THE PRECISION SCREW IN SCIENTIFIC INSTRUMENTS OF THE 17th-19th CENTURIES:
WITH PARTICULAR REFERENCE TO ASTRONOMICAL,
NAUTICAL AND SURVEYING INSTRUMENTS

RANDALL CHAPMAN BROOKS

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A thesis submitted as partial fulfillment of the degree of

Doctor of Philosophy

at the University of Leicester

Department of Astronomy
Appendix A:
Results of Charles Maddock's Research

The columns are: OD, TPI, Depth of Thread, Thread Angle, Radius of Crest/Root

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>OD</th>
<th>TPI</th>
<th>Depth of Thread</th>
<th>Thread Angle</th>
<th>Radius of Crest/Root</th>
<th>Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams, George (Sr.)</td>
<td>Sundial, Levelling</td>
<td>0.275</td>
<td>37.3</td>
<td>0.014</td>
<td>36</td>
<td>.006/.007</td>
<td></td>
</tr>
<tr>
<td>Adams, George (Jr.)</td>
<td>Levelling Screws-brass, 3-off</td>
<td>0.277</td>
<td>32.2</td>
<td>0.013</td>
<td>65</td>
<td>.007/.008</td>
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<tr>
<td></td>
<td></td>
<td>0.199</td>
<td>37.2</td>
<td>0.013</td>
<td>66</td>
<td>.007/.008</td>
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<td>Averages:</td>
<td>TPI</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>35.5</td>
</tr>
<tr>
<td></td>
<td>Th. Angle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>55.67</td>
</tr>
<tr>
<td>Bird, John</td>
<td>Portable Equatorial</td>
<td>0.166</td>
<td>45.5</td>
<td>0.010</td>
<td>-</td>
<td>.006/.006</td>
<td></td>
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<tr>
<td></td>
<td>Levelling Screws-brass, 3-off</td>
<td>0.168</td>
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<td>-</td>
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<td></td>
<td>0.163</td>
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<td></td>
<td></td>
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<td></td>
<td>45.5</td>
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<tr>
<td>Bird, John</td>
<td>Portable Equatorial</td>
<td>0.276</td>
<td>26.3</td>
<td>0.021</td>
<td>-</td>
<td>.006/.006</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Levelling Screws-brass, 3-off</td>
<td>0.277</td>
<td>26.4</td>
<td>0.020</td>
<td>-</td>
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<td></td>
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<td>0.250</td>
<td>25.5</td>
<td>0.013</td>
<td>-</td>
<td>.010/.010</td>
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<tr>
<td>Averages:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>26.1</td>
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<tr>
<td>Bird, John</td>
<td>Quadrant (18&quot;)</td>
<td>0.366</td>
<td>24.3</td>
<td>0.023</td>
<td>53</td>
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<tr>
<td></td>
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<td>0.366</td>
<td>24.3</td>
<td>0.023</td>
<td>50</td>
<td>.007/.007</td>
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<tr>
<td></td>
<td></td>
<td>0.365</td>
<td>24.5</td>
<td>0.023</td>
<td>53</td>
<td>.007/.007</td>
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<tr>
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<td></td>
<td>0.365</td>
<td>24.1</td>
<td>0.023</td>
<td>57</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>24.3</td>
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<tr>
<td></td>
<td>Th. Angle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>53.25</td>
</tr>
<tr>
<td>Bird, John</td>
<td>Quadrant (12&quot;)</td>
<td>0.530</td>
<td>16.5</td>
<td>0.041</td>
<td>55</td>
<td>.006/---</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Levelling Screws-brass, 4-off</td>
<td>0.530</td>
<td>16.5</td>
<td>0.041</td>
<td>58.5</td>
<td>.008/.011</td>
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<td></td>
<td></td>
<td>0.524</td>
<td>16.5</td>
<td>0.040</td>
<td>54</td>
<td>.007/.010</td>
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<tr>
<td></td>
<td></td>
<td>0.522</td>
<td>16.5</td>
<td>0.040</td>
<td>51.5</td>
<td>.008/.010</td>
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<tr>
<td>Averages:</td>
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<td></td>
<td></td>
<td></td>
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<td>16.5</td>
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<td></td>
<td>Th. Angle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>54.75</td>
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<tr>
<td>(made about 1770)</td>
<td></td>
<td></td>
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</tbody>
</table>

Bird, John (1709-76)

--Quadrant (18"):
Levelling Screws-brass, 4-off (≈ SML 1937-600)

<table>
<thead>
<tr>
<th>OD</th>
<th>TPI</th>
<th>Depth of Thread</th>
<th>Thread Angle</th>
<th>Radius of Crest/Root</th>
<th>Averages</th>
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<tbody>
<tr>
<td>0.530</td>
<td>16.5</td>
<td>0.041</td>
<td>55</td>
<td>.006/---</td>
<td></td>
</tr>
<tr>
<td>0.530</td>
<td>16.5</td>
<td>0.041</td>
<td>58.5</td>
<td>.008/.011</td>
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</tr>
<tr>
<td>0.524</td>
<td>16.5</td>
<td>0.040</td>
<td>54</td>
<td>.007/.010</td>
<td></td>
</tr>
<tr>
<td>0.522</td>
<td>16.5</td>
<td>0.040</td>
<td>51.5</td>
<td>.008/.010</td>
<td></td>
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<tr>
<td>Averages:</td>
<td>TPI</td>
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</tr>
<tr>
<td></td>
<td>Th. Angle</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

(made about 1770)

--Quadrant (12"):
Levelling Screws-brass, 4-off (≈ SML 1900-138)

<table>
<thead>
<tr>
<th>OD</th>
<th>TPI</th>
<th>Depth of Thread</th>
<th>Thread Angle</th>
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<th>Averages</th>
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<tbody>
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<td>0.364</td>
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<td>50</td>
<td>.005/.009</td>
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<tr>
<td>0.372</td>
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<td>0.025</td>
<td>53</td>
<td>.006/.008</td>
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<tr>
<td>0.369</td>
<td>24.25</td>
<td>0.025</td>
<td>52</td>
<td>.006/.008</td>
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</tr>
<tr>
<td>0.363</td>
<td>24.25</td>
<td>0.029</td>
<td>-</td>
<td>--/.008</td>
<td></td>
</tr>
<tr>
<td>Averages:</td>
<td>TPI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Th. Angle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(made about 1767)
<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Description</th>
<th>Levelling Screws-brass, Type</th>
<th>TPI</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dollond, John (1706-61)</td>
<td></td>
<td>Portable Equatorial: Levelling Screws-brass, 3-off (SML 1912-204)</td>
<td>0.394 24 0.031 50 .006/.005 0.393 24 0.030 47.5 .006/.007 0.389 24 0.033 47.5 .004/.006</td>
<td>24</td>
<td>48.8</td>
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<tr>
<td>Dollond, Peter (1730-1820)</td>
<td></td>
<td>Portable Equatorial: Levelling Screws-brass, 3-off (SML 1911-233)</td>
<td>0.350 23 0.028 65 .006/.006 0.359 23 0.022 63 .006/.006 0.358 23 0.025 60 .006/.006</td>
<td>23</td>
<td>62.7</td>
</tr>
<tr>
<td>Harris (fl 1733)</td>
<td></td>
<td>Portable Equatorial: Levelling Screws-brass, 3-off</td>
<td>0.033 30 0.017 55 .006/.006 0.033 30 0.018 54 .006/.006 0.033 30 0.020 54 .006/.006</td>
<td>30</td>
<td>54.5</td>
</tr>
<tr>
<td>Heath, Thomas (fl 1729)</td>
<td></td>
<td>Double Telescopic Level and Compass-brass, 4-off</td>
<td>0.205 37 0.017 .005/.003 0.205 38.5 0.007 106 .009/.003 0.210 37 0.016 44.5 .006/.004 0.238 35.7 0.017 50.5 .005/.004</td>
<td>37.5</td>
<td>67.0</td>
</tr>
<tr>
<td>Heath and Wing (fl 1758)</td>
<td></td>
<td>Plane Table: Levelling screws-brass, 4-off</td>
<td>0.326 29.9 0.014 52.5 .007/.007 0.321 29.4 0.013 87 .004/.008 0.313 29.9 0.013 87 .004/.008</td>
<td>29.7</td>
<td>69.9</td>
</tr>
<tr>
<td>Jones, William &amp; Samuel (fl 1793-1831)</td>
<td></td>
<td>English Equatorial: Levelling Screws-brass, 3-off</td>
<td>0.441 14 0.041 62.5 .012/.012 0.443 14 0.041 62 .009/.009 0.442 14 0.041 60.5 .009/.009</td>
<td>14</td>
<td>61.7</td>
</tr>
<tr>
<td>Martin, Benjamin (1704-82)</td>
<td></td>
<td>Portable Reflector: Levelling Screws-brass, 3-off (1 missing)</td>
<td>0.236 20 0.023 74 .007/.010 0.235 20 0.023 - .006/.010</td>
<td>20</td>
<td>74</td>
</tr>
</tbody>
</table>

(Maddock noted these were near 7/16" Whitworth and "appear to be of later manufacture")
<table>
<thead>
<tr>
<th>Ramsden, Jesse (1735-1800)</th>
<th>---Portable Equatorial---brass, 3-off (= SML 1938-1329)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.267 25.3 0.019 - -</td>
<td>0.004/---</td>
</tr>
<tr>
<td>0.283 27 0.024 47.5</td>
<td>0.007/0.006</td>
</tr>
<tr>
<td>0.276 23.8 - -</td>
<td>--/0.007</td>
</tr>
<tr>
<td><strong>Averages:</strong></td>
<td><strong>TPI 25.4</strong></td>
</tr>
</tbody>
</table>

---Portable Equatorial---brass, 3-off (= SML 1913-281)

| 0.513 19.6 0.045 - - | 0.005/0.007 |
| 0.522 19.6 0.045 - - | 0.006/0.006 |
| 0.516 19.2 0.043 - - | --/-- |
| **Averages:** | **TPI 19.5** |

Sisson, Jonathan (fl 1747-ca. 1788)
---Quadrant (6")---brass, 4-off (1 missing) (= SML 1918-168)

| 0.180 41.6 0.020 40.5 | 0.003/0.003 |
| 0.180 41.6 0.019 42 | 0.003/0.002 |
| 0.177 41.6 0.020 45 | 0.003/0.002 |
| **Averages:** | **TPI 41.6** | **Th. Angle 42.5** |

---Portable Equatorial---brass, 3-off

| 0.172 35.8 0.012 58 | 0.006/0.007 |
| 0.169 36.2 0.012 60 | 0.006/0.007 |
| 0.168 36.5 0.011 64 | 0.007/0.007 |
| **Averages:** | **TPI 36.2** | **Th. Angle 60.7** |

Troughton, Edward (1753-1835)
---Sextant---steel, 4-off but one missing

| 0.187 30.5 0.011 70 | 0.006/0.010 |
| 0.187 29.8 0.011 73 | 0.007/0.010 |
| 0.184 31.2 0.011 76.5 | --/0.010 |
| **Averages:** | **TPI 30.5** | **Th. Angle 73.2** |

(Made about 1800)

Rowley, John
---Surveyor's Level: Adjusting screw---iron with brass head

| 0.175" 29.4 0.010 91 |

---Universal Sundial: Levelling screws---brass

| 0.250 34.5 0.015 68 | 0.004/0.004 |
| 0.249 34.5 0.015 62.75 | 0.006/0.005 |
| 0.249 35.7 0.015 63 | 0.006/0.005 |
| **Averages:** | **TPI 34.9** | **Th. Angle 64.6** |

Wright, Thomas (1711-86)
---Gunter Quadrant: Levelling Screws---brass, 3-off (= SML 1920-430)

| 0.205 23 0.022 63 | 0.006/0.010 |
| 0.208 22.7 0.019 71.5 | --/0.008 |
| 0.209 23.2 0.021 69 | 0.006/0.007 |
| **Averages:** | **TPI 23.0** | **Th. Angle 67.8** |

(Made about 1740?)
Appendix B

The following are copies of the FORTRAN programs used for the analysis of the profiles and the micrometer data. The purpose of each and sequence of use is described in Chapter 5.

**Program JURK.FOR**

```
C SWINGLER'S MODIFIED JURKEVICH PERIODOGRAM PROGRAM
C PROGRAM GIVES INDEX AS A FUNCTION OF FREQUENCY
C
C NPNTS = NUMBER OF DATA POINTS, N1,N2 ARE DUMMY VARIABLES
C X = ARRAY OF X VALUES
C Y = ARRAY OF Y VALUES
C PHI = PHASE OF EACH DATA POINT
C FSTART = INITIAL FREQUENCY
C FDELTA = SPACING BETWEEN TRIAL FREQUENCIES
C NPRD = NUMBER OF FREQUENCIES TO BE SEARCHED
C RESULT = ARRAY OF JURKEVICH INDEX FOR EACH TRIAL PERIOD
C GAMMA =
C SUMRL = Y COS(GAMMA)
C SUMIM = Y SIN(GAMMA)

REAL PHI(500)
DIMENSION ICOUNT(20), BINDEX(20), X(500), Y(500), RESULT(1000)
COMMON XVALUE(20), YVALUE(20)
LOGICAL'l FILNAM(15), FILOUT(15), DATE(6), XNAME(10)

TYPE*, 'NAME OF FILE TO BE READ?'
ACCEPT 15, FILNAM
FILNAM(l 5)=O
OPEN (UNIT=2, NAME=FILNAM, TYPE='OLD', READONLY)
READ (2,29) NPNTS, N1, N2
READ (2,22) (X(K), Y(K), K=1, NPNTS)
C
C TEST THAT FILE IS CORRECTLY READ
C TYPE 22, (X(K), Y(K), K=1, NPNTS)

CLOSE (UNIT=2)
PI=3.14159265
C TYPE*, 'CODE OF INSTRUMENT'
ACCEPT 17, XNAME

C NPRD IS LIMITED TO 250 POINTS BY DATAGRAP
C THE INDEX IS CALCULATED FOR EACH PERIOD
C
C TYPE*, 'INPUT FSTART AND FDELTA (FSTART > FEND)'
ACCEPT*, FSTART, FDELTA
C
C NER IS A DUMMY NUMBER USED FOR DATAGRAP
C
NER=O
C TYPE*, 'NAME OF FILE FOR DATA TO BE WRITTEN TO?'
ACCEPT 25, FILOUT
```
Program LSQ.FOR

C PROGRAM LSQ.FOR LAST MODIFIED 20 NOV 1986
C C PROGRAM TO CALCULATE LEAST SQUARES POLYNOMIAL FITS
C WITH MAXIMUM OF 10 DEGREES WHICH IS READ AS FIRST NUMBER
C OF THE DATA FILE (REF McCrackin & Dorn p.262)
C NUMBER = NUMBER OF DATA PAIRS
C NDATA = NUMBER OF INPUT DATA PAIRS
C ND1, ND2 ARE DUMMY VARIABLES TO MATCH DATA FILES W/JURK.FOR
C NCURV = NUMBER OF POINTS TO BE CALCULATED FOR LSO CURVE
C M = DEGREE OF POLYNOMIAL; N = NUMBER OF EQUATIONS (M-1)
C X,Y = DATA PAIRS
C A = ARRAY OF SUMS (COEFFICIENTS OF THE UNKNOWNS
C B = ARRAY OF CONSTANT TERMS
C C = ARRAY FOR THE UNKNOWNS IN THE POLYNOMIAL EQUATIONS
C P = ARRAY FOR THE POWERS OF THE X(I) (1 TO 2M)
C
C DOUBLE PRECISION A,B,C,P,XN,YN
C LOGICAL *1 FILNAM(15), FILOUT(15)
C TYPE*, 'NAME OF FILE TO BE READ?'
C ACCEPT 5,FILNAM
C
C FORMAT (15A1)
C TYPE*, 'DEGREE OF POLYNOMIAL TO BE CALCULATED (1-10)'
C ACCEPT 6,M
C
C FORMAT (12)
C TYPE*, 'NO. OF PTS. TO BE CAL. FOR LSO CURVE FIT--USUALLY 100'
C ACCEPT 7,NCURV
FILNAM(15)=0
OPEN (2, NAME=FILNAM, FORM='FORMATTED', STATUS='OLD')
READ (2,20) NDATA,ND1,ND2
READ (2,10) X(I), Y(I)
WRITE (6,25) X(I), Y(I)
DO 10 I=1,NUMBER
C 25 FORMAT (2X,E15.7,2X,E15.7)
C 11 CONTINUE
DO 12 I=1, NUMBER
C 12 NUMBER=I-1
MX2=M*2
P(I)=0.0
DO 13 J=1, NUMBER
C 13 P(I)=P(I) + X(J)**L

C THE COEFFICIENTS AND CONSTANTS OF THE EQUATIONS ARE DEVELOPED
C
N=M+1
DO 30 I=1,N
DO 30 J=1, N
K=I+J-2
IF (K) 29,29,28
C 28 A(I,J)=P(K)
C 29 A(1,1)=NUMBER
WRITE (6,32) I, J, A(I,J), P(K), NUMBER
GO TO 30
C 30 CONTINUE
B(1)=0.0
DO 21 J=1, NUMBER
C 21 B(1)=B(1)+Y(J)
DO 22 I=2, N
B(I)=0.0
DO 22 J=1, NUMBER
C 22 B(I)= B(I) + Y(J)*X(J)**(I-1)
WRITE (6,42) I, B(I)
C 42 FORMAT (' B(I)= ', D10.4)

C PIVOTAL CONDENSATION IS CARRIED OUT—BLOCK DIAGRAM 8.8 TO L500
C
NM1=N-1
DO 300 K=1, NM1
KP1=K+1
L=K
DO 400 I=KP1, N
C 400 CONTINUE
IF (L-K) 500, 500, 405
C 405 DO 410 J=K, N
\begin{verbatim}
TEMP=A(K,J)
A(K,J)=A(L,J)
WRITE (6,409) J,K,L,A(K,J),A(L,J)
C 409 FORMAT (PC[2] J= ',I3,'K= ',I3,'L= ',I3,'AKJ= ',D10.4,
1 'ALJ= ',D10.4)
A(L,J)=TEMP
B(K)=B(L)
B(L)=TEMP
C
THE ELIMINATION AND BACK SOLUTIONS ARE CARRIED OUT
C
500 DO 300 I=KP1,N
FACTOR=A(I,K)/A(K,K)
WRITE (6,507) I,A(I,K),A(K,K)
C 507 FORMAT (' EL-1 I= ',I3,' AIK= ',D10.4,'AKK= ',D10.4)
A(I,K)=0.0
DO 301 J=KP1,N
301 A(I,J)=A(I,J)-FACTOR*A(K,J)
WRITE (6,501) J,A(I,J),A(K,J)
C 501 FORMAT (' EL-2 J= ',I3,' AIJ= ',D10.4,' AKJ= ',D10.4)
C
BLOCK DIAGRAM 8.6 TO L901 (q.v. McCracken & Dorn)
C
300 B(I)=B(I)-FACTOR*B(K)
WRITE (6,502) N,A(N,N)
C 502 FORMAT (' N= ',I3,' ANN= ',D10.4)
C(N)=B(N)/A(N,N)
I=NM1
710 IP1=I+1
SUM=0.0
DO 700 J=IP1,N
700 SUM=SUM+A(I,J)*C(J)
C(I)=(B(I)-SUM)/A(I,I)
I=I-1
IF (I) 800,800,710
800 DO 900 I=1,N
900 WRITE (6,901) I,C(I)
C 901 FORMAT (' I= ',I3,' C= ',D15.7)
C
CALCULATE NCURV POINTS ON THE POLYNOMIAL CURVE
C
TYPE*,’NAME OF OUTPUT DATA FILE (LSF????.DAT)*
ACCEPT 915, FILOUT
915 FORMAT (15A1)
FILOUT(15)=0
OPEN (3,NAME=FILOUT,FORM=’FORMATTED’,STATUS=’NEW’)
WRITE (3,922) NCURV
C 922 FORMAT (14, ',1.0*')
XDEC=(X(NUMBER)-X(1))/NCURV
DO 950 I=1,NCURV
902 XN(I)=X(1)
GOTO 904
903 XN(I)=XN(I-1)+XDEC
904 YN(I)=0.0
DO 950 J=1,N
IF (J .EQ. 1) GOTO 907
IF (J .NE. 1) GOTO 908
907 YTEMP1(I)=C(1)
\end{verbatim}
GOTO 950
908   YTEMP1(J) = YTEMP1(J-1) + C(J) * XN(I)**(J-1)
   IF (J .EQ. N) GOTO 940
   IF (J .NE. N) GOTO 950
940   YN(I) = YTEMP1(N)
950   CONTINUE
   DO 970 I = 1, NCURV
   WRITE (6,921) I, XN(I), YN(I)
   921 FORMAT (' I = ', I4, ': XN(I) = ', E15.7, ': YN(I) = ', E15.7)
   WRITE (3,960) XN(I), YN(I)
   960 FORMAT (E15.7, ' ', E15.7)
970   CONTINUE
C
C THIS SECTION CALCULATES DIFFERENCE OF Y VALUES OF INPUT DATA
C MINUS THE VALUE CALCULATED FROM THE POLYNOMIAL COEFFICIENTS AND
C WRITES DATA TO DATAGRAF COMPATIBLE FILE.
C
TYPE*, 'IS DATA-LSQ DIFFERENCE REQUIRED? YES = 1'
ACCEPT 1014, ITEST
1014 FORMAT (I1)
   IF (ITEST .EQ. 0) GOTO 1070
   TYPE*, 'FILENAME FOR LSQ DIFFERENCE DATA (LSD????.DAT)'
   ACCEPT 1015, FILOUT
   1015 FORMAT (5Al)
   FILOUT(15) = 0
   OPEN (4, NAME = FILOUT, FORM = 'FORMATTED', STATUS = *NEW)
   WRITE (4,1016) NDATA
   1016 FORMAT (14, '.1.0')
   DO 1050 I = 1, NDATA
      DO 1050 J = 1, N
         IF (J .EQ. 1) GOTO 1007
         IF (J .NE. 1) GOTO 1008
         1007   YTEMP2(I) = C(1)
         GOTO 1050
         1008   YTEMP2(J) = YTEMP2(J-1) + C(J) * X(I)**(J-1)
         IF (J .EQ. N) GOTO 1040
         IF (J .NE. N) GOTO 1050
         1040   YCAL(I) = YTEMP2(N)
      1050 CONTINUE
   DO 1070 I = 1, NDATA
      YDIFF(I) = Y(I) - YCAL(I)
   1061 FORMAT (' I = ', I4, ': X(I) = ', D13.5, ': Y(I) = ', D13.5, ': YDIFF(I) = ', D15.7)
   WRITE (4,1062) X(I), YDIFF(I)
   1062 FORMAT (E15.7, ' ', E15.7)
1070 CONTINUE
   CLOSE (1)
   CLOSE (2)
   CLOSE (3)
   CLOSE (4)
   STOP
END
Program: PROFIL1.FOR

C PROGRAM PROFILE.FOR LAST MODIFIED 17/01/1987
C PROFIL1 READS INPUT DATA AS X,Y PROFIL2 AS Y,X BUT
C OUTPUT FROM BOTH HAS X FIRST
C
C PROGRAM TO CALCULATE 1) LINEAR LEAST SQUARES FIT FOR
C THREAD PROFILES. IT THEN ROTATES DATA AND CALCULATES A
C PHASE FOR EACH DATA POINT TO GIVE A MEAN PROFILE. THE
C PROFILE IS THEN FITTED WITH A MEAN CURVE READY FOR
C PROFILE MEASUREMENT AND PUTS DATA IN A FILE SUITABLE
C FOR DATAGRAF WITH THREE OPTIONS: 0=PHASE POINTS, 1=
C CURVE ONLY OR 2=BOTH. THE FIRST STAGE IS MODIFIED LSO PROGRAM
C WITH N=1
C
C NUMBER = NUMBER OF DATA PAIRS
C NDATA = NUMBER OF INPUT DATA PAIRS
C ND1, ND2 ARE DUMMY VARIABLES TO MATCH DATA FILES W/JURK.FOR
C NCURV = NUMBER OF POINTS TO BE CALCULATED FOR LSO CURVE
C M = DEGREE OF POLYNOMIAL; N = NUMBER OF EQUATIONS (M-1)
C X,Y = DATA PAIRS
C A = ARRAY OF SUMS (COEFFICIENTS OF THE unknowns
C B = ARRAY OF CONSTANT TERMS
C C = ARRAY FOR THE unknowns IN THE POLYNOMIAL EQUATIONS
C P = ARRAY FOR THE POWERS OF THE X(I) (1 TO 2M)
C
REAL PHI(2000)
DIMENSION X(2000), Y(2000), A(11,11), B(11), C(11), P(20), XN(2000),
YN(2000), YTEMP1(11), YTEMP2(11), YDIFF(2000), YCAL(2000),
COMMON XVALUE(20), YVALUE(20)
DOUBLE PRECISION A, B, C, PXN, YN, RESULT, XMAX, YMAX, PHI
1GAMMA, TEMPR, TEMPI, YDIFF, SUMRL, SUMIM, SUMIN, PERIOD
LOGICAL*1 FILNAM(15), FILOUT3(15), FILOUT4(15), XNAME(10),
1FILOUT7(15)
TYPE*,*** NAME OF FILE TO BE READ?*
ACCEPT 5, FILNAM
5 FORMAT (15A1)
6 FORMAT (14, ' 1 0')
7 FORMAT (D15.7: W15.7)
M=1
NCURV=100
FILNAM(15)=0
OPEN (2,NAME=FILNAM,FORM= 'FORMATTED',STATUS= 'OLD')
READ (2,20) NDATA, NCURV
20 FORMAT (I4,I11)
WRITE (6,24) NDATA, NCURV
24 FORMAT (' NO DATA POINTS', I4, ' NO NCURV FOR CURVE =', I4)
DO 11 I=1, NDATA
READ (2,10) X(I), Y(I)
10 FORMAT (E14.6,E14.6)
11 CONTINUE
CLOSE (2)
12 NUMBER=I-1
DO 13 I=1,2
P(I)=0.0
DO 13 J=1, NUMBER
13 P(I)=P(I) + X(J)**I

C THE COEFFICIENTS AND CONSTANTS OF THE EQUATIONS ARE DEVELOPED
DO 30 I=1,2
DO 30 J=1,2
    K=I+J-2
    IF (K) 29,29,28
28     A(I,J)=P(K)
    GO TO 30
29     A(1,1)=NUMBER
30 CONTINUE
    B(1)=0.0
    DO 21 J=1,NUMBER
21    B(1)=B(1)+Y(J)
    I=2
    B(I)=0.0
    DO 22 J=1,NUMBER
22    B(I)= B(I) + Y(J)*X(J)**(I-1)
C
C PIVOTAL CONDENSATION IS CARRIED OUT--BLOCK DIAGRAM 8.8 TO L500
C
K=1
KP1=K+1
L=K
DO 400 I=KP1,2
    IF (DABS(A(I,K))-DABS(A(L,K))) 400,400,401
400 CONTINUE
    L=I
401 CONTINUE
    IF (L-K) 500,500,405
405 DO 410 J=K,2
    TEMP=A(K,J)
    A(K,J)=A(L,J)
410 A(L,J)=TEMP
    TEMP=B(K)
    B(K)=B(L)
    B(L)=TEMP
C
C THE ELIMINATION AND BACK SOLUTIONS ARE CARRIED OUT
C
500 DO 300 I=KP1,2
    FACTOR=A(I,K)/A(K,K)
    A(I,K)=0.0
    DO 301 J=KP1,2
301 A(I,J)=A(I,J)-FACTOR*A(K,J)
300 B(I)=B(I)-FACTOR*B(K)
C(2)=B(2)/A(2,2)
    I=1
710 IP1=I+1
    SUM=0.0
    DO 700 J=IP1,2
700 SUM=SUM+A(I,J)*C(J)
    C(I)=(B(I)-SUM)/A(I,I)
    I=I-1
    IF (I) 800,800,710
800 DO 900 I=1,2
900 WRITE (6,901) I, C(I)
901 FORMAT (' I= ', I3, ', C= ', F15.7)
C
C CALCULATE NCURV POINTS ON THE POLYNOMIAL CURVE
C
XDEC=(X(NUMBER)-X(1))/NCURV
DO 950 I=1,NCURV
    IF (I .EQ. 1) GOTO 902
    IF (I .NE. 1) GOTO 903
902 XN(1)=X(1)
GO TO 904
903   XN(I) = XN(I-1) + XDEC
904   YN(I) = 0.0
DO 950 J = 1, 2
   IF (J .EQ. 1) GO TO 907
   IF (J .NE. 1) GO TO 908
907   YTEMP1(1) = C(1)
   GOTO 950
908   YTEMP1(J) = YTEMP1(J-1) + C(J) * XN(I)**(J-1)
   IF (J .EQ. 2) GO TO 940
   IF (J .NE. 2) GO TO 950
940   YN(I) = YTEMP1(2)
950   CONTINUE
C
C     THIS SECTION CALCULATES DIFFERENCE OF Y VALUES OF INPUT DATA
C     MINUS THE VALUE CALCULATED FROM THE POLYNOMIAL COEFFICIENTS AND
C     WRITES DATA TO DATAGRAF COMPATIBLE FILE.
C
   TYPE*,'>> WANT TO WRITE LSQ DIFF TO A FILE? 1 = YES'
   ACCEPT*, TEST2
   IF (TEST2 .EQ. 0) GOTO 1016
   TYPE*,'>> FILNAME FOR LSQ DIFFERENCE DATA'
   ACCEPT 5, FILOUT4
   FILOUT4(15) = 0
   OPEN (4, NAME = FILOUT4, FORM = 'FORMATTED', STATUS = 'NEW')
1016 DO 1050 I = 1, NDATA
      DO 1050 J = 1, 2
         IF (J .EQ. 1) GOTO 1007
         IF (J .NE. 1) GOTO 1008
1007    YTEMP2(1) = C(1)
         GOTO 1050
1008    YTEMP2(J) = YTEMP2(J-1) + C(J) * X(I)**(J-1)
         IF (J .EQ. 2) GOTO 1040
         IF (J .NE. 2) GOTO 1050
1040    YCAL(I) = YTEMP2(2)
1050    CONTINUE
   DO 1070 I = 1, NDATA
      YDIFF(I) = Y(I) - YCAL(I)
   C WRITE (6, 1061) I, X(I), Y(I), YDIFF(I)
   C1061 FORMAT (' I= ', I4, ' X(I)= ', D13.5, ' Y(I)= ', D13.5, ' YDIFF(I)= ', D15.7)
   C1070 CONTINUE
   TEST = 0
   NDATA2 = 250
   IF (NDATA .LT. 250) NDATA2 = NDATA
   DO 1100 I = 1, NDATA
      IF (TEST) 1101, 1101, 1102
1101    WRITE (4, 6) NDATA2
1102    WRITE (4, 7) X(I), YDIFF(I)
   C WRITE (6, 1106) TEST, NDATA2, NDATA3
   C1106 FORMAT (' TEST= ', D10.3, ', NDATA2= ', I4, ', NDATA3= ', I4)
      IF (NDATA3 .LT. 250) NDATA2 = NDATA3
   1100 CONTINUE
   CLOSE (4)
C
C     SWINGLER'S MODIFIED JURKEVICH PERIODOGRAM PROGRAM.
C     PROGRAM GIVES INDEX AS A FUNCTION OF FREQUENCY.
C     FIRST TIME THROUGH: INPUT START AND END PERIODS--
C     SHOULD BE SMALL RANGE FOR SUFFICIENT RESOLUTION
C

TYPE*, 'JURKEVICH PERIOD SEARCH SECTION'
PI = 3.14159265
NPASS = 0
TYPE*, 'INPUT PSTART AND PEND'
ACCEPT*, PSTART, PEND

2000 FSTART = 1/PSTART
FDELTA = (1/PSTART - 1/PEND) / 500
NDATA2 = 250

C

NDATA2 IS LIMITED TO 250 POINTS BY DATAGRAF BUT MAY
HAVE UP TO 7 DATA SETS EACH OF 250 PTS.
THE INDEX IS CALCULATED FOR EACH PERIOD

C

TYPE*, 'DO YOU WANT JURK DATA SAVED? YES = 1'
ACCEPT*, TEST3
IF (TEST3 .EQ. 0) GOTO 2027
TYPE*, 'NAME OF FILE FOR DATA TO BE WRITTEN TO?'
ACCEPT 5, FILOUT3
FILOUT3(15) = 0
OPEN (3, NAME = FILOUT3, FORM = 'FORMATTED', STATUS = 'NEW')
WRITE (3, 6) NDATA2

2027 TEST = 0
DO 2008 IA = 1, 500
    TEST = TEST + 1
    IF (TEST - 251) 2035, 2030, 2035
2030 WRITE (3, 6) NDATA2
2035 FREQ(IA) = FSTART - FDELTA * FLOAT(IA - 1)
SUMIM = 0.0
SUMRL = 0.0
DO 2005 IB = 1, NDATA
    PHI(IB) = AMOD(X(IB) * FREQ(IA), 1.0)
    IF (PHI(IB) .LT. 0.0) PHI(IB) = PHI(IB) + 1.0
    GAMMA = PHI(IB) * 2.0 * PI
    TEMPR = YDIFF(IB) * COS(GAMMA)
    TEMPI = YDIFF(IB) * SIN(GAMMA)
    SUMRL = SUMRL + TEMPR
    SUMIM = SUMIM + TEMPI
2005 CONTINUE
RESULT(IA) = SUMRL**2 + SUMIM**2
RESULT(IA) = (2.0 / NDATA)**2 * RESULT(IA)
PERIOD(IA) = 1 / FREQ(IA)
IF (TEST3 .EQ. 0) GOTO 2008
WRITE (3, 7) PERIOD(IA), RESULT(IA)
2008 CONTINUE
CLOSE (3)

C

THIS SECTION FINDS MAXIMUM JURKEVICH VALUE.

C

IF (NPASS .NE. 0) GOTO 3040
YMAX = RESULT(1)
XMAX = FREQ(1)
DO 3005 IA = 1, 1499
    IF (RESULT(IA + 1) .GT. YMAX) THEN
        YMAX = RESULT(IA + 1)
        XMAX = FREQ(IA + 1)
    ELSE
        CONTINUE
    ENDIF
3005 CONTINUE
TPERIOD = 1 / XMAX
WRITE (6,3008) TPERIOD
3008 FORMAT (*****>> PERIOD = ,D12.7)
3040 TYPE*;>> RECALCULATE FOR ANOTHER PERIOD RANGE? YES=1'
    ACCEPT*,TEST6
    IF (TEST6.EQ.0) GOTO 3060
    NPASS=NPASS+1
    IF (NPASS .EQ. 2) GOTO 3050

C
C THIS SECTION INCREASES THE PERIOD SEARCH RANGE FOR PROFILE
C SEARCHES--FIRST TIME < PERIOD, SECOND > PERIOD AND STEPS OFF
C SO THAT PRIMARY PEAK IS NOT INCLUDED IN PLOTS
C
PSTART=0.09090909*TPERIOD
PEND=0.85*TPERIOD
GOTO 3051
3050 PSTART=1.2*TPERIOD
PEND=11*TPERIOD
3051 IF (NPASS. NE. 3) GOTO 2000
    TYPE*, '****> RESET NPASS; 0=RESTART; 1=LO PERIOD; 2=HI PERIOD'
    TYPE*, '>> WHAT NEW VALUE OF NPASS? 0,1,2'
    ACCEPT,NPASS
    GO TO 2000

C
C THIS SECTION CALCULATES THE PHASES OF DIGITIZED PROFILE DATA
C AND WRITES TO FILE OF FORM TEMPP1.DAT
C
3060 TYPE*;>> CALCULATE PHASE? YES=1'
    ACCEPT*,TEST4
    IF (TEST4.EQ.0) GOTO 9999
    TYPE*;>> NAME FOR PHASE DATA FILE? TEMPP*.DAT
    ACCEPT 5,FILOUT7
    FILOUT7(15)=0
    OPEN (7,NAME=FILOUT7,FORM='FORMATTED',STATUS='NEW')
    TYPE*;>> WANT TO INCREMENT THE TRIAL PERIOD? YES = 1'
    ACCEPT*,TEST5
    IF (TEST5) 3010,3010,3011
3011 TYPE*;>> WHAT IS NEW PERIOD? (ENTER ACTUAL IN MM)'
    ACCEPT*,TPERIOD
3010 TEST=0
    NDATA2=250
    IF (NDATA.LT.250) NDATA2=NDATA
    DO 3100 I=1,NDATA2
        XP(I)=X(I)/TPERIOD
        XM(I)=XP(I)-INT(XP(I))
    C WRITE (6,3096) X(I), XP(I), XM(I)
    C3096 FORMAT (D15.7,2X, D15.7,2X, D15.7)
    IF (TEST) 3101,3101,3102
3101 WRITE (7,6) NDATA2
3102 WRITE (7,7) XM(I), YDIFF(I)
    TEST=TEST+1
    IF (TEST.GT.249) TEST=0
    NDATA3=NDATA-1
    IF (NDATA3.LT.250) NDATA2=NDATA3
3100 CONTINUE
    CLOSE (7)
9999 CONTINUE
    CALL EXIT
END
Sample of the prompts requested by PROFI1.EXE:

$ RUN PROFI1.EXE
>> NAME OF FILE TO BE READ?
PSMLCU96
   NO DATA POINTS 499  NO NCURV FOR CURVE = 100
   I=  1 C=  0.1379694D+02
   I=  2 C=  -0.2197349D-01
>> WANT TO WRITE LSQ DIFF TO A FILE? 1 = YES
1
>> FILENAME FOR LSQ DIFFERENCE DATA
TEMP.DAT
JURKEVICH PERIOD SEARCH SECTION
>> INPUT PSTART AND PEND
2.95,3.05
>> DO YOU WANT JURK DATA SAVED? YES = 1
0
****>> PERIOD = ,3003772D+01
>> RECALCULATE FOR ANOTHER PERIOD RANGE? YES=1
1
>> DO YOU WANT JURK DATA SAVED? YES = 1
1
>> NAME OF FILE FOR DATA TO BE WRITTEN TO?
TEMP1.DAT
>> RECALCULATE FOR ANOTHER PERIOD RANGE? YES=1
1
>> DO YOU WANT JURK DATA SAVED? YES = 1
1
>> NAME OF FILE FOR DATA TO BE WRITTEN TO?
TEMP2.DAT
>> RECALCULATE FOR ANOTHER PERIOD RANGE? YES=1
0
>> CALCULATE PHASE? YES=1
1
>> NAME FOR PHASE DATA FILE? TEMPP*.DAT
TEMPPI.DAT
>> WANT TO INCREMENT THE TRIAL PERIOD? YES = 1
0
$
Program: CALBRAT.FOR

Program CALBRAT subtracts a calibration curve from micrometer data by interpolation.
MX, MY are the micrometer data points
CX, CY are the calibration data points
Y is the micrometer (data - calibration) value
FRAC is the interpolation factor
This program is compatible with programs LSQ, PROFIL* and JURK

REAL MX, MY
LOGICAL*1 FILNAM(15), FILOUT(15), FILEIN(15)
TYPE*, '>> WHAT WAS THE DIAL INDICATOR ZERO READING?
ACCEPT 3, ZERO
WRITE (6,7) ZERO
TYPE*, '>> NAME OF CALIBRATION DATA FILE?
ACCEPT 15, FILEIN
FILEIN(15) = 0
OPEN (2, NAME=FILEIN, FORM='FORMATTED', STATUS='OLD')
READ (2,5) NCDATA, ND1, ND2
DO 11 N=1, NCDATA
   READ (2,4) CX1(N), CY(N)
   CX(N) = CX1(N) - ZERO
   C WRITE (6,4) CX(N), CY(N)
11 CONTINUE
CLOSE (2)
3 FORMAT (F8.4)
4 FORMAT (D15.7, ',D15.7')
5 FORMAT (I4,I1,I1)
6 FORMAT (D15.7, ',D15.7')
7 FORMAT ('<< ZERO IS =', F8.4)
14 FORMAT (E10.4)
15 FORMAT (15AI)
TYPE*, '>> NAME OF MICROMETER DATA TO BE READ?
ACCEPT 15, FILNAM
TYPE*, '>> NAME OF FILE FOR DATA TO BE WRITTEN TO?
ACCEPT 15, FILOUT
FILNAM(15) = 0
FILOUT(15) = 0
OPEN (3, NAME=FILNAM, FORM='FORMATTED', STATUS='OLD')
OPEN (4, NAME=FILOUT, FORM='FORMATTED', STATUS='NEW')
TYPE*, '>> IS DIAL INDICATOR DATA FIRST=1 OR SECOND=0 IN DATA 1 FILE?
ACCEPT*, TEST
READ (3,5) NDATA, ND1, ND2
IF (TEST.EQ.1) GOTO 19
DO 17 I=1, NDATA
   READ (3,6) MX(I), MY(I)
17 CONTINUE
GOTO 20
19 DO 20 I=1, NDATA
   READ (3,6) MY(I), MX(I)
20 CONTINUE
WRITE (6,16) NDATA, NCDATA
16 FORMAT (' NUMBER OF MICROMETER DATA PTS = ',I4,' NUMBER OF 1 CALIBRATION PTS = ',I5)
SUMYI = 0.0
DO 31 I=1, NDATA
   DO 21 N=1, NCDATA
      WRITE (6,16) MX(I), MY(I)
   21 CONTINUE
31 CONTINUE
WRITE (6,16) NDATA, NCDATA

IF (MX(I)-CX(N) .EQ. 0.0) GOTO 22
IF (MX(I)-CX(N) .LT. 0.0) GOTO 23

CONTINUE

Y(I)=MY(I)-CY(N)
GOTO 30

FRAC=(MX(I)-CX(N-1))/(CX(N)-CX(N-1))
Y(I)=MY(I)-((CY(N-1)-CY(N))*FRAC+CY(N))

SUMYI=SUMYI+Y(I)**2

CONTINUE

STDDEV=(SUMYI/NDATA)**0.5
WRITE (6,32) STDDEV

FORMAT ('RECORD THIS NUMBER AS STANDARD DEVIATION','F9.5','<<<<')
DO 41 I=1,NDATA
WRITE (4,26) MX(I)
FORMAT (F9.4)
DO 51 I=1,NDATA
WRITE (4,27) Y(I)
FORMAT (F10.6)
WRITE (6,36) NDATA,FILOUT

FORMAT (I5,'DATA POINTS HAVE BEEN WRITTEN TO','15A1)
CLOSE (3)
CLOSE (4)
call exit
END
### Appendix C
Summary of Known Dividing and Ruling Engines:

* Indicates engine has been described and illustrated in this work (usually Chapter 4)
* * Indicates an illustration of this engine is given in the reference.

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<th>Type/Location</th>
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<td>Taughton: 1809, Stimson: 1985, p.113</td>
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<td></td>
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<td>UK Pat. 3446</td>
<td>Sectograph.</td>
</tr>
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</table>
1814 Kater CDE Kater: 1814
ca. 1815 Fraunhofer RE Anbronn: p.427; Payen: 1985, 160
ca. 1820 Gambey CDE (CNAM-8323) Gambey's method for making the Paris
      Derry/Williams, p.12 Obs. 2m mural circle (1840) is found in History of

1822 Barton/Maudslay? RE (SML-34)
1826, 1828 Donkin LDE Holtzapffel: 1854, p.652 Appears that the first CDE was modified with error
compensating bar in 1828.

ca. 1825 Amici CDE Anbronn: p.427
*1830 Ross CDE Brashear: p.414
ca. 1830-92+ Repsold CDE Brashear says was still operating in 1892 and had
      divided more instruments than perhaps any other DE. It
      was accurate to 1.6" in 1892 having been continually
      improved by three generations of Repsold.
      One of Donkin's DE's is in the Science Museum.

1842 Donkin LDE Holtzapffel: p.652-3
e.1840's Joseph Saxton RE Warner: 1986, p.126
*1843 Simms CDE Simms: 1846; Anbronn: p.438-40
*<1845 Nobert RE Turner: 1967
      First automatic machine built in US; firm later
      became Brown & Sharpe.

**ca. 1850 Oertling CDE Anbronn: p.429-38
**ca. 1850 Sécretan CDE Anbronn: p.440-43

1852 Samuel Darling LDE Roe: 1914, p.203
**1852/72 John H. Temple CDE Anbronn: p.445
      C. From Bangor, Maine.
      This engine went to Buff & Berger in 1877 and to C.L
      Berger & Sons in 1898.
      This machine had 4320 divisions having been copied
      from the Troughton & Simms Machine made by Simms.

<1854 Wurdeman (Washington) CDE Brashear: p.414;
      Roe: 1914, p.206.1854 Diameter--14.1cm

1855 Perreaux CDE (ITT-1)
1855 Perreaux LDE (ITT-2)
**ca. 1852-7 E. & G.W. Blunt CDE Bowditch: 1857, ads p.2
1859 Joseph R. Brown LDE Roe: 1914, p.203
ca. 1863-72 Lewis Rutherford RE Warner: 1986, p.126
ca. 1860's J. Sprenger CDE Anbronn: p.444
*1860/70 Waterhouse RE (RMS) Turner: 1988
ca. 1870 Rayleigh RE Rayleigh: 1874

LDE, CDE purchased at Paris Exposition-1855
<table>
<thead>
<tr>
<th>Year</th>
<th>Maker/Manufacturer</th>
<th>Reference</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1872</td>
<td>Frederick Cooke</td>
<td>CDE (SML-37)</td>
<td>Spon: 1874, p.1803</td>
</tr>
<tr>
<td>**&lt;1874</td>
<td>M. Salleron</td>
<td>LDE</td>
<td>Spon: 1874, p.1805</td>
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<tr>
<td>**&lt;1874</td>
<td>M. Salleron</td>
<td>CDE</td>
<td>Rogers: 1884</td>
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<tr>
<td>ca.1874</td>
<td>Buff &amp; Berger</td>
<td>CDE</td>
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<tr>
<td>**&gt;1875?</td>
<td>G.N. Saegmüller (Fauth &amp; Co.)</td>
<td>CDE</td>
<td>Anbronn: p.445-8</td>
</tr>
<tr>
<td>**&gt;1875?</td>
<td>Heyde</td>
<td>CDE</td>
<td>Anbronn: p.452-3</td>
</tr>
<tr>
<td>**&gt;1875?</td>
<td>Obertheil</td>
<td>CDE</td>
<td>Anbronn: p.451-2</td>
</tr>
<tr>
<td>**&gt;1875?</td>
<td>Max Ott</td>
<td>CDE</td>
<td>Anbronn: p.451</td>
</tr>
<tr>
<td>**&gt;1875?</td>
<td>Th. Wegener</td>
<td>CDE</td>
<td>Anbronn: p.449-50</td>
</tr>
<tr>
<td>1878</td>
<td>van Woerd/Ballou</td>
<td>RE</td>
<td>Rogers: p.225</td>
</tr>
<tr>
<td>&lt;1879</td>
<td>Desmoulins-Froment</td>
<td>LDE</td>
<td>Rogers: p.221</td>
</tr>
<tr>
<td>&lt;1879</td>
<td>Brunner Frères</td>
<td>LDE</td>
<td>Rogers: pp.221,222</td>
</tr>
<tr>
<td></td>
<td>Thomas Grubb</td>
<td>RE</td>
<td>Warner: 1986, p.129</td>
</tr>
<tr>
<td>*1879/81</td>
<td>Mallock/Munro</td>
<td>RE</td>
<td>Mallock: 1882</td>
</tr>
<tr>
<td>ca.1880</td>
<td>Ballou</td>
<td>RE</td>
<td>Rogers: p.225</td>
</tr>
<tr>
<td>1882</td>
<td>Rowland</td>
<td>RE</td>
<td>Rowland: 1882</td>
</tr>
<tr>
<td>&lt;1884</td>
<td>Hoe</td>
<td>CDE</td>
<td>Rogers: p.255</td>
</tr>
<tr>
<td>*1887-8</td>
<td>Adam Hilger</td>
<td>RE (SML-33)</td>
<td>Scoble: 1912</td>
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<tr>
<td>1889</td>
<td>Rowland</td>
<td>RE</td>
<td>Warner: Strong: 1986</td>
</tr>
<tr>
<td>1894</td>
<td>Rowland</td>
<td>RE</td>
<td>Warner: Strong: 1986</td>
</tr>
<tr>
<td>*1897</td>
<td>Smith</td>
<td>RE</td>
<td>Smith: 1897</td>
</tr>
<tr>
<td>**ca.1904</td>
<td>E.R. Watts &amp; Son</td>
<td>CDE</td>
<td>McCaw: p.226-8</td>
</tr>
<tr>
<td>nd</td>
<td>Pistor &amp; Martín</td>
<td>CDE</td>
<td>Brashear: p.414</td>
</tr>
<tr>
<td>nd</td>
<td>Bamberg</td>
<td>CDE</td>
<td>Brashear: p.414</td>
</tr>
<tr>
<td>nd</td>
<td>Gautier</td>
<td>CDE</td>
<td>Brashear: p.414</td>
</tr>
<tr>
<td>nd</td>
<td>Warner &amp; Swasey</td>
<td>CDE</td>
<td>Brashear: p.414</td>
</tr>
</tbody>
</table>

See J.H. Temple above. B&B also made one for Rogers who then modified it in 1878 to have a free nut. See also Warner: 1986.

Divided to 5'.

Endless screw was of Hindley form. Limb carried two scales.

Circle 1m in diameter and divided to 5'.

Circle 1m diameter.

Circle 1m diameter.

Made for Rogers at Waltham Watch Comp.

Made for Prof. Wm. Anthony of Cornell Univ.

Errors measured by Prof. Morley to be <1°.
### Appendix D:
U.K. Patents for Screws and Related Tools to 1852

**Source:** Woodcroft: 1854

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Patentee</th>
<th>Short Description of the Patent</th>
</tr>
</thead>
<tbody>
<tr>
<td>306</td>
<td>2/12/1692</td>
<td>Joseph Williams</td>
<td>Engine consisting of screws, wheels and wrenches for drawing and raising great weights; useful in raising minerals, buildings and merchant's goods; loading/unloading ships, etc.</td>
</tr>
<tr>
<td>751</td>
<td>14/05/1760</td>
<td>Job/Wm. Wyatt</td>
<td>Cutting screws of iron, called wood-screws.</td>
</tr>
<tr>
<td>1179</td>
<td>5/02/1778</td>
<td>William Harrison</td>
<td>Making screws and machines for dividing of Peter Atherton instruments from said screws.</td>
</tr>
<tr>
<td>1381</td>
<td>29/07/1783</td>
<td>Wm. Forbes</td>
<td>Manufacturing bolts and other ships' fastenings.</td>
</tr>
<tr>
<td>1388</td>
<td>2/10/1783</td>
<td>Wm. Collins</td>
<td>Making and preparing bolts to fasten ships' timbers together.</td>
</tr>
<tr>
<td>1408</td>
<td>17/12/1783</td>
<td>Wm. Playfair</td>
<td>Cutting or dividing pieces of metal and giving them a cylindrical or other uniform shape through their whole length, or making them taper regularly, for the formation of bars, bolts, rods, wire...</td>
</tr>
<tr>
<td>1536</td>
<td>4/03/1786</td>
<td>John Butler</td>
<td>Making ships' bolts and rods, from iron, copper, brass or iron shearings.</td>
</tr>
<tr>
<td>1691</td>
<td>7/07/1789</td>
<td>Thomas Todd</td>
<td>Machine for making screws and nuts and boxes for screws.</td>
</tr>
<tr>
<td>2482</td>
<td>17/02/1801</td>
<td>John Bennoch</td>
<td>Machine for making nails, bolts, rods, watch springs and metal plates.</td>
</tr>
<tr>
<td>3428</td>
<td>1/04/1811</td>
<td>Thomas Wm. Sturgeon</td>
<td>Micrometers.</td>
</tr>
<tr>
<td>3860</td>
<td>10/12/1814</td>
<td>Ed. Glover</td>
<td>Apparatus for drawing or extruding bolts, nails, etc. and/or various other purposes.</td>
</tr>
<tr>
<td>4060</td>
<td>15/08/1816</td>
<td>Anthony Gilchrist</td>
<td>Machine for making nails and screws and for working all metallic substances.</td>
</tr>
<tr>
<td>4117</td>
<td>13/05/1817</td>
<td>James Gerard Colbert</td>
<td>Making screws of iron, brass, steel or other metals for use in woodwork.</td>
</tr>
<tr>
<td>4258</td>
<td>7/05/1818</td>
<td>Wm. Church</td>
<td>Machinery for making nails and spikes and also wire and screws of iron, copper, brass, or other metal</td>
</tr>
<tr>
<td>4554</td>
<td>1/05/1821</td>
<td>Alex. Law</td>
<td>Formation of bolts and nails for ships and other fastenings.</td>
</tr>
</tbody>
</table>
4571  17/07/1821  Alex. Law
       Formation of bolts and nails for ships and other fastenings.
5703  18/10/1828  Lennuel Wellman Wright
       Machinery for making screws.
5929  24/04/1830  Samuel Brown
       Making bolts and chains.
6200  22/12/1831  Wm. Jones, Dan. Ledsam
       Machinery for making pins, rivots, wood screws and nails.
6558  19/02/1834  Miles Berry
       Machinery for shaping metal into bolts, rivots, nails and other articles...partly
           applicable to other purposes.
6566  27/02/1834  Joseph Whitworth
       Machinery for cutting screws.
6571  06/03/1834  Thomas John Fuller
       Shape of nails, spikes and bolts.
6576  18/03/1834  James Jamieson Cordes
       Machinery for making rivots and screw blanks and bolts.
6599  24/04/1834  John Bethell
       Machinery for making metal screws, pins, bolts and rivots.
6687  08/08/1834  James Jamieson Cordes
       Machinery for making rivots and screw blanks and bolts.
6850  11/06/1835  Joseph Whitworth
       Tools or apparatus for turning, boring, planing and cutting metals and other materials.
6956  16/12/1835  Robert Griffiths
       Machinery for making rivot screw-blanks and bolts.
7203  06/10/1836  Miles Berry
       Machinery for making metal screws.
7237  29/1836  Henry Downing
       Manufacturing rivots, screw-blanks and other articles.
7271  11/01/1837  Sam. Evers, Robert Griffiths
       Manufacturing of bars and nuts for screws.
7291  28/01/1837  Miles Berry
       Machinery for making metal screws: applicable to shaping metal for other purposes.
7332  28/03/1837  Joseph Whitworth
       Tools or apparatus for turning, boring, planing and cutting other materials.
7441  5/10/1837  Joseph Whitworth
       Tools or apparatus for turning, boring, planing and cutting other materials.
7862  8/11/1838  Thomas Mayos Woodyalt, Sam. Harrison
       Manufacture of wood screws.
7953  29/01/1839  John Hillard
       Machinery for making screws.
7999  12/03/1839  Job Cutler
       Constructing chains for suspension bridge cables, mining and other purposes; making
           the bars, links and bolts thereof.
8005  11/03/1839  Thomas Henry Ryland
       Manufacture of screws for wood, in iron, brass, copper or mixed metal. "Wood Screws".
8048  23/04/1839  James & Wm. Edmonson
       Machinery for manufacture of wood screws and screw-bolts.
<table>
<thead>
<tr>
<th>Patent No.</th>
<th>Date</th>
<th>Name</th>
<th>Description</th>
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<tr>
<td>8064</td>
<td>8/05/1839</td>
<td>Richard Prosser</td>
<td>Machinery for making nails and screws.</td>
</tr>
<tr>
<td>8188</td>
<td>7/08/1839</td>
<td>Joseph Whitworth</td>
<td>Tools or apparatus for planing, boring and cutting metals or other substances.</td>
</tr>
<tr>
<td>8246</td>
<td>24/10/1839</td>
<td>William Newton</td>
<td>Machinery for manufacturing screws.</td>
</tr>
<tr>
<td>8269</td>
<td>12/11/1839</td>
<td>Moses Poole</td>
<td>Making nails, bolts and spikes.</td>
</tr>
<tr>
<td>8438</td>
<td>19/03/1840</td>
<td>John Jackson</td>
<td>Manufacture of nails, nuts, bolts and rivets.</td>
</tr>
<tr>
<td>8705</td>
<td>17/11/1840</td>
<td>Joe Whitworth, John Spear</td>
<td>Tools or apparatus for planing, boring and cutting metals or other substances.</td>
</tr>
<tr>
<td>8720</td>
<td>25/11/1840</td>
<td>Nathaniel Bartho</td>
<td>Tools or apparatus for planing, boring and cutting metals or other substances.</td>
</tr>
<tr>
<td>8764</td>
<td>31/12/1840</td>
<td>Joseph Stubbs</td>
<td>Construction of screw-wrenches and spanners, for screwing and unscrewing nuts and bolts.</td>
</tr>
<tr>
<td>8822</td>
<td>30/01/1841</td>
<td>Ezra Jenks Coates</td>
<td>Forging bolts, spikes and nuts.</td>
</tr>
<tr>
<td>8835</td>
<td>8/02/1841</td>
<td>Wm. Ryder</td>
<td>Apparatus for forging, drawing, moulding or forming spindles, rollers, bolts and various other like articles in metal.</td>
</tr>
<tr>
<td>9210</td>
<td>24/12/1841</td>
<td>Benjamin Wakefield</td>
<td>An improved bolt for building and other purposes.</td>
</tr>
<tr>
<td>9641</td>
<td>21/02/1843</td>
<td>Bn. Brunton Blackwell</td>
<td>Coating iron nails, screws, nuts, bolts and other articles made of iron, with certain other metals.</td>
</tr>
<tr>
<td>10065</td>
<td>21/02/1844</td>
<td>Ezra Jenks Coates</td>
<td>Forging bolts, spikes and nails.</td>
</tr>
<tr>
<td>10324</td>
<td>19/09/1844</td>
<td>Wm. Newton</td>
<td>Machinery to be employed in manufacturing nails, rivots, screws and pins.</td>
</tr>
<tr>
<td>10457</td>
<td>11/01/1845</td>
<td>Robert Griffiths</td>
<td>Manufacture of bolts, railway-pins, spikes and rivots.</td>
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<tr>
<td>10800</td>
<td>4/08/1845</td>
<td>Chas. Henry Joe Forret</td>
<td>Archimedian screw called &quot;Davaines screw&quot;.</td>
</tr>
<tr>
<td>10839</td>
<td>26/09/1845</td>
<td>Vincent Alfred</td>
<td>Machinery for manufacturing screws.</td>
</tr>
<tr>
<td>10840</td>
<td>26/09/1845</td>
<td>Vincent Alfred</td>
<td>Machinery for manufacturing metal pipes or screws.</td>
</tr>
<tr>
<td>10987</td>
<td>10/12/1845</td>
<td>Thomas Williams</td>
<td>Wrenches or spanners.</td>
</tr>
<tr>
<td>11196</td>
<td>5/05/1846</td>
<td>Alfred Vincent Newton</td>
<td>Machinery for manufacturing screws.</td>
</tr>
<tr>
<td>11363</td>
<td>31/08/1846</td>
<td>James Warren</td>
<td>Manufacture of cast-screws.</td>
</tr>
<tr>
<td>Patent Number</td>
<td>Date</td>
<td>Name(s)</td>
<td>Description</td>
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<td>11620</td>
<td>10/03/1847</td>
<td>Louis Nicolas DeMeckenheim</td>
<td>Machinery for making nails, screw blanks, rivots, bolts and pins.</td>
</tr>
<tr>
<td>11741</td>
<td>12/06/1847</td>
<td>James Johnson</td>
<td>Machinery for the manufacture of rivots, railway or other pins, bolts, nuts and spikes.</td>
</tr>
<tr>
<td>11791</td>
<td>12/07/1847</td>
<td>Wm. Edward Newton</td>
<td>Manufacture of screws.</td>
</tr>
<tr>
<td>12907</td>
<td>19/12/1849</td>
<td>Joseph Whitworth</td>
<td>Machinery for cutting metals.</td>
</tr>
<tr>
<td>13089</td>
<td>1/06/1850</td>
<td>Ezra Jenks Coates</td>
<td>Manufacture of bolts, spikes and nails.</td>
</tr>
<tr>
<td>13187</td>
<td>23/07/1850</td>
<td>Leonard Bower, Thomas Fortune</td>
<td>Machinery for manufacturing screws, bolts, rivots and nails.</td>
</tr>
<tr>
<td>13247</td>
<td>5/09/1850</td>
<td>Frederick Woodbridge</td>
<td>Machinery for manufacturing rivots, bolts and screw-blanks.</td>
</tr>
<tr>
<td>13557</td>
<td>15/03/1851</td>
<td>Richard Archibald Brooman</td>
<td>Manufacturing screws.</td>
</tr>
<tr>
<td>13654</td>
<td>3/06/1851</td>
<td>Cornelius Alfred Jaquin</td>
<td>Manufacture of nails, pins, tacks, screws and other similar articles.</td>
</tr>
<tr>
<td>13773</td>
<td>16/10/1851</td>
<td>Wm. Onions</td>
<td>Manufacture of nuts and bolts; of bearings...; mills and dies for engravers; of bells, lathe and other spindles.</td>
</tr>
<tr>
<td>13915</td>
<td>24/01/1852</td>
<td>John Hinks</td>
<td>Machinery to be used in the manufacture of nails, rivets, bolts or pins and screw blanks.</td>
</tr>
<tr>
<td>13957</td>
<td>9/02/1852</td>
<td>Jeremiah Driver, John Feather</td>
<td>Screws.</td>
</tr>
<tr>
<td>14084</td>
<td>22/04/1852</td>
<td>Alfred Vincent Newton</td>
<td>Manufacturing wood-screws; machinery used therein; partly applicable to arranging and feeding pins; sorting screws, pins and other articles or various sizes.</td>
</tr>
<tr>
<td>14213</td>
<td>6/06/1852</td>
<td>John Ramsden</td>
<td>Machinery for cutting screws.</td>
</tr>
<tr>
<td>14298</td>
<td>18/09/1852</td>
<td>Bernard Peard Walker, James Warren</td>
<td>Manufacture of screws and screw-keys, etc.</td>
</tr>
</tbody>
</table>
E.1 Parameters and fields used on the profile figures
Appendix E

Compilation of the Graphic Results

This appendix comprises the shadowgraphs for each screw sample and an accompanying figure with the relevant measured parameters. These are described below with reference to Fig. E.1. Within each classification of screw, e.g. 'filar', the shadowgraphs are ordered by the 'study code'. One is referred to Tables 6.1 or 6.2 for a listing by study code or date (resp.) and if one is looking for instruments by a specific maker or for a specific classification, this is the best method to locate desired instruments. Perusal of the various sections of Table 6.2 will locate related screws, i.e. ones from the same instrument but of different function. The Jurkevich/Swingler period searching graphs for each micrometer screw is shown facing the digitized profiles. Although these were plotted for all samples, it would not be useful to include those for lower precision classes. Samples of results are found in Chapter 6 and their use as a discriminating method is discussed there.

Acetate overlays are provided in the back pocket for the shadowgrams and for the periodograms. For the shadowgrams, one can compare a given screw profile with that of various standards. The overlays for the periodograms will help identify the fraction of the primary peak which is not included. As was described in §6.7, broad peaks at the right of the upper periodogram have little significance; the level of significance can be checked by remembering that the maximum travel of the dial indicator was \(-20\text{mm}\). Spurious periods result in the range above \(-1/2\) the full travel of the dial indicator (which may be less than 20mm).

For the various classes of micrometers and dividing engines, data and graphs generated from the dial indicator method of investigation will also be found facing the digitized profiles. The Jurkevich/Swingler periodograms for these measurements are—in most cases—found below those generated from the shadowgrams. The exceptions are those where, for space reasons, one periodogram is placed below its compliment, but these may be identified by the sample code at the top of the figure.

Characteristics:

1) Screw/Nut: Black box indicates whether the sample was a screw or nut. For gauges, samples intended for testing nuts are indicated as screws while samples for testing screws are indicated as nuts.

2) Length: Given for the screw &/or nut and appears under the appropriate box. The length given is for the threaded portion only.
3) Diameter: Given for the OD of the screw. Since no means was at hand to measure the internal diameter of nuts, the OD of the screw is usually the nominal value used. Where four significant figures are given, the measurement was made with a bench micrometer (accuracy ±0.002-3mm). Those with fewer digits where measured with a precise ruler and for those nuts were the thread is in a blind hole, the length was estimated by 'feeling' the threads with a fine pointed tool.

4) Material: Most instruments tested were either steel or brass. A few were iron or wrought iron. No attempt was made to more precisely determine the metallurgical content of the material of the samples.

Instrument Identification:

5) Study code: See §5.1.2. Note that instruments followed by a lower case letter indicate that more than one sample was acquired from the instrument. Comparison should be made to others on the same instrument which may appear under any of the different classes noted in 10).

6) Instrument: The common name used for the type of the instrument.

7) Maker: This gives the signed name but should not be interpreted as the definitive maker since many instruments of the period investigated were made wholesale and sold to the trade. Indeed, subcontracting meant that components for a single instrument originated from various sources particularly as the 19th c progressed. For samples with maker's names such as Ramsden, any one of his journeymen or apprentices could have made the particular sample. However, for micrometer and dividing engine samples, it may be assumed that only the most competent workmen would have made and finished the precision screws.

8) Date: Few of the instruments studied were engraved with the date of manufacture. Thus the date given is based on information known of its origin by the museum, on design characteristics (including illustrations of such instruments from contemporary sources) or on the dates a maker was known to be in business. Interpretations: ca.1860 =1860 ± 5-10yrs.; 1860's indicates there is reason to believe that an instrument was made in a particular decade; 3rd q 19th c = 1850-1875 and 2nd h 19th c = 1850-1900 are used when a maker or firm was in business for a long period but no information permits narrowing the date more precisely--these are most commonly used for simpler forms of instruments since design details of more complex instruments usually confine the period to some extent. For plotting purposes, a 'best guess' was necessary and in most cases is the largest source of error.

9) Acquisition &/or serial number: Gives a museum acquisition number when known. If the instrument carries a serial number that is given as well.
10) Screw class (more than one may be indicated where it assists in specifying the use):

**Micrometers:**
- **Filar**: includes both filar and bifilar micrometers usually intended for astronomical use with an eyepiece,
- **Scale**: micrometers intended for reading subdivisions of instrument scales,
- **Bench**: micrometers intended for use as tools or as part of tools to determine size of objects.

**Dividing Engines**: Screws found on such instruments for scale division, ruling spectral gratings or related artifacts, e.g. Barton's buttons.

**Adjusting**: Screws used to adjust the position of instrument components but excluding leveling screws used on the mounting of astronomical or surveying instruments. Screws used to adjust the alignment of tubes of transits or theodolites are included as adjusting screws.

**Leveling**: Used on the feet of astronomical or surveying instruments.

**Focusing**: Used for focusing the lenses of telescopes, microscopes etc.

**Eyepiece**: Any thread found on a telescope or microscope eyepiece for attaching the eyepiece to the parent instrument or a filter to an eyepiece.

**Tube**: Any thread used for assembly of an eyepiece or for attaching one section of a tube to another including an objective lens cell to a tube.

**Tool**: Threads found on instruments whose primary purpose is as a workman's tool rather than for making scientific measurements.

**Gauge**: Threads or 'quasi'-threads intended for testing the profile of screws.

**Binding**: Screws whose purpose is simply to hold or fix two components together.

**Miscellaneous**: Threads which do not clearly fall under any of the above categories. A description of the use is generally given in Field 18.

11) **Depth**: Gives the thread depth as measured from the digitized profile of the thread. In general, the metric value is given to three decimal places but the accuracy is dependent on the quality of the digitized profile and the number of points in the profile. The accuracy in most cases is better than 0.01mm. The metric value was converted to English units because the majority of screw samples were made in English workshops where English measuring instruments would have been employed.

12) **Flank angles**: Left, right and full flank angles are given and were measured with respect to a line running parallel to the mean line of the profile. See §5.2.5 for estimates of the accuracy.

13) **Pitch**: Also determined in metric units and then converted to English units and to TPI for convenience only. Reference should be made for comparison purposes to the metric values. As was the case for the thread depth, the accuracy of the pitch is profile dependent, being greater for those threads with more digitized points (hence of higher TPI) and of more consistent form. The accuracy in the majority of cases is at least 0.005mm.

14) **Truncation** (for both the root and crest): Determined by extending the flanks to their intersection point and measuring the distance to the mean crest or root line and dividing by the overall untruncated profile. Truncation measurements are not good
discriminators, particularly in older samples, due to the uncertainty in fixing the top or bottom of the crest or root and to the intrusion of errors in the flank angles.

15) **Rounding** (for both the root and crest): Determined by using a circle template and scaling the radius appropriately. Can be reasonably accurate despite large scatter of digitized points especially in samples where one run of digitized points may be measured and compared with other runs for individual thread profiles.

16) **Mean Error:** The scatter of the points on both left and right flanks were measured and averaged. Taken as an indication of the screw's precision. Measurements were made at approximately the mid-line between root and crest although in many cases this would not have been the point of contact between the screw and nut. However, not having samples of all nuts so that the profiles could be compared with the screw to determine the point of contact, the centre line is the most appropriate choice and provides some consistency. In most cases this is a small point since the scatter does not vary widely along each flank.

17) **Ratios:**
   - **A/R (Aspect Ratio):** Ratio of the thread depth to pitch. This is useful to discriminate between use and date. In general a smaller aspect ratio indicates older threads.
   - **D/OD:** Ratio of the depth of the thread to the overall diameter of the screw or internal diameter of nuts. In precision screws this is not an important factor since very little stress is encountered. In binding or leveling screws the stress may be considerable and lower values will be encountered.

18) **Notes:** Any relevant information on the identification of the thread or instrument, its maker, date, classification, etc. will be found in this area.
Characteristics:
- Screw
- Nut
- Length: 1.5" / 0.625"
- Diameter: 0.156"
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: MHS-1b
- Instrument: Micrometer
- Maker: Wm. Simms
- Date: ca. 1850
- Ser./Acq. No. 7

MHS-1B

- CREST

- T_c = \frac{1}{2.6}
- R_c = 0.05 \text{ mm}
- \text{A/R: 0.65}
- D/DD: 0.040

- Mean Error = 3.3 %
- R_f = 0.05 \text{ mm}
- T_f = 3.2
- LF = 16.1
- RF = 10.3
- TFA = 26.4

- Pitch: 0.2436 mm
- 0.0096 in
- TPI: 104.3

See MHS-1a for Drum/Scale description
The dial housing was damaged.

**Characteristics:**
- Screw [ ]
- Nut [ ]
- Leng: 5.5° / 0.50°
- Diameter: 0.281°
- Steel [ ]
- Brass [ ]
- Other:

**Instrument Identification:**
- Study Code: MHS-3b
- Instrument: Micrometer
- Maker: John Bird
- Date: ca.1770
- Ser./Acq. No.

![Diagram showing MHS-3B characteristics and measurements](image-url)
Characteristics:
- Screw
- Nut
- Length: 1.00" / 0.38"
- Diameter: 0.1542"
- Steel
- Other:

Instrument Identification:
- Study Code: MHS-9
- Instrument: Microscope Micrometer
- Maker: Powell & Leeland
- Date: 1864
- Ser./Acq. No.

MHS-9

CREST

Ratios:
- A/R: 0.55
- D/OD: 0.069

Mean Error = 5.5%

Rc = 0.08 mm
Rr = 0.08 mm
Tr = 4.6
Tc = \frac{1}{3.7}

Depth 0.256 mm

Drum: 1.313" diameter with 0-100 divisions and ±0.2 div.
resolution
(at 170 Euston Rd)

Wenham microscope #1 type

See next page for comparison
**Characteristics:**
- Screw [ ]
- Nut [ ]
- Leng: 1.00" / 0.38"
- Diameter: 0.1542"
- Steel [ ]
- Brass [ ]
- Other:

**Instrument Identification:**
- Study Code: MHS-9-2
- Instrument: Micrometer
- Maker: Powell & Leyland
- Date: 1864
- Sel./Acq. No. marked "R.L."*

**MHS-9**

**CREST**

**Ratios:**
- $R_c = 0.08 \text{ mm}$

**Mean Error**

**Comparison with previous page**

The quality of the SG seemed poor for the date and thus repeated but with the same results. The SG's and digitized profiles agree with Hackmann's observation that Powell made his micrometer screws by hand.
Characteristics:
- Screw □ Nut ■
- Leng: 1.00" / 0.38"
- Diameter: 0.1542"
- Steel □ Brass ■
- Other:

Instrument Identification:
- Study Code: MHS-9-2
- Instrument: Micrometer
- Maker: Powell & Leeland
- Date: 1864
- Ser./Acq. No. marked "R.L."

* R.L. = Radcliffe Library

Compare with previous page

The quality of the SG seemed poor for the date and thus repeated but with the same results. The SG's and digitized profiles agree with Hackmann's observation that Powell made his micrometer errors in his...
Characteristics:
- Screw [ ] Nut [ ]
- Leng: 1.50" / 0.375"
- Diameter: 0.261" nom.
- Steel [ ] Brass [ ]
- Other:

Instrument Identification:
- Study Code: PO-1d
- Instrument: Micrometer
- Maker: C. Langlois
- Date: 1738
- Ser./Acq. No. 1A 1811

Nut for PO-1a
Parent instrument is a 6ft portable sextant used by de LaCaille at the Cape (1751)
Characteristics:

- Screw
- Leng: ≈1.25" / ≈0.13"
- Diameter: 0.1428"
- Steel

Instrument Identification:

- Study Code: ROG-1
- Instrument: Eyepiece Micrometer
- Maker: Wm. or A. Herschel
- Date: ca. 1780(?)
- Ser./Acq. No. 0L76 and marked E5

Drum: 2" diameter divided 0-60-0 with resolution of ±0.5 div.
Scale: none but total travel ≈1"

Mean Error = 11 %

R_c = 0.11 mm

R_f = 0.07 mm

T_c = \frac{1}{4.9}

Tr = 7.2

L_f = 39.0

R_f = 36.2

T_f = 75.2

Pitch: 0.5022 mm

0.0196 in

TPI: 50.6
**Characteristics:**
- Screw [ ]  
- Nut [ ]
- Leng: 1.375"  
- Diameter: 0.156"
- Steel [□] Brass [ ]
- Other:

**Instrument Identification:**
- Study Code: R06-3b  
- Instrument: Binocular micrometer  
- Maker: Dollond  
- Date: ca. 1840  
- Ser./Acq. No. 0L-17

---

**Diagram Description:**
- **ROG-3B**
- **Crest**
- **Characteristics:**
  - Ratios: A/R: 0.39  
  - D/OD: 0.024
- **Instrument Identification:**
  - Study Code: R06-3b  
  - Instrument: Binocular micrometer  
  - Maker: Dollond  
  - Date: ca. 1840  
  - Ser./Acq. No. 0L-17

---

**Additional Information:**
- **Tc = 1/4.1**
- **Rc = 0.05 mm**
- **Rf = 0.04 mm**
- **Mean Error = 9.1%**
- **Depth: 0.0037 m**
- **Pitch: 0.2441 mm**
- **TPI: 104.1**

See R06-3a for drum description.
Characteristics:
- Screw □ Nut □
- Leng: 1.125''
- Diameter: 0.1776''
- Steel □ Brass □
- Other:

Instrument Identification:
- Study Code: ROG-4b
- Instrument: Bifilar Mu
- Maker: Troughton & Simms
- Date: ca.1840
- Ser./Acq. No. 0L-18

ROG-4B

CREST

Mean Error = 7.7 %

Ratios:
- A/R: 0.89
- D/OD: 0.050

Tc = 1 / Ig.

Rc = 0.07 mm

Rr = 0.05 mm

Filar Scale
Bench
Div. Eng.
Adjust.
Leveling
Focus
Eye P.
Tube
Tool
Gauge
Binding
Misc.

Mu Drum: dia.: 1.875''
# divisions: 100
resolution: 1/10 div.
Characteristics:
- Screw
- Nut
Leng: 1.125"
Diameter: ≈ 0.156"
- Steel
- Brass
Other:

Instrument Identification:
- Study Code: ROG-5
- Instrument: Dynameter
- Maker: N/S (T. Jones?)
- Date: ca. 1943
- Ser./Acq. No. 0L-16

ROG-5

\[ T_c = \frac{1}{3.5} \]

Ratios:
- A/R: 0.58
- D/OD: 0.074

R_c = 0.08 mm
R_f = 0.13 mm
T_c = 1.3
T_f = 2.3

Mean Error ≈ 2.6 μ

Drum: 1.25" diameter, 0-100 divisions with ±0.5 div. resolution

- Filar
- Scale
- Bench
- Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding
- Misc.

PITCH 0.5110 mm
0.0201 in
TPI 49.7
Characteristics:
- Screw
- Nut
- Length: 0.875" / 0.5"
- Diameter: 0.1146"
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: ROG-7b
- Instrument: Bifilar micrometer
- Maker: Delland
- Date: ca. 1780
- Ser./Acq. No. 00/R13=Gunter 200

Mean Error = 2.8 %

See ROG-7a for drum description
Characteristics:

- Screw □ Nut □
- Leng: 1.688" / 0.313"
- Diameter: 0.2738"
- Steel □ Brass □ Other:

Instrument Identification:

- Study Code: RGD-8A
- Instrument: Heliometer
- Maker: Dollond & Son
- Date: ca.1755
- Ser./Acq. No. 00/RF26

Graph:

- Ratio: A/R: 0.66
- D/OD: 0.061
- Tc = 1 - 4.8
- Rc = 0.08 mm
- Rr = 0.14 mm
- Mean Error = 2.0 %
- Depth: 0.457 mm
- Pitches: 1/4.5, 0.6501 mm, 0.0256 in
- TPI: 39.1

Drum: 1.125" diameter, 0-60 divisions with ±0.2 div. resolution
Scale: 0-25 divisions
Characteristics:

- Screw
- Nut
- Leng: 1.125" / ≈ 0.75"
- Diameter: 0.219" nom.
- Steel
- Brass
- Other:

Instrument Identification:

- Study Code: SML-1d
- Instrument: Bifilar micrometer
- Maker: Heath & Wing
- Date: ca. 1760's
- Ser./Acq. No. 1938-719

![Graph and Diagram](image-url)

**Characteristics:**
- R = 0.15 mm
- A/R = 0.66
- D/D = 0.061
- T = \( \frac{1}{5.2} \)
- T = \( \frac{1}{5.5} \)
- R = 0.09 mm
- Tc = 0.341 mm
- TF = 0.762 mm
- RF = 0.0300 in
- TF = 30.5
- RF = 36.5
- TFA = 75.0

**Mean Error:** 5.8 %

**Nut for SML-1b**

**Note:** The image includes a graph and a diagram with various measurements and calculations related to the characteristics and identification of an instrument.
Characteristics:
- Screw □
- Nut □
- Length: 3.00″
- Diameter: 0.351″
- Steel □
- Brass □
- Other:

Instrument Identification:
- Study Code: SML-5
- Instrument: Binocular microscope
- Maker: Not signed (French)
- Date: 3rd qtr 19th c
- Ser./Acq. No. 1986-377

Diagram:
- SML-5
- Characteristics of the instrument:
  - Filar Scale
  - Bench
  - Div. Eng.
  - Adjust.
  - Leveling
  - Focus
  - Eye P.
  - Tube
  - Tool
  - Gauge
  - Binding
  - Misc.
- Measurement:
  - $T_C = \frac{1}{1+g}$
  - $R_C = 0.07\text{mm}$
  - $R_f = 0.07\text{mm}$
  - Mean Error = 3.6%

Drum:
- Diameter: 2.625″
- Scale: 0-400 divisions with ±0.5 division resolution
- Roots very uneven in depth

Pitch:
- 0.398 mm
- TPI: 63.8

Note:
- $L_f = 11.7$
- $R_f = 12.6$
- $T_f = 24.3$
SML-6A

**Characteristics:**
- Screw
- Nut
- Length: 1.00" / 0.50
- Diameter: 0.1532"
- Steel
- Brass
- Other:

**Instrument Identification:**
- Study Code: SML-6a
- Instrument: Bifilar micrometer
- Maker: Ramsden
- Date: 1791
- Ser./Acq. No. 1929-979

**Diagram Details:**
- Ratios:
  - A/R: 0.56
  - D/OD: 0.034
- R_c = 0.05 mm
- R_r = flat nom
- R_t = 2.3
- Tr = 1
- T_e = 3.3
- LF = 13.8
- RF = 12.0
- TFA = 25.8
- Depth = 0.035 in
- PITCH = 0.0094 in
- TPI = 106.8

**Drum:**
- 1.22" diameter, 0-100 divisions with 0.4 div. resolution
- Scale: comb 1" long, 21 divisions subdivided into 5 divisions

**Miscellaneous:**
- Scale
- Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding

**Legend:**
- Filar
- Scale
- Bench
- Mu
Characteristics:
- Screw
- Nut

- Leng: 0.75" / ≈0.50"
- Diameter: 0.228"

- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-8a
- Instrument: Portable equatorial refracting telescope
- Maker: John Smeaton
- Date: ca. 1770
- Ser./Acq. No. 1931-347

Characteristics:
- Tc = 3.3
- Rc = 0.12 mm

Ratios:
- A/R: 0.29
- D/OD: 0.029

Mean Error
- 5.8%

Drum: 2.375" diameter, 0-100 divisions with ±0.2 div. resolution
Screws show evidence of tempering.
Characteristics:
- Screw
- Nut
- Leng: 5.25" / 0.5" (marked)
- Diameter: 0.25" nom.
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-26
- Instrument: Bifilar micrometer
- Maker: Jerimiah Sisson
- Date: ca. 1780
- Ser./Acq. No. 1927-1491

Drum: 2.5" diameter, 0-40 divisions with 0.1 div. resolution

Graham-type micrometer in the King George III Collection

Mean Error = 4.1 %

PITCH: 0.6449mm
TPI: 39.4

Ratios:
- A/R: 0.35
- D/DD: 0.036

T = 4.7

R = 0.09mm

R = 0.11mm

M = 0.2664mm

Depth: 0.0254in
Characteristics:
- Screw □ Nut □
- Length: 0.188" / 0.094"
- Diameter: 0.0542"
- Steel □ Brass □
- Other:

Instrument Identification:
- Study Code: SML-28a
- Instrument: Eyepiece micrometer
- Maker: Wm. or A. Herschel
- Date: ca.1780
- Ser./Acq. No. 1925-468 #E6

Drum: 0.97" diameter, 0-60 divisions with ±0.25 division resolution
Marked "E6" on eyepiece

Mean Error = 4.7%
Characteristics:
Screw [ ] Nut [ ]
Leng: 2.0" / 0.094"
Diameter: ~0.215"
Steel [ ] Brass [ ]
Other:

Instrument Identification:
Study Code: WMHS-7a
Instrument: Micrometer
Maker: John Rawley
Date: ca.1703
Ser./Acq. No. 1004

Drum: 2.5" diameter, 0-100 divisions with ±0.2div. resolution
Scale: 1.78" long, 0-60 divisions
Screw has light corrosion
Minimum wire separation #0.09"
Covers slide in 0.1" wide slots
Characteristics:
- Screw [ ] Nut [ ]
- Length: 0.75''
- Diameter: 0.1416''
- Steel [ ] Brass [ ]
- Other:

Instrument Identification:
- Study Code: SML-13a
- Instrument: Geodetic theodolite
- Maker: Randow
- Date: 118th c
- Ser./Acq. No. 1981-111

Diagram:
- SML-13A
- CREST
- Ratios: A/R: 0.62, D/OD: 0.061
- Mean Error = 3.5%
- Depth: 0.219 mm
- Pitch: 0.01140 in
- TPI 71.4
- Tc = 1/43
- Rc = 0.06 mm
- Pf = 3.7
- LF = 21.2
- RF = 25.0
- TFA = 44.2

Legend:
- Mu
- Filar Scale
- Bench Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding
- Misc.
SML-23C

Characteristics:
- Screw
- Nut
- Leng: 2.625"
- Diameter: 0.1841"
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-23c
- Instrument: Portable Quadrant
- Maker: Dollend
- Date: ca. 1767
- Ser./Acq. No. 1911-214

(Used by Samuel Holland in the survey of Gulf of St. Lawrence)
Characteristics:
Screw ☐ Nut ☐
Leng: 1.813" / 0.438"
Diameter: 0.1676 - 92°
Steel ☐ Brass ☐
Other:

Instrument Identification:
Study Code: SML-25a
Instrument: Portable quadrant
Maker: John Bird
Date: ca. 1767
Ser./Acq. No. 1900-138 (RS#63)

See Bennett: 1987, p.122
Characteristics:
- Screw □
- Nut □
- Leng: 1.719° / 0.563°
- Diameter: 0.3022”
- Steel □
- Brass □
- Other:

Instrument Identification:
- Study Code: Comparison
- Instrument: Micrometer
- Maker: Moore & Wright
- Date: 3rd q 20th c
- Ser./Acq. No.

MOORE-WRIGHT METRIC

MOORE-WRIGHT METRIC

<table>
<thead>
<tr>
<th>Characteristics:</th>
<th>Instrument Identification:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw □ Nut □ Leng: 1.719° / 0.563° Diameter: 0.3022” Steel □ Brass □ Other:</td>
<td>Study Code: Comparison Instrument: Micrometer Maker: Moore &amp; Wright Date: 3rd q 20th c Ser./Acq. No.</td>
</tr>
</tbody>
</table>

(Metric micrometer)
Characteristics:

- Screw □ Nut □
- Leng: ≈2.0° / ≈0.97°
- Diameter: 0.3403"
- Steel □ Brass □
- Other:

Instrument Identification:

- Study Code: MSTB-5
- Instrument: Micrometer
- Maker: Humphage, Jacques & Pederson
- Date: ca.1890
- Ser./Acq. No. 59-1064

---

**Diagram:**

- Mean Error = 0.9%
- Tc = 1/2.6
- Rc = Flat
- Tt = 1/4.3
- LF = 36.5
- RF = 34.9
- TFA = 71.4

---

**Dimensions:**

- Pitch: 2.520 mm (0.0992 in)
- TPI: 10.1
Characteristics:
- Screw □ Nut □
- Length: 1.00" □
- Diameter: 0.175" □
- Steel □ Brass □
- Other:

Instrument Identification:
- Study Code: MSTB-8a
- Instrument: Micrometer
- Maker: Holtzapfel & Co.
- Date: ca.1870's
- Ser./Acq. No.

MSTB-8A

![Graph](image-url)

Ratios:
- A/R: 0.64
- D/OD: 0.094

Mean Error = 2.3%
Characteristics:
- Screw
- Nut
- Length: 2.50" / 0.75"
- Diameter: 0.375"
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-20a
- Instrument: Micrometer
- Maker: James Watt
- Date: ca. 1770
- Ser./Acq. No.: 1876-1370

Diagram:
- SML-20A
- Characteristics:
  - T_c = \frac{1}{4.1}
  - R_c = 0.12 mm
  - A/R: 0.45
  - D/O/D: 0.0067
  - Mean Error: 1.9%
  - R_f = 0.18 mm
  - T_f = \frac{1}{3.9}
  - LF = 21.4
  - RF = 27.5
  - TFA = 48.9
  - Pitch: 1.397 mm
  - TPI: 19.2
Characteristics:
Screw [ ] Nut [X]
Length: 2.50" / 0.75"
Diameter: 0.375"
Steel [X] Brass [ ]
Other:

Instrument Identification:
Study Code: SML-20b
Instrument: Micrometer
Maker: James Watt
Date: ca. 1770
Ser./Acq. No. 1876-1370

[Diagram showing various measurements and ratios with labels such as Tc, Rc, Tr, LF, RF, TFA, etc., and calculations indicating mean error as 3.2% and pitch measurements as 1.425 mm or 0.0561 in.]
Characteristics:
- Screw
- Nut
- Leng: 3.75" 
- Diameter: 0.156" 
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-21
- Instrument: Micrometer
- Maker: Henry Maudsley
- Date: <1800
- Ser./Acq. No. 1900-75

Diagram:
- Chart showing measurement data
- SML-21
- Ratios: A/R: 0.45
- D/DD: 0.029
- Pitch: 0.2537 mm
- TPI: 100.1
- Mean Error: 5.8%
Characteristics:
- Screw
- Nut
- Length: 1.875" / ~0.25"
- Diameter: 0.984"
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-22a
- Instrument: "Atometer"
- Maker: John Barton
- Date: 1806
- Ser./Acq. No. 1928-719
Characteristics:
- Screw: ☑️
- Nut: ☐
- Length: 1.313° / circular
- Diameter: 0.720°
- Steel: ☐
- Brass: ☑️
- Other: ☐

Instrument Identification:
- Study Code: IMSS-1a
- Instrument: Circular dividing eng.
- Maker: Chouinard
- Date: 1762
- Ser./Acq. No.: 

The wheel is 85cm in diameter and 9/16" thick.
Characteristics:
Screw □ Nut □
Leng: 2.125" / 16.5"
Diameter: ~0.220"
Steel □ Brass □
Other:

Instrument Identification:
Study Code: IMSS-2a
Instrument: Linear Dividing Eng.
Maker: Chevalles (?)
Date: ca.1762 (?)
Ser./Acq. No.

The nut is in fact a long half nut
Characteristics:
- Screw
- Nut
- Length: 2.125" / 16.5"
- Diameter: 0.218" (a)
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: IMSS-2b
- Instrument: Linear Dividing Eng.
- Maker: Chevalier (a)
- Date: 1762 (a)
- Ser./Acq. No.

IMSS-2B

CREST

Ratios:
- A/R: 0.63
- D/DD: 0.14

Mean Error
- 1.6%

Other:
- LF = 38.8
- RF = 33.9
- TFA = 72.7

Pitch: 1.220 mm
- TPI 20.8
- Depth: 0.0835 in

Mu
- Filar
- Scale
- Bench
- Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding
- Misc.
Characteristics:
- Screw
- Nut
- Length: 1.25" / 0.88"*
- Diameter: ~0.35"*
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: IMSS-3b
- Instrument: Circular dividing eng.
- Maker: Amici (attributed)
- Date: ca. 1820
- Ser./Acq. No.

---

Ratios:
- $A/R: 0.62$
- $D/D: 0.072$

Ratios:
- $R_c = \text{flat (nom)}$
- $T_c = \frac{1}{4.5}$

Mean Error:
- $= \%$

---

Wheel thickness is 0.88" while radius is 14".

** Error cannot be given due to effect of curvature of the wheel.
The function of this unusual instrument is not known but may be a DE or possibly was for ruling gratings on glass though the lines would have been slightly curved.
Characteristics:
- Screw
- Nut
- Leng: 1.831"/R=5.55"
- Diameter: #0.75" thick
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: ITT-1b
- Instrument: Circular dividing eng.
- Maker: Perreux
- Date: 1855
- Ser./Acq. No. A176/1855

Ratios:
- A/R: 0.43
- D/OD: N/A

Mean Error = 4.5%°

Rc = Flat
Rg = Flat

Rc = 1.1
Rg = 7.7

IT = 37.6
RF = 51.1 40.5
TFA = 88.7 78.1

Pitch 1.420 mm
0.0563 in
TP 17.8

* Error is affected by the curvature of the wheel.
Purchased at the Paris Exhibition
Characteristics:
Screw □ Nut □
Length: 24.0" / 1.67" 
Diameter: 0.669"
Steel □ Brass □
Other:

Instrument Identification:
Study Code: ITT-2a
Instrument: Linear dividing eng.
Maker: Perreau
Date: 1855
Ser./Acq. No. A177/1855

Drum has R=10.7cm and is divided 0-400 with a resolution of ±0.1 div.

Purchased at the Paris Exhibition
This engine is known as the Blythswood engine after Lord B. who funded and oversaw the project. Modifications were being made as late as 1912.
特性:

- 螺丝 □ 螺母 □
- 长度: 2.875" / 12"
- 直径: 0.3115"
- 钢 □ 铜 □
- 其他: □

仪器标识:

- 项目代码: SML-34A
- 仪器: 扭转引擎
- 制造商: John Barton
- 日期: ca. 1820
- 序号/获取编号: 1920-32

图中数据:

- $T_c = \frac{1}{10.1}$
- $R_c = 0.06\text{mm}$
- $R_f = 0.10\text{mm}$
- 平均误差
  \[ = 0.4 \% \]
- $A/R: 1.31$
- $D/O D: 0.187$
- 长度
  - $L_F = 18.0$
  - $R_F = 16.5$
  - $TFA = 24.5$
- 间隙
  - $PITCH = 1.269 \text{ mm}$
  - 每转 $0.0500 \text{ in}$
  - TPI 20.0

注意：精度受轮齿数为460的轮子限制。
Instrument Identification:
Study Code: SML-36a
Instrument: Circular Division Eng.
Maker: John Troughton
Date: 1773

Characteristics:
Screw: 1.156"/2.3125"D
Diameter: 1.156"
Steel ✔
Other: 0

Depth: 0.07948 mm

Hole Diameter: 2.125
Resolution: 0.1/10

Mean Error: 0.173

Pitch: 2.026 in

Crest"
Characteristics:
- Screw
- Nut
- Length: 1.156"/23.125" D
- Diameter: ≈1.156"
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-36b
- Maker: John Troughton
- Date: 1778
- Ser./Acq. No.

Ratios:
- A/R: 1.32
- D/OD: 0.070

Mean Error: 0.8 %

Pitch: 1.681 mm
TPI: 15.1

Tc = 1 / 8.9
Characteristics:
- Screw
- Nut
- Length: 1.125" / 0.297"**
- Diameter: 1.0117 - 0.058"*
- Steel
- Brass
- Other: possibly w/ bronze

Instrument Identification:
- Study Code: SML-37b
- Instrument: Circular dividing eng.
- Maker: Frederick Cooke
- Date: 1872
- Ser./Acq. No.: 1953-446

![Graph](image)

**Wheel has 14" radius and is 0.297" wide at the teeth**
**Characteristics:**
- Screw: [ ]
- Nut: [ ]
- Length: 0.938
- Diameter: 0.1444

**Instrument Identification:**
- Study Code: GMMT-8
- Instrument: Theodolite--Everest pattern
- Date: 1896(?)
- Ser./Acq. No.: 1972.5

**Diagram:**
- Mean Error: 3.0 mm
- LF = 10.0
- RF = 24.2
- TFA = 34.2
- Pitch: 0.5117 mm
- TPI = 49.6

**Notes:**
- Filar Scale
- Bench
- Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tool
- Gauge
- Binding
- Misc.

(Vernier adjust)
Characteristics:
- Screw:
- Nut:
- Length: 1.375"
- Diameter: 0.2482"
- Steel:
- Brass:
- Other:

Instrument Identification:
- Study Code: GMMT-9a
- Instrument: Y-level
- Maker: W & S Jones
- Date: ca.1840
- Ser./Acq. No. 1968.15

Diagram:
- GMMT-9A
- Characteristics:
  - $T_C = \frac{1}{2.3}$
  - $R_C = 0.23 \text{mm}$
  - $R_F = 0.14 \text{mm}$
  - Mean Error = 4.0%
- Ratios:
  - A/R: 0.71
  - D/0D: 0.078
- Measurements:
  - Depth: 0.0194 in
  - Pitch: 0.0316 in
  - TPI: 31.7
- Other:
  - Filar
  - Scale
  - Bench
  - Div. Eng.
  - Adjust.
  - Leveling
  - Focus
  - Eye P.
  - Tube
  - Tool
  - Gauge
  - Binding
  - Misc.
  - (Azimuth adj.)
Characteristics:
- Screw [ ] Nut [ ]
- Length: 1.25" [ ]
- Diameter: 0.2840" [ ]
- Steel [ ] Brass [ ]
- Other:

Instrument Identification:
- Study Code: MSTB-8b
- Instrument: Micrometer
- Maker: Holtzapfel & Co.
- Date: ca. 1870's?
- Ser./Acq. No.

MSTB-8b

![Graph and Diagram]

- Mean Error: 3.0%
- Pitch: 0.9894 mm
- TPI: 25.7
Characteristics:
- Screw □
- Nut □
- Leng: 2.125" / 0.438"
- Diameter: 0.2052"
- Steel □
- Brass □
Other:

Instrument Identification:
- Study Code: PO-5
- Instrument: Reflecting telescope
- Maker: Foucault/Secretan
- Date: 1860
- Ser./Acq. No.

(Altitude adjust. The telescope mounting was made by Secretan for Foucault's first silver on glass reflector)
(shadowgraph made from the mould)
Characteristics:
Screw □ Nut □
Len: 0.625“
Diam: 0.1922“
Steel □ Brass □
Other:

Instrument Identification:
Study Code: ROG-4f
Instrument: Micrometer
Maker: Troughton & Simms
Date: ca.1840
Ser./Acq. No. OL-18

Ratios:
A/R: 0.85
D/OD: 0.113

Mean Error = 7.0 %

μ

Filer Scale
Bench Div. Eng.
Adjust.
Leveling Focus
Eye P.
Tube Tool
Gauge
Binding
Misc.

Pitch 0.0259 in
TPI 39.6
Characteristics:
- Screw [ ] Nut [ ]
- Length: 0.813 / ~0.5''
- Diameter: 0.2768''
- Steel [ ] Brass [ ]
- Other:

Instrument Identification:
- Study Code: ROG-6
- Instrument: Gregorian mounting
- Maker: Haupois
- Date: 1787
- Ser./Acq. No. 00/R6

Notes:
- This is the mounting for a Dollond Gregorian
Characteristics:
- Screw ☐
- Nut ☐
- Leng: 1.125"
- Diameter: 0.1568"
- Steel ☐
- Brass ☐
- Other:

Instrument Identification:
- Study Code: SML-10a
- Instrument: Geodetic theodolite
- Maker: Eitel & Sohn
- Date: ca. 1840
- Ser./Acq. No. 1950-246

Diagram:
- SML-10A
- CREST
- Characteristic values:
  - T_c = \frac{1}{5.2}
  - R_c = 0.04 mm
  - R_f = 0.05 mm
  - Mean Error = 5.7%
  - LF = 22.7
  - RF = 29.6
  - TFA = 52.3
  - Pitch = 0.3217 mm
  - TPI = 79.0

Legend:
- Filar Scale
- Bench
- Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding
- Misc.
  - (Vernier—right)
Characteristics:
- Screw  ■ Nut  □
- Leng: 1.00"  □
- Diameter: 0.2122"  □
- Steel  ■ Brass  □
- Other:

Instrument Identification:
- Study Code: SML-11a
- Instrument: Alazimuth theodolite
- Maker: Thomas Jones
- Date: 2nd q 19th c
- Ser./Acq. No. 1948-128

![Graph showing wave height against phase with key specifications and measurements.](image-url)
Characteristics:
Screw ■ Nut □
Leng: 0.938" / 0.25"
Diameter: 0.1511"
Steel ■ Brass □
Other:

Instrument Identification:
Study Code: WMHS-4
Instrument: Universal Instrument
Maker: Uitsschneider & Fraunhofer
Date: ca.1825
Ser./Acq. No. 2172

---

WMHS-4

Σ

CREST

---

Tc = \frac{1}{4.9}

Rc = 0.08\, \text{mm}

Rf = 0.08\, \text{mm}

Tr = 6.3

LF = 34.9

RF = 33.6

TFA = 60.5

PITCH = 0.5166\, \text{mm}

0.0203\, \text{in}

TP1 49.2

---

Filer Scale
Bench
Div. Eng.
Adjust.
Leveling
Focus
Eye P.
Tube
Tool
Gauge
Binding
Misc.
Characteristics:
- Screw
- Nut
- Length: 2.25° / 0.75°
- Diameter: 0.3690°
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: MHS-4c
- Instrument: Portable quadrant
- Maker: John Bird
- Date: 1770
- Ser./Acq. No.: none

Filar Scale
Leveling Focus Eye P.
Tube Tool Gauge Binding Misc.
Characteristics:
- Screw
- Nut
- Length: 0.75" / 0.125"
- Diameter: 0.1560"
- Steel
- Brass
- Other: Iron

Instrument Identification:
- Study Code: MHS-10a
- Instrument: Surveyor’s level
- Maker: Thomas Wright
- Date: 1724
- Serial/Acquisition No.: 32.29

Mean Error = 4.2%

Ratios:
- A/R: 0.34
- D/OD: 0.049

T_c = \frac{1}{5.6}

R_c = 0.10mm

R_f = 0.14mm

T_f = 4.9

\begin{align*}
LF &= 41.4 \\
RF &= 45.1 \\
TFA &= 64.5
\end{align*}

Pitch = 0.5709 mm
0.0225 in

TPI = 44.5
Characteristics:
- Screw □
- Nut □
- Length: 1.375" / 0.219"
- Diameter: 0.2415"
- Steel □
- Brass □
- Other:

Instrument Identification:
- Study Code: PO-2c
- Instrument: Gregorian telescope
- Maker: James Short
- Date: 1753/4
- Ser./Acq. No. 237/96.4 = 9.6

Mean Error: 7.1%
Characteristics:
- Screw
- Nut
- Leng: 1.375"
- Diameter: 0.3299"
- Steel
- Brass

Instrument Identification:
- Study Code: SML-12d
- Instrument: Transit Theodolite
- Maker: Thomas Jones
- Date: 2nd q 19th c
- Ser./Acq. No.: 1876-1206

---

**SML-12D**

![Graph showing depth vs. phase with CREST marker and various measurements and ratios](image)

- **T_c = \frac{1}{1g.}**
- **R_c = 0.11 mm**
- **R_r = 0.15 mm**
- **Mean Error = 4.4%**
- **Pitch = 0.7757 mm**
- **TPI = 32.7**
Characteristics:
Screw ■ Nut □
Leng: >1.125"/0.5"
Diameter: 0.281"
Steel ■ Brass ■
Other:

Instrument Identification:
Study Code: SML-C093
Instrument: 3° Gregorian
Maker: Benjamin Martin
Date: ca.1750
Ser./Acq. No. 1911-283
Characteristics:
- Screw
- Nut
- Leng: 1.75" / 1.5"
- Diameter: 0.266"
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-C094
- Instrument: 2" equatorial refractor
- Maker: Dollond
- Date: ca. 1800
- Ser./Acq. No. 1912-204

SML-C094

Mean Error = 2.5 %

Ratios:
- A/R: 0.72
- D/OD: 0.114

T_c = \frac{1}{3.4}

R_c = 0.14 \text{ mm}

R_f = 0.08 \text{ mm}

T_f = 4.6

PITCH = 1.054 \text{ mm}

TPI = 24.1

MAR

Filtar
Scale
Bench
Div. Eng.
Adjust.
Leveling
Focus
Eye P.
Tube
Tool
Gauge
Binding
Misc.

(III. lm Bennett, 1987 p.124, f.122)
Characteristics:
- Screw
- Nut
- Length: 2.5" / 1.875"
- Diameter: 0.511"
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-C095
- Instrument: Cassegrain Reflector
- Maker: Ramsden
- Date: ca. 1775
- Ser./Acq. No.: 1913-281

Mean Error = 1.6%

Ratios:
- A/R: 0.87
- D/GD: 0.009

Ramsden's 1775 patent design
Characteristics:
- Screw □  Nut □
- Leng: 1.125" / 0.375"
- Diameter: 0.188"
- Steel □  Brass □
- Other:

Instrument Identification:
- Study Code: SML-C097
- Instrument: 6° Quadrant (?)
- Maker: Sisson
- Date: 3rd q 18th c
- Ser./Acq. No. 1918-168

SML-C097

Characteristics:
- T_c = 1.61 m
- R_c = 0.08 mm
- R_r = 0.12 mm
- Mean Error = 3.3%
- LF = 23.0
- RF = 24.5
- TFA = 49.5

Depth 0.395 mm

Pitch 0.6115 mm

TPI 41.5

Filter Scale
Bench
Div. Eng.
Adjust.
Leveling
Focus
Eye P.
Tube
Tool
Gauge
Binding
Misc.
Characteristics:
- Screw
- Nut
- Leng: 1.5 / ≈0.625"
- Diameter: 0.184"
- Steel
- Brass
- Other: (nut of wood)

Instrument Identification:
- Study Code: SML-C098
- Instrument: Gunter Quadrant
- Maker: Thomas Wright
- Date: 1715-40
- Ser./Acq. No. 1920-439

Characteristics of the graph:
- CREST
- SML-C098
- Mean Error
- RF = 0.18 mm
- 4.4
- 2.82
- Pitch = 1.131 mm
- TPI = 22.5

Instrument Identification:
- Fillar
- Scale
- Bench
- Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding
- Misc.

(double thread)
Characteristics:
Screw ☐ Nut ☐
Length: 1.0" / 0.75"
Diameter: 0.206"
Steel ☐ Brass ☐ Other:

Instrument Identification:
Study Code: SML-C100
Instrument: Surveying sextant
Maker: J & E Troughton
Date: <1806
Ser./Acq. No. 1931-95

CREST

SML-C100

Ratios:
A/R: 0.25
D/OD: 0.056

Mean Error = 2.8%

$T_c = \frac{1}{4.1}$

$R_c = \text{Flat}$

$R_f = 0.25 \text{ mm}$

$T_f = \frac{1}{4.2}$

$L_f = 38.9$

$R_f = 34.4$

$TFA = 63.3$

Pitch: 0.8422 mm

0.0332 in

TP1 30.2

Thread is double
Characteristics:
- Screw
- Nut
- Leng: 1.125"  
- Diameter: 0.232"  
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: SML-C106  
- Instrument: Sundial  
- Maker: not known  
- Date: not known  
- Ser./Acq. No: Madison's Sundial 2

![Diagram of Sundial Characteristics](image)

- **Ratios:**  
  - A/R: 0.44  
  - D/OD: 0.056

- **Mean Error:** 1.8%

- **Mean Error:**
  - T = 3.4
  - R = 0.19 mm
  - R = 0.16 mm

- **Pitch:**  
  - 0.7531 mm
  - 0.0296 in

- **TPI:** 33.7

Charles Madison's "Sundial-2"
Characteristics:
- Screw
- Nut
- Length: 0.938" 
- Diameter: 0.1391" 
- Steel

Instrument Identification:
- Study Code: RB-6a
- Instrument: Bar-limb Microscope
- Maker: Hartnack
- Date: ca. 1892/3
- Ser./Acq. No.

![Graph with labeled dimensions and errors]
Characteristics:
- Screw
- Nut
- Length: 0.25\" 
- Diameter: 1.033\" 
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: GMMT-5c
- Instrument: Gregorian Telescope
- Maker: John Cuff (II?)
- Date: ca.1780
- Ser./Acq. No. 1986.3

![Diagram of GMMT-5c telescope characteristics and measurements.](image_url)
Characteristics:
- Screw
- Nut
- Leng: 0.313" (9.5 mm)
- Diameter: 1.188" (30 mm)
- Steel
- Brass
- Other

Instrument Identification:
- Study Code: RB-9d
- Instrument: Refracting Telescope
- Maker: Broadhurst/Clarkson
- Date: >1858
- Ser./Acq. No.

RB-9D

CREST

Graphical data showing phase vs. position with various measurements and calculations included.

Mean Error = 5.2 %

Ratios:
- A/R: 0.60
- D/OD: 0.104

Additional measurements:
- Target L: 32.5
- RF: 25.0
- TFA: 57.5
- Pitch: 0.6865 mm
- TPI: 37.0

Notes:
- Filler for eyepiece
- Bench
- Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding
- Misc.
Characteristics:
- Screw [ ] Nut [ ]
- Length: 0.188" / 0.281"
- Diameter: 0.844"
- Steel [ ] Brass [ ]
- Other:

Instrument Identification:
- Study Code: RB-11a
- Instrument: Spyglass
- Maker: Not signed
- Date: late 19th c
- Ser./Acq. No.

CREST

Characteristics:
- $T_c = \frac{1}{4.7}$
- $R_c = 0.18$ mm
- $R_r = 0.14$ mm
- Mean Error $= 4.3 \%$
- $T = 5.0$
- $L_f = 46.0$
- $R_f = 41.0$
- TFA $= 87.0$

Pitch $= 0.6714$ mm
0.0264 in
TPH 37.8
Characteristics:
- Screw
- Nut
- Length: 0.219"  
- Diameter: 1.234"  
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: RB-13a
- Instrument: Telescope eyepiece set
- Maker: Thomas Cooke(?)
- Date: ca. 1890
- Ser./Acq. No.

Diagram:
- RB-13A
- CREST
- Tc = 1/5.4
- Rc = 0.29 mm
- Rr = 0.27 mm
- Mean Error = 2.3%
- LF = 33.5
- RF = 40.4
- TFA = 73.9
- Pitch 0.0794 in
- TPI 12.6
- Depth 0.0349 in
- 6.51 mm
- Mounting thread for EP
Characteristics:
- Screw ☐
- Nut ☐
- Length: 0.156" / 0.219"
- Diameter: 1.328"
- Steel ☐
- Brass ☐
- Other:

Instrument Identification:
- Study Code: RB-13c
- Instrument: Telescope Eyepiece Set
- Maker: Thomas Cooke (?)
- Date: ca.1890
- Ser./Acq. No.

![Graph of RB-13C with CREST marker]

Ratios:
- A/R: 0.61
- D/OD: 0.016

Mean Error = 4.9%

<table>
<thead>
<tr>
<th>LF</th>
<th>RF</th>
<th>TFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.0</td>
<td>31.5</td>
<td>61.3</td>
</tr>
</tbody>
</table>

PITCH: 0.0340m
TPI: 29.4

Thread for filter
**Characteristics:**
- **Screw:** [ ]
- **Nut:** [ ]
- **Length:** 0.25''
- **Diameter:** 0.75''
- **Steel:** [ ]
- **Brass:** [ ]
- **Other:**

**Instrument Identification:**
- **Study Code:** RS-1c
- **Instrument:** Newtonian Telescope
- **Maker:** Isaac Newton/Heath & Wing
- **Date:** 1671/ca.1760
- **Ser./Acq. No.:**

**NEWTON-EP BUSH**

**Crest**

**Mean Error:** 5.3%

**Ratios:**
- A/R: 0.43
- D/OD: 0.022

**Mean Error:**
- $T_c = \frac{1}{6.7}$
- $R_c = 0.16$ mm
- $R_f = \text{Variable}$
- $R_e = 6.7$
- $E_F = 42.5$
- $R_F = 35.8$
- $T_F = 78.3$

**Pitch:**
- $1.019$ mm
- $0.0401$ in

**TPI:** 24.9
Characteristics:
- Screw
- Nut
- Length: 0.188".
- Diameter: 1.375".
- Steel
- Brass
- Other: Lignum vitae

Instrument Identification:
- Study Code: SML-28b
- Instrument: Eyepiece micrometer
- Maker: Wm. or A. Herschel (?)
- Date: Ca.1780
- Ser./Acq. No. 1925-468 (*E6)
Characteristics:
- Screw
- Nut
- Leng: 0.969" 
- Diameter: 0.3125" 
- Steel
- Brass
- Other: Lignum Vitae

Instrument Identification:
- Study Code: SML-29c 
- Instrument: Eyepiece Micrometer 
- Maker: Wm. or A. Herschel (?) 
- Date: ca. 1780 
- Ser./Acq. No. 1925-469

---

**SML-29C**

**CREST**

**Characteristics:**
- Ratio: A/R: 0.49
- D/OD: 0.098

**Instrument Identification:**
- Study Code: SML-29c
- Instrument: Eyepiece Micrometer
- Maker: Wm. or A. Herschel (?)
- Date: ca. 1780
- Ser./Acq. No. 1925-469

---

**Mean Error:**

- 3.3 %

**Marked:**
- E2 and Fec 1.755 (154)

---

**Pitch:**
- 0.0625 in
- TPI 16.0
Characteristics:
- Screw □
- Nut □
- Length: 0.188" / 0.391"
- Diameter: 0.9090"
- Steel □
- Brass □
- Other:

Instrument Identification:
- Study Code: RB-1c
- Instrument: Sextant
- Maker: Chas. P...S, Liverpool
- Date: ca.1860
- Serial/Acquisition No.

Diagram:
- RB-1c
- CREST
- Ratios: A/R: 0.46
- D/OD: 0.019
- TC = \frac{1}{5.3}
- RC = 0.13 mm
- RF = 0.14 mm
- LF = 34.0
- RF = 34.5
- TFA = 68.5
- Pitch: 0.7703 mm
- TPI: 33.0
- Telescope Mount
Characteristics:
Screw [ ] Nut [ ]
Leng: 0.172" / 0.156"
Diameter: 0.875"
Steel [ ] Brass [ ]
Other:

Instrument Identification:
Study Code: RB-2c
Instrument: Octant
Maker: van der Yoodt
Date: ca.1860
Ser./Acq. No.

Characteristics:
R = 0.13 mm
Rf = 0.22 mm
Tc = 1/6.7

Mean Error = 4.4 %

Pitch 0.8236 mm
0.0324 in
TPI 30.8

Filar Scale
Bench
Div. Eng.
Adjust.
Leveling
Focus
Eye P.
Tube
Tool
Gauge
Binding
Misc.

Telescope Mounting
Characteristics:

Screw  
Nut  
Length: 0.156" / 0.375"  
Diameter: 0.9498"  
Steel  
Brass  
Other:

Instrument Identification:

Study Code: RB-11C  
Instrument: Spyglass  
Maker: Not signed  
Date: Late 19th c  
Ser./Acq. No.

Ratios:

A/R: 0.27  
D/OD: 0.006  

$R_c = 0.07$ mm  
$T_c = \frac{1}{12.9}$  

Mean Error $= 5.2\%$

$T_f = 3.0$  
$R_f = \text{flat (nom)}$

Possibly of French manufacture  
1st draw joint

Filer  
Scale  
Bench  
Div. Eng.  
Adjust.  
Levelling  
Focus  
Eye P.  
Tube  
Tool  
Gauge  
Binding  
Misc.
Characteristics:

- Screw
- Nut
- Leng: 0.156" / 0.373"
- Diameter: 0.938"
- Steel
- Brass
- Other:

Instrument Identification:

- Study Code: RB-11d
- Instrument: Spyglass
- Maker: Not signed
- Date: Late 19th c
- Ser./Acq. No.

Museum Scale
Bench
Div. Eng.
Adjust.
Leveling
Focus
Eye P.
Tube
Tool
Gauge
Binding
Misc.

First draw joint mating with 11d
Possibly of French manufacture

Characteristics:

- Tc = 1/5.5
- Re = 0.11 mm
- Rf = 0.17 mm
- Tc = 4.2

Mean Error = 6.0%
### Characteristics:
- **Screw**: No
- **Nut**: Yes
- **Length**: 0.188" / 0.281"
- **Diameter**: 1.688"
- **Material**: Steel
- **Other**: Brass

### Instrument Identification:
- **Study Code**: RB-12d
- **Instrument**: Spyglass
- **Maker**: Harris & Co.
- **Date**: ca. 1840’s
- **Serial/Accession Number**: [Blank]

---

**Diagram Description**

- **RB-12D**
- **CREST**
- **Ratios**:
  - **A/R**: 0.51
  - **D/OD**: 0.007
- **Mean Error**: 10.7°
- **Rear Face (RF)**: 32.9°
- **Front Face (FF)**: 37.0°
- **Taper Face (TFA)**: 69.9°
- **Pitch**: 0.6038 mm
  - **0.0238 in**
- **Thread Pitch**: 0.0238 in
  - **TPI**: 42.1

---

**Key Components**

- **MU**: Filter
  - Scale
  - Bench
  - Div. Eng.
  - Adjust.
  - Leveling
  - Focus
  - Eye P.
  - Tube
  - Tool
  - Gauge
  - Binding
  - Misc.

---

1st-draw joint for RB-12c
Characteristics:
Screw □ Nut □
Leng: 1.125"
Diameter: 0.875"
Steel □ Brass □
Other: N/A

Instrument Identification:
Study Code: WMHS-C2
Instrument: Wilson screw barrel microscope
Make: N/A
Date: N/A
Ser./Acq. No.

WMHS-C2

- CREST

Characteristics:
Rα = 0.14 mm
Rβ = 0.05-15 mm
Tα = 1,0.7
Tβ = 0.877 mm

Mean Error: 2.4 %

Ratios:
A/R: 0.53
D/DD: 0.026

Pitch 1.090 mm
0.0429 in
TPI 23.3
Characteristics:
- Screw □ Nut □
- Leng: 7.75''
- Diameter: 0.375''
- Steel □ Brass □
- Other:

Instrument Identification:
- Study Code: MSTD-1
- Instrument: Lathe
- Maker: Maudsley
- Date: ca. 1800
- Ser./Acq. No. 83-3662

Ratios:
- A/R: 0.41
- D/O/D: 0.118

Mean Error = 0.6 %

Cross slide screw
CREST

Characteristics:
- Screw [ ] Nut [ ]
- Length: 0.50" / 0.375"
- Diameter: 0.250"
- Steel [ ] Brass [ ]
- Other:

Instrument Identification:
- Study Code: NHM-5A
- Instrument: Chuck with nut
- Maker: not signed
- Date: 19th c
- Ser./Acq. No.
SML-15B DIE

Characteristics:
- Screw: [Blank]
- Nut: [Filled]
- Leng: N/A / \(0.37\)" 
- Diameter: 0.32" nom.
- Steel: [Filled]
- Brass: [Blank]
- Other: 

Instrument Identification:
- Study Code: SML-15b die
- Instrument: Experimental die
- Maker: Maudsley
- Date: 19th c
- Ser./Acq. No.: 1925-164

Diagram:
- CREST
- Ratios:
  - A/R: 0.83
  - D/OO: 0.052
- Mean Error: 4.9  
- \(T_c = \frac{1}{4.1}\)
- \(R_c = 0.08\) mm
- \(R_r = 0.07\) mm
- LF = 11.2
- RF = 19.5
- TFA = 30.7
- Pitch: 0.5046 mm
  - 0.0199 in
  - TPI 50.3

Experimental die: 20TS #22
Characteristics:
- Screw [ ]
- Nut [ ]
- Length: 2.09"
- Diameter: 0.438"
- Steel [ ]
- Brass [ ]
- Other: [ ]

Instrument Identification:
- Study Code: SML-15bTap
- Instrument: Experimental tap
- Maker: Henry Maudsley
- Date: e19th c
- Ser./Acq. No. 1925-165

---

**SML-15B Tap**

Characteristics:
- Length: 2.09"
- Diameter: 0.438"
- Steel

Instrument Identification:
- Study Code: SML-15bTap
- Instrument: Experimental tap
- Maker: Henry Maudsley
- Date: e19th c
- Ser./Acq. No. 1925-165

---

**Characteristics:**
- Length: 2.09"
- Diameter: 0.438"
- Steel

**Instrument Identification:**
- Study Code: SML-15bTap
- Instrument: Experimental tap
- Maker: Henry Maudsley
- Date: e19th c
- Ser./Acq. No. 1925-165

---

**Characteristics:**
- Length: 2.09"
- Diameter: 0.438"
- Steel

**Instrument Identification:**
- Study Code: SML-15bTap
- Instrument: Experimental tap
- Maker: Henry Maudsley
- Date: e19th c
- Ser./Acq. No. 1925-165

---

**Characteristics:**
- Length: 2.09"
- Diameter: 0.438"
- Steel

**Instrument Identification:**
- Study Code: SML-15bTap
- Instrument: Experimental tap
- Maker: Henry Maudsley
- Date: e19th c
- Ser./Acq. No. 1925-165
Characteristics:

- Screw □ Nut □
- Leng: 1.65" / N/A
- Diameter: ≈0.625"
- Steel □ Brass □ Other:

Instrument Identification:

- Study Code: SML-16b
- Instrument: Screw tap
- Maker: Whitworth
- Date: ca. 1857
- Ser./Acq. No. 1857-8

Characteristics:

- Ratios:
  - A/R: 0.47
  - D/OD: 0.068

- Mean Error: 0.5%

- Tr = 3.9
- Rc = 0.41 mm
- Rf = 0.52 mm

- Tc = 1/3.8

- LF = 27.8
- RF = 26.9
- TFA = 54.7

- Pitch: 2.309 mm
- TPI: 11.0

- Depth: 0.0427 in

- MU: Scale

- Miscellaneous:
  - Filar
  - Bench
  - Div. Eng.
  - Adjust.
  - Leveling
  - Focus
  - Eye P.
  - Tube
  - Tool
  - Gauge
  - Binding
  - Misc.

8-groove tap: 11-5/8"
**Characteristics:**
- Screw:  ✔
- Nut:  ❌
- Length: 8.5" / 0.958"
- Diameter: 0.375"
- Material: Steel
**Instrument Identification:**
- Study Code: SML-18d
- Instrument: Screw lathe
- Maker: Henry Maudsley
- Date: 1800
- Ser./Acq. No.: 1900-19

**Graph:**
- **SML-18D**
- **Phase**
- **Pitch**
  - 0.7252 mm
  - 0.0286 in
- **TPI** 35.0
- **Mean Error:** ± 2.5 %
- **Ratios:**
  - A/R: 1.02
  - D/OD: 0.077

**Notes:**
- **CREST**
Characteristics:
- Screw □ Nut □
- Length: -0.5" / 0.958"
- Diameter: 0.375"
- Steel □ Brass □
- Other: Copper

Instrument Identification:
- Study Code: SML-18E
- Instrument: Screw Lathe
- Maker: Henry Madsen
- Date: 1800
- Ser./Acq. No. 1900-19

Graph:
- Phase axis: 0.1 to 0.9
- Depth axis: -2 to 2
- CREST
- Pitch: 0.8102 mm
- TPI 31.4
- Mean Error = 4.9 %
- Ratios:
  - A/R: 1.05
  - D/OD: 0.089
- Tool: Filar Scale
- Leveling: Focus Eye P.
- Tube: Tool Gauge
- Binding: Misc.
TAP 2BA CAST (SG-005)

Characteristics:
- Screw
- Nut
- Leng: 0.875" nom.
- Diameter: 4.70mm nom.
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: Tap-2BA
- Instrument: Screw tap
- Maker: N/S
- Date: 3rd q 20th c
- Ser./Acq. No.

Mean Error = 1.6 %

Rc = 0.14 mm
Rf = 0.13 mm
Tc = 4.8
Tr = 4.4

LF = 23.0
RF = 24.0
TFA = 47.0

PITCH 0.8058 mm
0.0317 in
TPI 31.5

Shadograph made from cast
Characteristics:
- Screw □
- Nut □
- Leng: 0.75" nom.
- Diameter: 2.80mm nom.
- Steel □
- Brass □
- Other:

Instrument Identification:
- Study Code: Tap 6BA
- Instrument: Screw tap
- Maker: N/S
- Date: 3rd q 20th c
- Ser./Acq. No.: .

TAP 6BA (GS-009)

- R = 0.08 mm
- Tc = 1/4.8
- A/R: 0.65
- D/OD: 0.124
- Mean Error: ± 1.8 %
- Pitch: 0.5301 mm
  0.0209 in
- TPI: 47.9

Shadowgraph made with original tap
Characteristics:
- Screw
- Nut
- Length: 0.625" nom
- Diameter: 2.200 mm nom
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: Tap 8BA
- Instrument: Screw tap
- Maker: N/S
- Date: 3rd q 20th c
- Ser./Acq. No.: .

TAP 8BA CAST (SG-006)

Characteristics:
- $T_c = \frac{1}{5.1}$
- $R_c = 0.06 \text{ mm}$
- Mean Error = 2.4%

Ratios:
- $A/R = 0.65$
- $D/OD = 0.126$

Dimensions:
- Depth: 0.0210 mm
- Pitch: 0.4271 mm
- TPI: 59.5

Shadowgraph made from cast.
Characteristics:
Screw ■ Nut □
Length: 0.625'' nom.
Diameter: 1.70mm nom.
Steel ■ Brass □
Other:

Instrument Identification:
Study Code: Tap 10BA
Instrument: Screw tap
Maker: N/S
Date: 3rd q 20th c
Ser./Acq. No.

TAP 10BA (SG-008)

Ratios:
A/R: 0.65
D/OD: 0.133

T C = \frac{1}{4.9}
R C = 0.05\, \text{mm}
R F = 0.05\, \text{mm}

Mean Error = 2.5% ± 2.2% ± 1.5%

Pitch: 0.3496 mm
0.0138 in
TPI 72.7

Depth: 0.227 mm

Shadowgraph made from original tap. Scatter in crest is due to tapering.
An apparently heavily worn tap where both the form and pitch have been altered. The form now most closely resembles the Cyclic Engineers Inst. thread though the pitch is near BBA (0.43mm).
Characteristics:

- Screw: [ ]
- Nut: [ ]
- Length: N/A / N/A
- Diameter: N/A
- Steel: [ ]
- Brass: [ ]
- Other: [ ]

Instrument Identification:

- Study Code: BAAS-3
- Instrument: Nut gauge
- Maker: Pratt & Whitney (Geo. M. Bond)
- Date: 1899
- Ser./Acq. No.: N/A

---

BAAS-3 (NUT GAUGE)

- Phase
- CREST

![Graphical Diagram]

- Pitch: 0.7293 mm
- TP1: 34.8
- LF: 24.5
- RF: 26.7
- TFA: 31.2

Mean Error: 1.8%
Characteristics:
- Screw: □
- Nut: □
- Length: N/A / N/A
- Diameter: N/A
- Steel: □
- Brass: □
- Other:

Instrument Identification:
- Study Code: BAAS-7
- Instrument: Screw gauge
- Maker: Pratt & Whitney (Geo. M. Bond)
- Date: 1899
- Ser./Acq. No: N/A
Characteristics:
- Screw □ Nut □
- Leng: 0.25" □
- Diameter: tapered □
- Steel □ Brass □
- Other:

Instrument Identification:
- Study Code: NHM-4
- Instrument: Ratchet mechanism
- Maker: ? associated with Deacon
- Date: 19th c?
- Ser./Acq. No.: none

NHM-4

CREST

Phases:
- R_c = 0.13mm
- R_r = 0.16mm
- T_c = \frac{1}{4.8}
- T_f = 5.6

Mean Error: 4.5%

Ratios:
- A/R: 0.43
- D/OD: n/a

Pitch:
- 0.775 mm
- 0.031 in
- TPI 32.8

Filar
- Scale
- Bench
- Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding
Characteristics:
- Screw
- Nut
- Leng: 0.50° / 0.469°
- Diameter: 1.109°
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: RB-4a
- Instrument: Dumpy level
- Maker: Yeates & Son, Dublin
- Date: 1.1840's
- Ser./Acq. No.

RB-4A

CREST

Depth

Pitch 1.528 mm
TPI 16.6

Mean Error = 1.6%
Characteristics:
Screw  []  Nut  []
Leng: 0.703" / 0.156"
Diameter: 0.2455"
Steel  []  Brass  []  Other:

Instrument Identification:
Study Code: RB-9a
Instrument: Refracting telescope
Maker: Broadhurst, Clarkson
Date: >1858
Ser./Acq. No.:

---

**RB-9A**

**CREST**

**Mean Error** = 1.2%

**Ratios:**
- A/R: 0.62
- D/OD: 0.138

**Mean Error**

**T_c = 1 / 5.1**

**R_c = 0.22 mm**

**R_f = 0.19 mm**

**T_f = 5.1**

**LF = 26.0**

**Rf = 26.0**

**TFA = 52.0**

**PITCH 1.400 mm**

**TPI 18.1**

**DEPTH 0.0339 in**

**Filer Scale**
- Bench
- Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding
- Misc.

Screw held at tip on base. This was suspected and is confirmed as a replacement screw of ISO form.
Characteristics:
Screw □ Nut □
Length: 0.656"
Diameter: 0.2446"
Steel □ Brass □
Other: Wrought Iron

Instrument Identification:
Study Code: SML-27e
Instrument: Pendulum Clock
Maker: van Call
Date: 1657
Ser./Acq. No. 1986-1697

FIGURES:

- SML-27E
- CREST

- Tc = 1/4.1
- Rc = 0.16mm
- Rf = 0.14mm
- Tc = 1/4.6
- LF = 49.9
- RF = 51.5
- TFA = 101.4
- Pitch 0.556 mm
- TPI 45.4

- Mean Error = 3.0 %

- Filar Scale
- Bench Div. Eng.
- Adjust.
- Leveling
- Focus
- Eye P.
- Tube
- Tool
- Gauge
- Binding (Bracket Mount-Left)
Characteristics:
- Screw [ ] Nut [ ]
- Length: 0.813" [ ]
- Diameter: 0.125" [ ]
- Steel [ ] Brass [ ]
- Other: [ ]

Instrument Identification:
- Study Code: MHS-2C
- Instrument: Micrometer-Bifilar
- Maker: Thomas Jones
- Date: ca. 1820
- Ser./Acq. No.: 79-23

**Diagram:**
- Mean Error = 1.9 %
- Pitch = 0.041 in
- Pitch = 1.031 mm
- T_F = 5.4
- R_F = 0.30 mm
- T_C = \frac{1}{3.9}
- R_C = 0.21 mm
- A/R: 0.31
- D/OD: 0.104
Characteristics:
- Screw
- Nut
- Length: 0.156
- Diameter: 0.745
- Steel
- Brass
- Other:

Instrument Identification:
- Study Code: RB-2b
- Instrument: Octant
- Maker: van der Voordt
- Date: ca. 1860
- Ser./Acq. No.

RB-2B

**CREST**

**R** = 0.09 mm

**R** = 0.90 mm

**T** = 6.7

**T** = 6.7

**F** = 33.5

**F** = 27.5

**F** = 61.0

**P** = 0.7020 mm

**P** = 0.0277 in

**TPI** 36.1

**Mean Error** = 4.2 %

**Thread for mounting solar filter**
Characteristics:
- Screw □ Nut □
- Length: 0.25" / ~0.109"
- Diameter: 0.1858"
- Steel □ Brass ■ Other:

Instrument Identification:
- Study Code: SML-23b
- Instrument: Portable quadrant
- Maker: Dollond
- Date: ca.1767
- Ser./Acq. No. 1911-214

SML-23B

![Diagram showing phase and crest with dimensions and annotations]

Clamp screw
Quadrant used in survey of Quebec by Samuel Holland
BRITISH ASSOCIATION
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