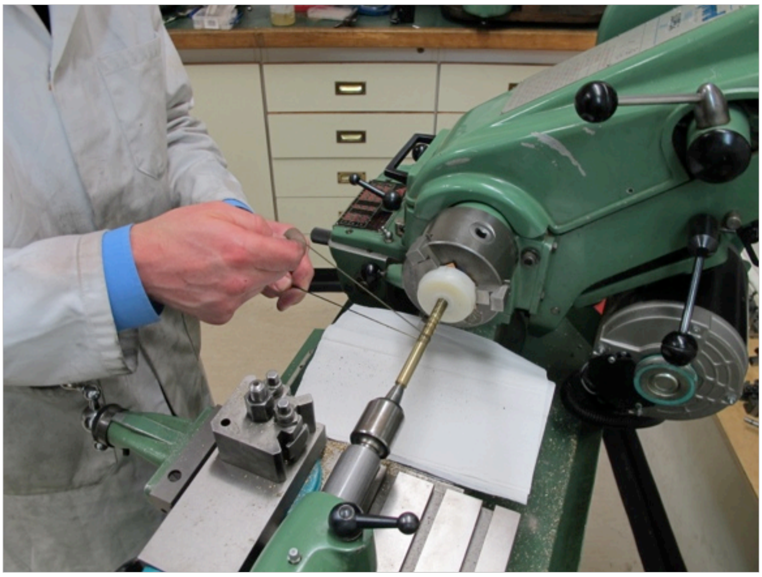

Fig. 43

Fig. 44

Observations

This telescope was Hindley's first telescope and also thought to be the first equatorially mounted telescope ever made. As such it can be considered a prototype. There are obvious signs that Hindley may have struggled with certain elements of the design and construction. Overall, the level of design and manufacturing skill is exceptional, yet there are some aspects that show a more developmental approach. Compared with the substantial construction of the three planes and their adjustment, the design of the actual telescope mount is relatively flimsy and may have contributed to difficulties in selling the instrument.

On disassembly, casting flaws to two of the worm screws were found *(fig. 45 and fig. 46)*. This is not atypical of eighteenth-century work. There were also areas where steady pins had been filed back *(fig. 47)* or moved, possibly underlining the prototype nature of the instrument.

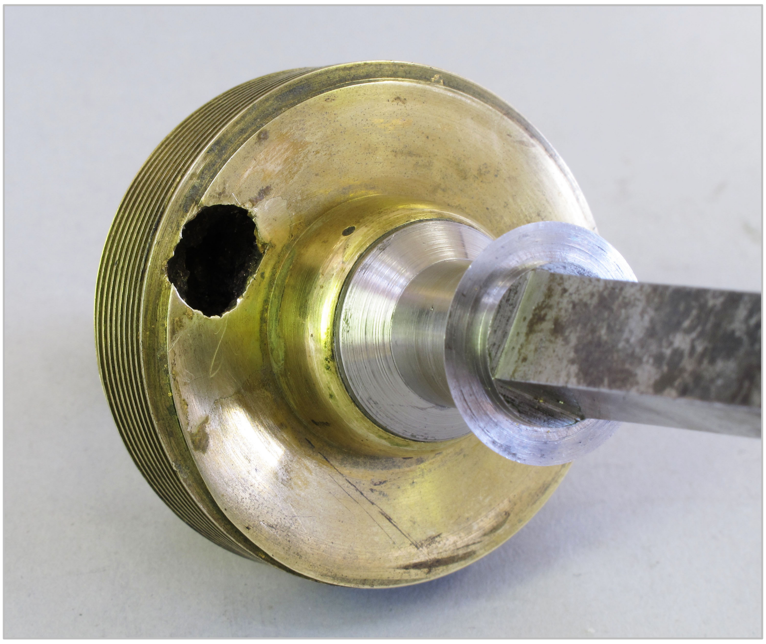

fig. 45

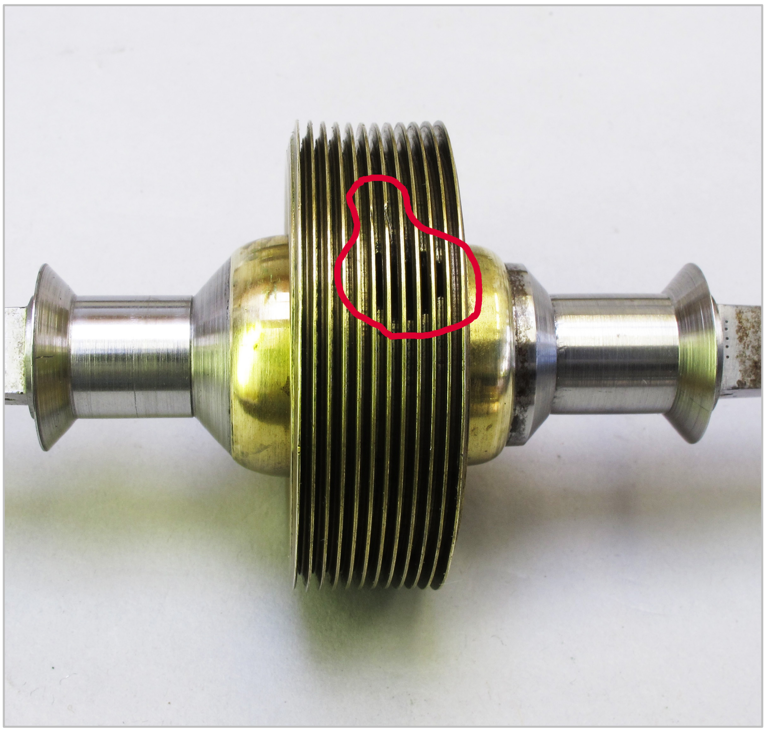

fig. 46

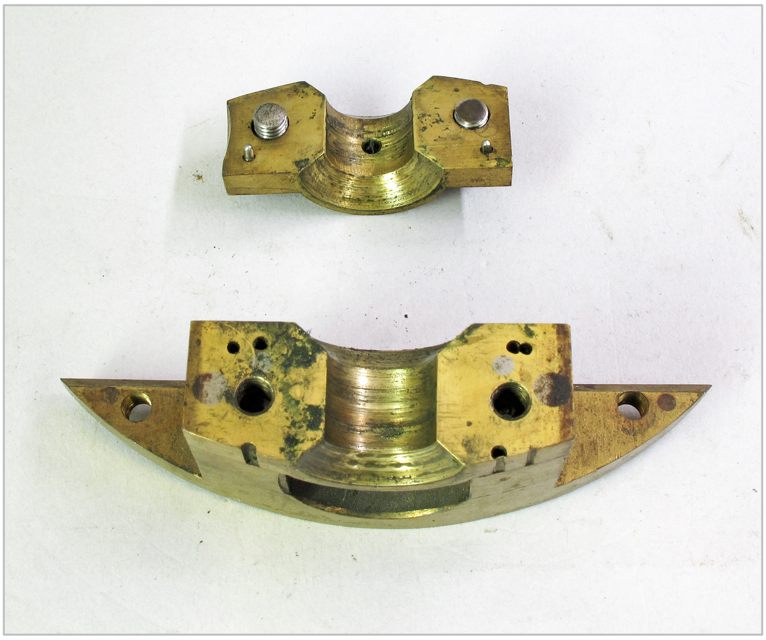

fig. 47 What appear to be multiple alterations to the steady pin arrangement

The lead filled counter weight appears to have been altered; evidence of re-soldered joints and rivets remains *(fig. 48)*, most probably after realising that the weight was (and still is) undersized and made the instrument unbalanced at certain angles *(fig. 49)*. A slot had been cut to the front of the weight to incorporate the spigot tube to the equatorial circle.

Fig. 49

Fig. 50

Appendix I

Train count

REF / RCF 56 Leeds,

West Dean Reference	RCF56	Date	21 1 2013.	Clock Name	Hindley Telescope,	Student Name	T. Hughes,

Wheel / Pinion Name	No. Teeth	Outside Diameter	Root Diameter	Wheel Thickness	Tooth Width	No. Leaves	Outside Diameter	Root Diameter	Pinion Length	Leaf Width	Front Pivot	Back Pivot
Contrate wheels in micrometer box												
Top cont B009	180	69.63	1.60	3.08	.53,							
Bottom cont/B012	180	69.43,	1.53,	2.53,	.53,							
Left cont/B010	180	69.58	1.68	2.85.	.53.							
Right cont/B011	180	69.35	1.77.	2.81	.53,							
Focus gear B002	45.	41.55.	2.06.	2.85,	1.32,							
Focus wheel B014	30	29.3	1.6.	3.55,	1.35							
		Semi circle										
Dec circle	181	150 mm	.48	7.70	.75							
Equa circle,	360	151.90	.60	7.30	.70							
		semi.										
Mari circle,	194	150 mm	.60	10.65	.70							
Setting circle,	360	154	.50	7.95	.75.							

End