

§. 2. Now to find the Content of the King's Royal Ships: Measure the length of the Keel, the breadth of the Mid-ship Beam, and the depth of the Hold: which three multiply into one another, and divide their Product by 100; so shall you find how many Tuns her Burthen is.

But for Merchants' Ships, which give no allowance for Ordnance, Masts, Sails, Cables, Anchors, &c. which are all a Burthen, but no Tonnage, you must divide the product by 95, so shall their true Burthen be found.

## P R O P. II.

By knowing the Measure of a Ship, of one Burthen, to make another Ship, of the same Mould, which shall be double, or triple, or in any proportion, either more or less than the said Ship.

First you shall multiply the Keel Cubically; and in like manner every Beam; the Mid-ship Beams multiply them Cubically; and also the Reaking of the Ship, both at Stem, and Stem-Post, multiply them Cubically; likewise the principal Timbers, that doth mould the Ship, multiply them Cubically; and the depth of the Hold, multiply it Cubically; and so consequently every Place, or Places, which doth lead any work, multiply them Cubically; then if it be required to have a Ship as big again, or thrice as big; double, or triple each respective Cubical number; then by prop. 9. §. 1. chap. 1: Or by prop. 4. §. 2. chap. 2. find the Cube-roots thereunto belonging; then according unto these respective Numbers, make your Keel, your Timbers, Beams, &c. which being done, you shall make a Ship of the Mould and Proportion desired.

C H A P.

## C H A P. XII.

## Of DIALLING.

**H**OROLOGIOPHIA, or the Art of DIALLING, is an Art Mathematical, which demonstrateth the precise Distinction of Times, by the Sun, Moon and Stars, whereby the Time of the Day, or Night, may be known\*. Now the Demonstrative delineation of Dials, consisteth chiefly in the finding out the Hour-lines, and their true distance one from the other: which lines are great Circles of a Sphere, which being projected on a plain Superficies, become straight-lines; which lines do continually vary, according as the Planes on which they are described, or projected, do lie situated in respect of the Horizon of the Place.

\* Which doth appear to have been in use above this 2400 Years, for King Achaz had a Dial: This Art requireth good skill in Geometry, and Astronomy: Now Ctesibius that famous Philosopher measured the Hours and Times by the orderly running of Water. Then by Sand was the Hours measured. After that by Trochilike with Weights, and of late with Trochilike with Springs.

Now

Now a Dial may be made on any Plain Superficies, for all Plain Superficies are Posited either Perpendicular, Parallel, or Oblique, to the Horizon of the Place, in which the Plane is seated.

In the delineation of all which Dials in this Chapter described, (which are the most Eminent, and usefull Dials now used) I have used this Method: First, I have shewed how to delineate them by Geometrical Projection, by Scale, and Compass only: and secondly how they may be described by Arithmetical Calculation, of both which I have been very plain and large.

## S E C T. I.

§. I. Of the Delineation and Projection of sundry most usefull Dials.

## P R O P. I.

How to draw the Hour-lines on an Equinoctial Plain.

Fig. 64. A N Equinoctial Plane, is such which lieth Parallel unto the Equinoctial, and is an Horizontal Plane, under the Pole. This is the first and plainest kind of Dials, and is made after this manner: First describe the Circle  $\text{Æ, W, E, R,}$  for your Planes, then Cross it with the two Diameters  $\text{EW,}$  and  $\text{ÆR.}$  Then divide the Semicircle  $\text{E, W, R,}$  into 12 equal parts in the points  $\odot, \odot, \odot, \&c.$  Then from the Center  $\text{Q,}$  and through the said points draw

draw streight lines, which shall be the true Hour-lines belonging unto this Equinoctial Plane. §. I. Now because these Planes are capable of receiving all the Hour-lines from Sun-rising unto the Sun-setting, in Summer; therefore the Hour-lines of 4, and 5; in the Morning; and 7, and 8, in the Evening; must be delineated as you see done in the Figure: These Hours may be subdivided into half Hours, and Quarters: The Stile of this Dial, must be a streight Pin, or Wyre set Perpendicular, to the Plain, on the Center  $\text{Q,}$  and of any convenient length. This Dial may be made for any Latitude, and is of good use for Seamen, and others.

## P R O P. II.

How to draw the Hour-lines on a Polar Plane.

A Polar Plane is one that lies Parallel unto the Pole; and under the Equinoctial is an Horizontal Dial: the way to make this Dial is thus. First draw the line  $\text{AB,}$  for the Horizontal line of the Plane; and cross it at the Middle at right angles, with the line  $\text{12, Q, 12,}$  which is the Meridian or Hour line of 12; Then upon the line  $\text{12, Q, 12,}$  either above or below the point  $\text{Q,}$  assume any point as  $\text{S,}$  then setting one foot of your Compasses in  $\text{S,}$  describe the Semicircle  $\text{CED,}$  which divide into 12 Equal parts, in the points  $\odot, \odot, \odot, \&c.$  Then lay a Ruler unto  $\text{S,}$  and unto the several points  $\odot, \odot, \odot, \&c.$  and it will cross the line  $\text{AB,}$  in the points  $\text{x, x, x, \&c.}$  Then through those points draw (by prop. 4. §. 1. chap. 4.) right lines all Parallel unto

§ I. unto 12 Q 12, and so is your Dial finished. Then according unto the breadth of the Plane, you may proportion your Stile, \*Whose height must be equal to the distance between the two Hour-lines 12, and 9, or 12, and 3, and then will the shadow of the upper edge thereof shew the Hour of the day: The height of the Stile, is also found thus.

Fig. 65. \* Which may be either a Pin of the length of QS, placed on Q, and Perpendicular unto the Plane, or it may be a piece of brass or else what of the breadth of 12, to 3, or 9.

As the Tangent of the Hour-line 4 or 5,  
To the Distance thereof from the Meridian.  
So is the Radius,  
To the Height of the Stile.

Then for the other Hour-line, say,  
As the Radius,  
To the Height of the Stile.

So is the Tangent of any other Hour-line,  
To the Distance thereof from the Meridian line.

### PROP. III.

How to draw the Hour-lines on a Meridian Plane, which is an East, or West Dial.

A Meridian Plane stands upright directly in the Meridian, and hath two Faces, one towards the East, and the other towards the West.

Now admit it be required to make a direct East Dial, in the Latitude of  $51^{\circ} 32'$ : let A, B, C, D, be a Dial-plane, on which you would describe a Direct East Dial, on the point D, describe

§ I. describe an obscure Arch HG, with the Radius of your line of Chords, then take  $38^{\circ} 28'$ , the Complement of your Latitude, place it from G to L; then draw DL quite through the Plane; Then to proportion your Stile unto your Plane, so that all the Hours may be placed thereon, from Sun-rising to 11 a Clock. Assume two points in the line LD, as K, for 11; and I for the 6 a Clock Hour-lines; then draw 6, I 6, and 11, K 11, Perpendicular to LD. This done, with the Radius of your line of Chords on L, strike the Arch OP, and from P, to O, place  $15^{\circ} 00'$ ; and draw OK, to cut 6 I 6, in M, so shall IM be the height of the Stile proportioned unto this Plane; which may be a Plate of Brass, whose breadth must be equal to the distance between the Hour-lines of 6, and 9, which must be placed Perpendicular to the Plane, on the line 6, I 6, whose shadow of the upper edge, shall shew the Hour of the day. Now to draw the Hour-lines, with the Radius of your line of Chords, on M strike the Arch QN, which divide into 5 equal parts in the points ●, ●, ●, &c. Then lay a Ruler from M unto each of those points, and it will cut the line IK in the points \*, \*, \*, &c. through which points (by prop. 4. § 1. chap. 4.) draw Parallels to 6 I 6, as the lines 77, 88, &c. which shall be the true Hour-lines of an East Plane, from 6 in the Morning, till 11 before Noon. Then for the Hour-lines of 4, and 5, you must prick off 5 as far from 6, as 6 is from 7; and 4, as far as 6 is from 8; and draw the Hour-lines 55, and 44, as before. Thus is your Dial completed, and in the forming of which, you have made

Fig. 66.

Fig. 66.

§ 1. unto 12 Q 12, and so is your Dial finished. Then according unto the breadth of the Plane you may proportion your Stile, \*Whose height must be equal to the distance between the two Hour-lines 12, and 9, 12, and 3, and then with the shadow of the upper edge thereof shew the Hour of the day: The height of the Stile, is also found thus.

\* Which may be either a Pin of the length of QS, placed on Q, and Perpendicular unto the Plane, or it may be a piece of brass or else what of the breadth of 12, to 3, or 9.

As the Tangent of the Hour-line 4 or 5,  
To the Distance thereof from the Meridian.  
So is the Radius,  
To the Height of the Stile.

Then for the other Hour-line, say,  
As the Radius,  
To the Height of the Stile.

So is the Tangent of any other Hour-line,  
To the Distance thereof from the Meridian line.

As the Radius,  
To the Height of the Stile.

So is the Tangent of any other Hour-line,  
To the Distance thereof from the Meridian line.

To the Distance thereof from the Meridian line.

### P R O P. III.

How to draw the Hour-lines on a Meridian Plane which is an East, or West Dial.

A Meridian Plane stands upright directly in the Meridian, and hath two Faces, one towards the East, and the other towards the West.

Now admit it be required to make a direct East Dial, in the Latitude of  $51^{\circ} 32'$ : let A, B, C, D, be a Dial-plane, on which you would describe a Direct East Dial, on the point D, describe

Fig. 66.

§ 1. scribe an obscure Arch HG, with the Radius of your line of Chords, then take  $38^{\circ} 28'$ , the Complement of your Latitude, place it from G to L; then draw DL quite through the Plane; Then to proportion your Stile unto your Plane, so that all the Hours may be placed thereon, from Sun-rising to 11 a Clock. Assume two points in the line LD, as K, for 11; and I for the 6 a Clock Hour-lines; then draw 6, I 6, and 11, K 11, Perpendicular to LD. This done, with the Radius of your line of Chords on L, strike the Arch OP, and from P, to O, place  $15^{\circ} 00'$ ; and draw OK, to cut 6 I 6, in M, so shall IM be the height of the Stile proportioned unto this Plane; which may be a Plate of Brass, whose breadth must be equal to the distance between the Hour-lines of 6, and 9, which must be placed Perpendicular to the Plane, on the line 6, I 6, whose shadow of the upper edge, shall shew the Hour of the day. Now to draw the Hour-lines, with the Radius of your line of Chords, on M strike the Arch QN, which divide into 5 equal parts in the points ●, ●, ●, &c. Then lay a Ruler from M unto each of those points, and it will cut the line IK in the points \*, \*, \*, &c. through which points (by prop. 4. § 1. chap. 4.) draw Parallels to 6 I 6, as the lines 77, 88, &c. which shall be the true Hour-lines of an East Plane, from 6 in the Morning, till 11 before Noon. Then for the Hour-lines of 4, and 5, you must prick off 5 as far from 6, as 6 is from 7; and 4, as far as 6 is from 8; and draw the Hour-lines 55, and 44, as before. Thus is your Dial completed, and in the forming of which, you have

Fig. 66.

Fig. 66.

¶ 1. made both an *East*, and a *West Dial*; which is the same in all respects; only whereas the *Arch H G*, through which the *Equinoctial* passed in the *East Dial*, was described on the right hand of the *Plane*, in the *West* it must be drawn on the left hand, and the *Hour-lines* 4, 5, 6, 7, 8, 9, 10, and 11, in the *Forenoon* in the *East Dial*, must be 8, 7, 6, 5, 4, 3, 2, and 1, in the *West* in the *Afternoon*; as in the *Figure* plainly appeareth: Now you may find the distance of the *Hour-lines* from the *Substile*, by this *Analogy* or *Proportion*.

*As the Radius,*

*To the Height of the Stile.*

*So is the Tangent of any Hours distance from 6,*

*To the distance thereof from the Substile.*

#### P R O P. IV.

*How to draw the Hour-lines on a direct South, and North Plane,*

Fig. 68. This *Plane* or *Dial* must stand upright, having his face or *Plane*, if it be a *South Dial*, directly opposite unto the *South*; but if a *North Plane*, directly opposite unto the *North*; now admit it be required to make a *Direct South Dial*, for the *Latitude* of  $51^{\circ} 32'$ : To make which first describe the *Circle ABCD*, to represent an *Exact direct South Plane*, cross it with the *Diameters* *CB*, and *AD*, then out of your *Line of Chords* take  $38^{\circ} 28'$ , the *Complement* of the *Latitude*, and set it from *A*, unto *a*, and from *B*, unto *b*, Then lay a *Ruler* from *C* unto *a*, and it will cut the *Meridian* *ARD*, in *P*, the *Poles* of the

the

§. 1

§. I.

Fig.

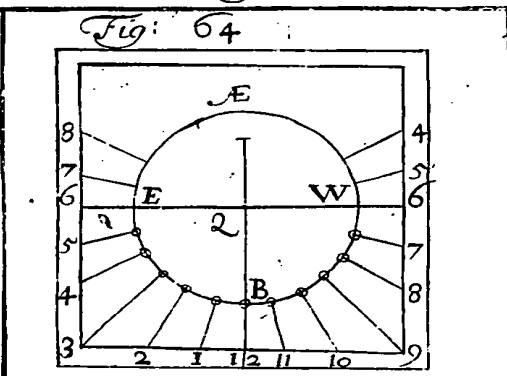
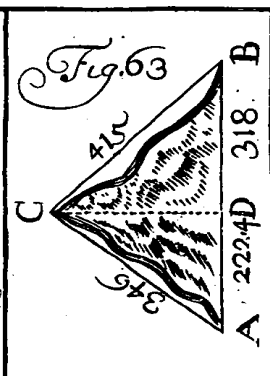
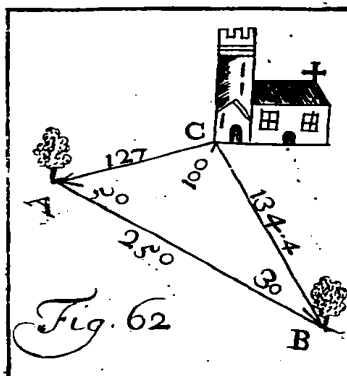


Fig. 68.

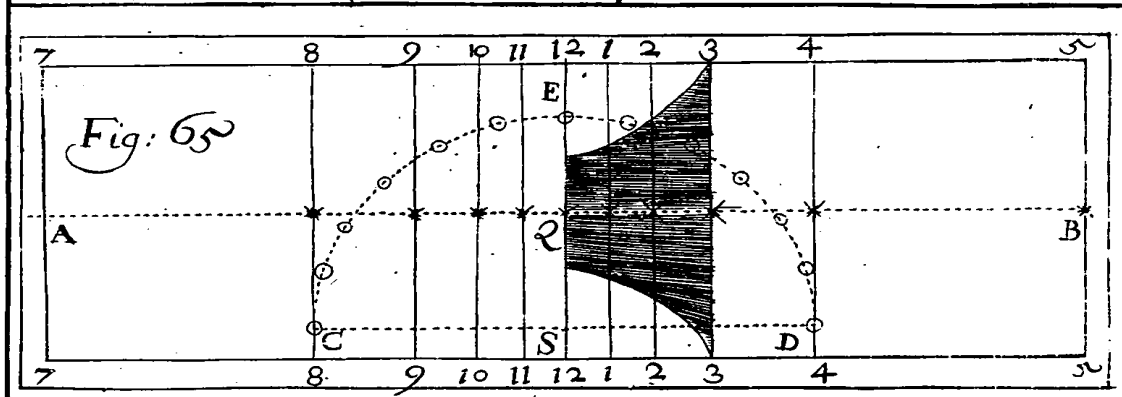
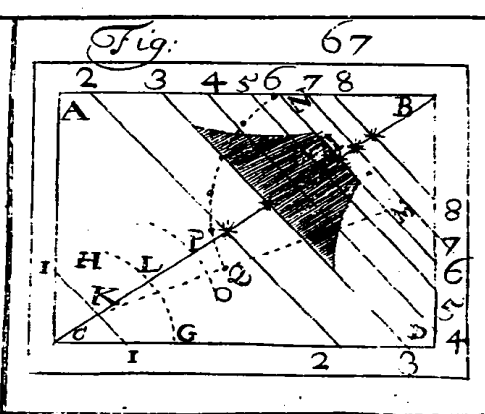
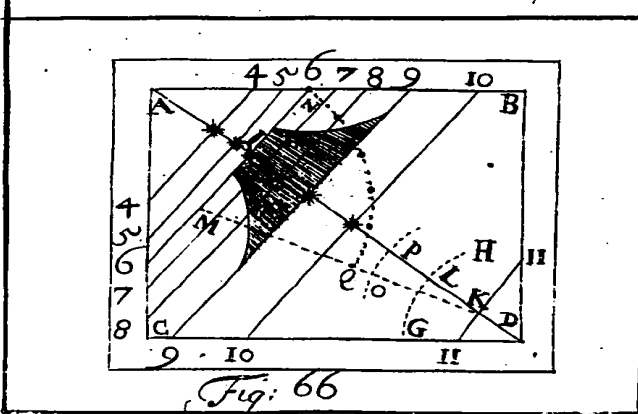


Fig.



69.

§. 1. other hath the *North Pole* of the *World* elevated above it, and beholdeth the *North part* of the *Meridian*. The *Hour-lines* of 9, 10, 11, or 1, 2, and 3, is not expressed on this *Plane*, because 12, representeth 12, at *Midnight*; neither are the other said *Hours* expressed, because the *Sun* is never above the *Horizon*, at those *Hours*;  
 Fig. 69. Therefore the *North Dial* is capable only to receive these *Hours*, namely 4, 5, 6, 7, and 8, in the *Morning*; and 4, 5, 6, 7, and 8, at *Night*; as doth plainly appear in the *Figure*: Now the distance of the *Hour-lines* from the *Meridian*, may be found by this *Analogy*, or *Proportion*.

As Radius or S.  $90^{\circ}$ ,  
 To Sc. of the *Latitude*.  
 So is T. of the *Hour* from *Noon*,  
 To T. of the *Hour-line* from the *Meridian*.

## P R O P. V.

How to draw the *Hour-lines* on an *Horizontal Plane*.

This *Horizontal Plane*, or *Dial*, is one of the best and most usefull *Dials* in our *Oblique Hemisphere*: Admit it be required to make an *Horizontal Dial*, for the *Latitude* of  $51^{\circ} 32'$ :  
 Fig. 70. To make which, first describe the *Circle* AB CD, which representeth your *Horizontal Plane*, Then cross it with the two *Diameters* ARC, and BRD, Then take  $51^{\circ} 32'$  out of your *Line of Chords*, and set it from B, to a, and from C, to b, Then lay a *Ruler* from A, unto a, and it will cut the *Meridian* BD, in P, the *Pole* of the *World*,

World, Then lay a *Ruler* from A, unto b, and it will cut ABD the *Meridian*, in the point  $\text{\AA}$ , where the *Equinoctial* cutteth the *Meridian*, then through the three points A,  $\text{\AA}$ , and C, draw the *Equinoctial Circle*, whose Center is at H; (and found as in the former proposition) Then divide the *Semicircle* ADC into 12 equal parts, in the points  $\bullet, \bullet, \bullet, \&c.$  Then lay a *Ruler* to R the Center of the *Plane*, and on those points, so shall the *Equinoctial Circle* AEC, be by it divided into 12 unequal parts in the points  $\ast, \ast, \ast, \ast, \&c.$  Then a *Ruler* laid unto P the *Pole* of the *World*, and those Points, shall cut the *Semicircle* CDA in those Points I, J, K, &c. Lastly, from the Center R, and through those Points, let there be drawn right lines, which shall be the true *Hour-lines* of such an *Horizontal Plane*, from 6 in the *Morning*, untill 6 at *Night*; but for the *Hours* of 4 and 5 in the *Morning*; and 7 and 8 in the *Evening*; they are delineated by producing 4 and 5 in the *Evening*, through the Center R, and 7 and 8 in the *Morning*; extending them out, unto the other side of the *Plane*, so shall you have those *Hour-lines* also on your *Plane* delineated as you see in the *Figure*. The *Stile* of this *Plane* may be a thin *Plate* of *Brass*, cut exactly unto the Quantity of an *Angle* of  $51^{\circ} 32'$ , and set *Perpendicular* on the *Meridian line*, for the forming of this *Stile* take out of your *Line of Chords*  $51^{\circ} 32'$ , and set it from D, unto e, and draw Re, which shall be the *Axis* of the *Stile*, you may also prefix the *Halves*, and *Quarters* of *Hours*, in the very same manner as the *Hours* themselves were drawn.

§. 1.

Now to find out the distance of the Hour-lines from the Meridian, say,  
 As the Radius or S. 90°,  
 To the S. of the Latitude.  
 So is the T. of the Hour from Noon,  
 To the T. of the Hour-line, from the Meridian Line.

Fig. 70.

These kinds of *Dials* being so frequently used with us, in this *Oblique Sphere*, for the help of the speedy delineating of them, I have annexed hereunto the Table of *Longomontanus*, wherein the *Hour-lines*, for many *Latitudes*, are calculated.

A Table

§. 1.

A Table shewing the Distance of the Hour-lines from the Meridian, in these Degrees of Latitude.

The Hours from the Meridian.

An Horizontal Dial, Latitude.	The Hours from the Meridian.								A South Erect Dial, Latitude.				
	xi.	i.x.	ii.ix.	iii.	viii.iv.	vii.	v.	vi.					
	D	MD	MD	MD	MD	MD	MD	M					
30	7	38	16	6	26	34	40	54	61	49	90	00	60
31	7	51	16	34	27	14	41	42	62	28	90	00	59
32	8	4	17	1	27	53	42	30	63	6	90	00	58
33	8	17	17	27	28	34	43	17	63	45	90	00	57
34	8	30	17	54	29	13	44	5	64	42	90	00	56
35	8	43	18	20	29	49	44	46	64	56	90	00	55
36	8	56	18	45	30	25	45	28	65	27	90	00	54
37	9	9	19	9	31	1	46	9	65	58	90	00	53
38	9	21	19	34	31	37	46	50	66	29	90	00	52
39	9	33	19	57	32	9	47	26	66	55	90	00	51
40	9	46	20	20	32	40	48	1	67	20	90	00	50
41	9	58	20	43	33	14	48	37	67	45	90	00	49
42	10	10	21	7	33	47	49	13	68	11	90	00	48
43	10	22	21	29	34	17	49	44	68	32	90	00	47
44	10	24	21	50	34	46	50	14	68	52	90	00	46
45	10	43	22	12	35	15	50	45	69	14	90	00	45
46	10	54	22	33	35	44	51	16	69	37	90	00	44
47	11	5	22	33	36	10	51	43	69	53	90	00	43
48	11	16	23	12	36	35	52	9	70	10	90	00	42
49	11	26	23	32	37	1	52	35	70	28	90	00	41
50	11	36	23	51	37	27	53	1	70	43	90	00	40
51	11	46	24	9	37	50	53	24	70	58	90	00	39
52	11	56	24	26	38	13	53	46	71	12	90	00	38
53	12	5	24	44	38	36	54	8	71	27	90	00	37
54	12	14	25	2	38	59	54	30	71	41	90	00	36
55	12	23	25	18	39	18	54	50	71	53	90	00	35
56	12	32	25	33	39	38	55	9	72	4	90	00	34
57	12	46	25	49	39	58	55	28	72	16	90	00	33
58	12	48	26	5	40	18	55	46	72	27	90	00	32
59	13	56	26	19	40	36	56	1	72	38	90	00	31
60	13	58	26	30	40	53	56	15	72	47	90	00	30

§. 1.

## P R O P. VI.

*How to draw the Hour-lines, on an Erect declining Plane.*

These Planes are made to set on the sides of Houses, wherein the Meridian is always a Perpendicular, drawn on the Plane, in whose top is the Center, where the Substile, and the Hour-lines all meet.

Now before we can delineate the Hour-lines on any such Planes, two things must be given: As the Latitude of the Place, and the Planes Declination; by having which we must find these three things: viz. The Poles height above the Plane. The distance of the substile from the Meridian. And the Plane's difference of Longitude.

For the finding of which Requisites, by Geometrical Projection, we describe on the Dial Plane, these Circles of the Sphere, viz. The Horizon, Meridian, and Equinoctial, which being described in their true Position, on the Plane, we proceed thus.

Admit it be required to make a Direct South Dial, on an Erect, Direct South Plane, Declining Westward  $24^{\circ} 20'$ , in the Latitude of  $51^{\circ} 32'$ .

Now in order to find the requisites before mentioned, describe the Circle ZHNO, and cross it with the two Diameters ZQN, and HQO: now Z is the Zenith, N the Nadir, ZQN the Hour-line of 12, HQO the Horizon. Now seeing the Plane declines S. W.  $34^{\circ} 20'$ : make Na, and Ob, each equal to  $34^{\circ} 20'$ : Then a Ruler layed from Z, to a, will cut the Horizon in S, the South

§. 1.

South point of the Horizon, through which draw the Meridian ZSN, whose Center is at Y, found as in the fourth Proposition foregoing: Then a Ruler laid from Z to b, will cut the Horizon in W, the West point thereof. Now the Horizon and the Meridian being projected on the Plane, take out of your line of Chords  $51^{\circ} 32'$ , which place from H, unto c, and from N, unto d; then lay a Ruler from W, unto c, and it cutteth the Meridian in P, the Pole of the World. Then through P and Q, draw the line PQD, which representeth the Axis of the World; and the Substilar line of the Dial, then lay a Ruler from W, to d, it cutteth the Meridian in E, so is WE two points through which the Equinoctial must pass, whose Center is found as afore to be at M, (being always in the Axis of the World) so have you on your Plane the Horizon HQO, the Meridian ZPSÆN, and the Equinoctial LÆKWG, described on the Plane as required.

Now first to find the Poles height above the Plane, which in this Scheme is represented by BP, Lay a Ruler from G, unto P, and it shall cut the Plane in V, then measure the distance BV, on your line of Chords, and you will find it to contain  $34^{\circ} 33'$ , which is the Poles height above the Plane.

Secondly, To find the distance of the Substile from the Meridian represented in the Scheme by the Arch ZB, or ND, which measured as afore will appear to be  $18^{\circ} 08'$ , the distance of the Substile from the Meridian.

Thirdly, To find the Plane's Difference of Longitude, which in the Scheme is represented by the

Fig. 71.

Fig. 71.

§. I. the Angle  $\angle EPK$ , lay a Ruler from P, unto  $\mathcal{A}$ , and it cutteth the Plane in X, then measure the Arch DX, as afore, and so will you find the Planes Difference of Longitude, to be  $30^{\circ} 00'$ :  
 Thus by Geometrical Projection have we found all the three Requisites: Now to find them by Arithmetical Calculation observe these Analogies or Proportions.

1. For the Poles height above the Plane, say,  
 As Radius or S.  $90^{\circ}$ ,  
 To Sc. of the Latitude  $38^{\circ} 28'$ .  
 So is Sc. of the Declination  $65^{\circ} 40'$ ,  
 To S. of the Poles height above the Plane  
 $34^{\circ} 33'$ .

2. For the Distance of the Substile, from the Meridian, say,  
 As the Radius or S.  $90^{\circ} 00'$ ,  
 To the S. of the Plane's Declination  $24^{\circ} 20'$ .  
 So is Tc. of the Latitude  $38^{\circ} 28'$ ,  
 To the T. of the Substilar Distance from the Meridian  $18^{\circ} 10'$ .

Fig. 71. 3. For the Plane's Difference of Longitude, say,  
 As the Sc. of the Latitude  $38^{\circ} 28'$ ,  
 To the Radius or S.  $90^{\circ} 00'$ .  
 So is S. of the Substilar Distance  $18^{\circ} 10'$ ,  
 To the S. of the Difference of Longitude  $30$  Deg.

Or, it may be found thus.  
 As the S. of the Latitude,  
 To the Radius.  
 So is the T. of the Declination,  
 To the T. of the Difference of Longitude requir-  
 red. These

§. I. These things found, we come now to shew how the Hour-lines may be projected. To project which observe, First, to lay a Ruler from P the Pole of the World, to  $\mathcal{A}$  the Intersection of the Equinoctial with the Meridian, and it will cut the Plane in x, where begin to divide the Semicircle LxG, into 12 Equal parts in the Points  $\bullet, \bullet, \bullet, \bullet, \bullet, \bullet, \bullet, \bullet, \bullet, \bullet, \bullet, \bullet$ , &c. Then lay a Ruler from Q, to every of those parts, and it shall cut the Equinoctial; and divide it into 12 unequal parts, in the points  $\ast, \ast, \ast, \ast, \ast, \ast, \ast, \ast, \ast, \ast, \ast, \ast$ , &c. Then a Ruler laid from P the Pole of the World unto each of these points, it will divide the Plane into 12 unequal parts in the Points J, J, J, J, &c. Then by a Ruler laid from the Center Q, to those points, draw right lines, which shall be the true Hour-lines proper unto such a Declining Plane, as you see plainly demonstrated by the Scheme.

Now the Substilar line falleth in this Dial, just on the Hour-line of 2, in the Afternoon, because the Plane declineth Westerly. The Angle of the Stile is DQR  $34^{\circ} 33'$ . which may be either a Plate or Wyre, brought into such an Angle, which must be placed Perpendicular to the Plane, and directly over the Substilar line QD 2.

Now the distance of the Hour-lines, from the Substilar line, may also be found by this Analogy or Proportion.

As the Radius,  
 To the S. height of the Pole above the Plane.  
 So is the T. of the Hour-line from the Meridian of the Plane,  
 To the T. of the Hour-line from the Substile.

Thus

Fig. 71.

¶ 1. Thus have you compleated your *Dial*, as you see in the *Scheme*, and here you may take notice that having finished a *West Decliner*, you have also made an *East Decliner*; if you only convert the *Hour-lines* of the *West Decliner*, in such manner as you see in *Fig. 72.* on the *East Decliner*, and compleat all as you see in that *Scheme*.

Thus I have explained the making and delineating of the best and most usefull *Dials* both by *Geometrical Projection*, and also by *Arithmetical Calculations*, in as brief and compendious a manner as possible. There are sundry other kind of *Dials*, as *Incliners*, *Decliners*, and *Recliners*, which being not so usefull, for brevity sake, they are here omitted: As for *Instrumental Dials*, as *Quadrants*, *Rings*, *Cylinders*, &c. Which depend on the Sun's height, I refer you to Mr. *Edm. Gunter's Book*, wherein they are largely described.

As for the Beautifying and Adorning of those *Dials*, &c. by describing on them the *Equinoctial*, *Tropicks*, *Parallels of Declination*, *Parallels of the Sun's Place*, *Length of Days*, the *Sun's Rising and Setting*, *Jewish*, *Italian*, and *Babylonish Hours*, *Almicantbars*, *Azimuths*, *Circles of Position*, the *Signs Right Ascending*, *Descending*, *Culminating*, &c. I do advise you to consult Mr. *Gunter*, Mr. *Foster*, Mr. *Wells*, and Mr. *Holwel's Works*, all which Authors have very learnedly shewed the describing of them, by several large *Schemes*, and *Figures*; for the plainer Illustration thereof.

Now seeing the *Latitude* of a Place must be first known, before a *Dial* can be made to it;

I have

§. I.

Fig. 72.

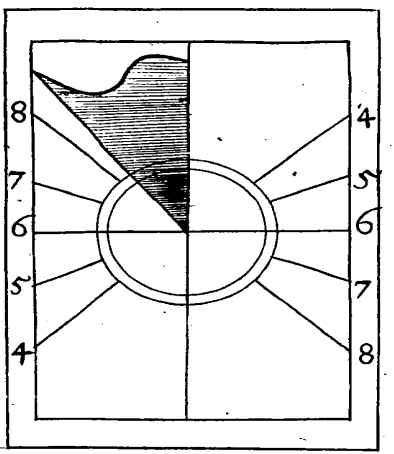
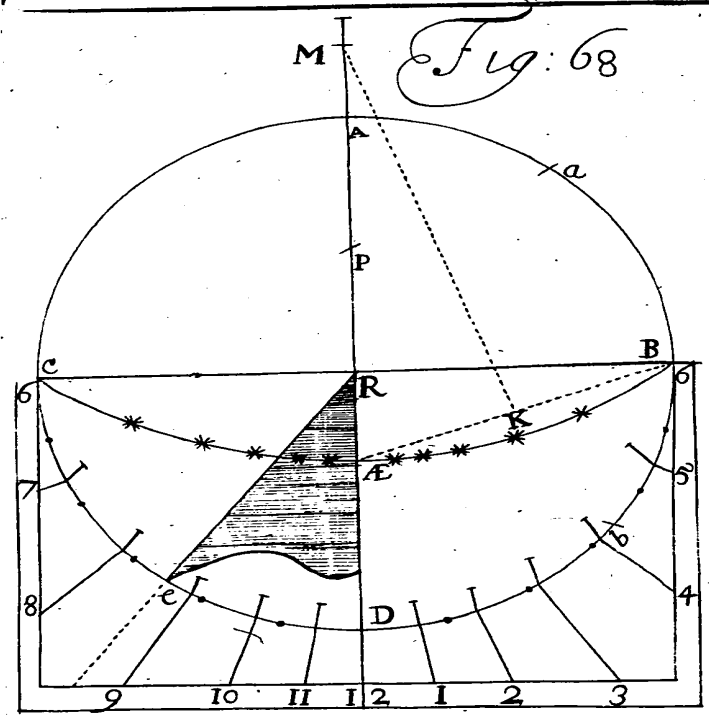
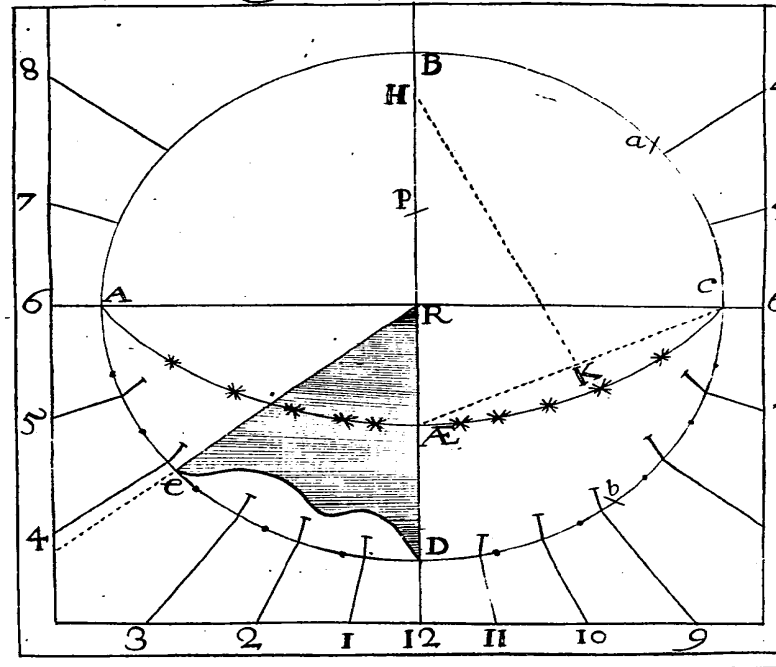
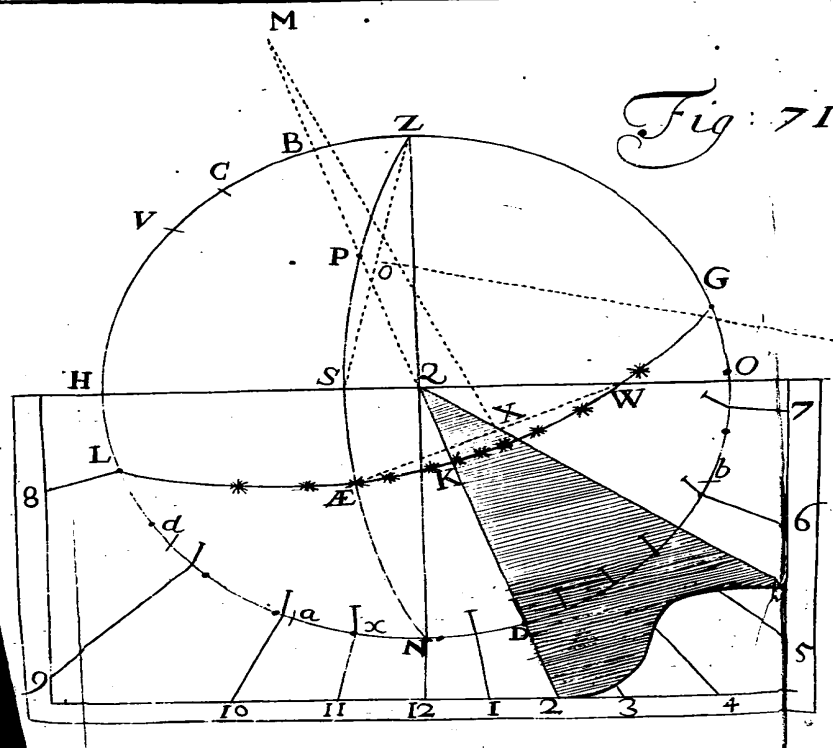


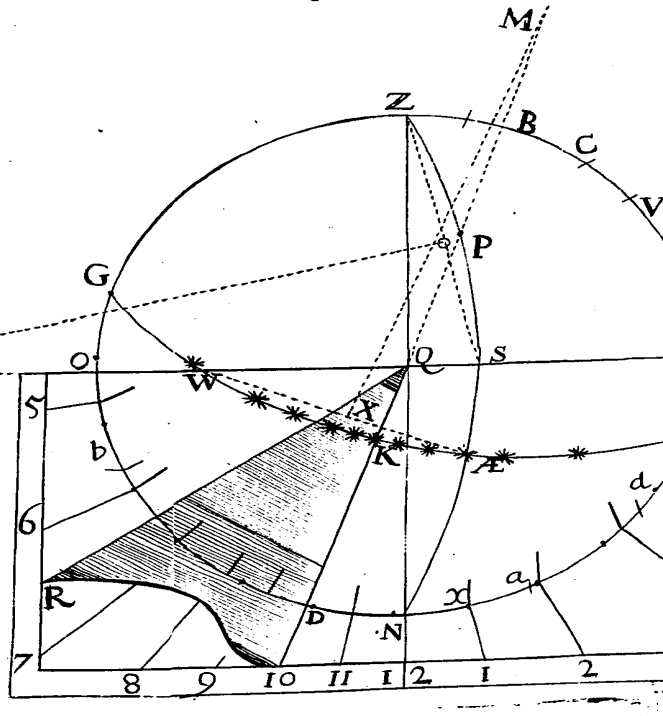
Figure 70



*Fig: 71*



*Fig: 72*



I have therefore hereunto annexed a Table of the *Latitudes* of all the principal *Cities, Towns,* and *Islands,* in and about *Great Britain and Ireland;* so that if you are to make a *Dial,* for any of those parts, you may have recourse to this Table, and make your *Dial* to the Latitude of that place, which you find to be the nearest to the Place, for which you are to make your *Dial.*

*A Table of the Names and Latitudes of all the Principal Cities, Towns, and Islands, in and about Great Britain and Ireland.*

ENGLAND.		D. M.
	<i>Falmouth</i>	55 22
	<i>Glocester</i>	51 57
	<i>Guilford</i>	51 12
	<i>Hartford</i>	51 54
	<i>Hereford</i>	52 17
	<i>Huntington</i>	52 30
	<i>Ipswich</i>	52 20
	<i>London</i>	51 30
	<i>Lincoln</i>	53 20
	<i>Leicester</i>	52 45
	<i>Lancaster</i>	54 15
	<i>Northampton</i>	52 24
	<i>Norwich</i>	52 45
	<i>Nottingham</i>	53 00
	<i>Newcastle</i>	55 12
	<i>Oxford</i>	51 50
	<i>Portsmouth</i>	51 08
	<i>Plimouth</i>	50 36
	<i>Reding</i>	51 40
	<i>Salsbury</i>	
<b>A</b>	<i>Rundel</i>	51 00
	<i>Bedford</i>	52 15
	<i>Barwick</i>	55 54
	<i>Bristol</i>	51 35
	<i>Buckingham</i>	52 10
	<i>Cambridge</i>	52 20
	<i>Canterbury</i>	51 25
	<i>Carlisle</i>	55 20
	<i>Chichester</i>	50 48
	<i>Chester</i>	53 18
	<i>Colchester</i>	52 08
	<i>Dover</i>	51 20
	<i>Derby</i>	53 00
	<i>Dorchester</i>	50 50
	<i>Durham</i>	54 56
	<i>Exeter</i>	50 48

§. I.

	D. M.		D. M.
Salsbury	51 12	St. Andrews	56 40
Stafford	52 50	Skyrassin	58 38
Stanford	54 44	Sterling	56 12
Shrewsbury	52 50		
Truero	50 30		
Winchester	51 03		
Worcester	52 25		
Warwick	52 30		
York	54 00		

## WALES. D. M.

<b>A</b> nglesey	53 28
Barmouth	52 50
Brecknock	52 01
Cardigan	52 12
Caermarthen	51 56
Carnarwan	53 16
Denbigh	53 13
Flint	53 17
Landaffe	51 35
Monmouth	51 51
Montgomery	51 56
Pembroke	51 46
Radnor	52 19
St. David	52 00

## SCOTLAND. D. M.

<b>A</b> Berdeen	57 30
Dunblain	56 21
Dunkel	56 48
Edenbrough	56 00
Glasgow	55 58
Kinfaile	57 44
Orkney	60 06

## IRELAND. D. M.

<b>A</b> Ntrim	54 38
Arglas	54 10
Armagh	54 14
Carterlagh	52 41
Clare	52 34
Corke	51 55
Droghedagh	53 58
Dublin	53 55
Dundalke	53 52
Galloway	53 02
Kenney	52 30
Kildare	53 00
Kings Town	53 08
Knockfergus	54 40
Kynsale	51 41
Lymerick	52 30
Queens Town	52 52
Waterford	52 09
Wexford	52 18
Youhall	51 53

## ISLANDS. D. M.

<b>W</b> ight	50 48
Portland	50 30
Man	54 24
Limdey	51 22
Ferzey	49 12
Garnzey	49 03

CHAP.

## C H A P. XIII.

## Of FORTIFICATION.

**T**HE Utility of this Mathematical Art called Fortification, or Military Architecture, is so well known, that it needs not my commendation, and therefore to speak any thing thereto, were but to light a Candle before the Sun.

In the handling of this part of the Mathematics, I shall be as brief as possible, yet as plain as can be desired: In the prosecution of which, I shall use this Method. As *First*, I shall give you the most principal Definitions or Terms belonging to this Art. *Secondly*, I shall prescribe the most conducing Maxims or Rules herein observed. *Thirdly*, I shall shew how to delineate the Ground-line of any Fortification, according to the several Proportions, used by the best and most experienc'd Ingeniars of Italy, France, Holland and England; *Fourthly*, I shall describe the Construction of the chief and principal Outworks now in use; and *Lastly*, lay down some general Maxims or Rules, by most Modern Authors observed in Irregular Fortifications.

T

SECT.