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The FAITHFUL

SURVEYOR:

TEACHING

How to *Measure* all manner of Ground
exactly, by the Chain onely :
Also, thereby to take *Distances* of a Mile space,
and the Situation of any Building.

SHEWING LIKEWISE

The Making and Use of a New Instrument,
called a *Pandoron* ; which supplies the use of
the *Plain-Table*, *Theodelite*, *Quadrant*,
Quadrat, *Circumferentor*, and
any other Observing Instrument.

As also divers Secrets for *Conveying* and *Clensing*
of *Water*, *Flowing* and *Draining* of *Grounds*,
Quenching Houses on fire, &c.

With

An *Appendix* unfolding Errours in Board
and Timber-measure :
With Directions for Making a Carpenters RULE.

By *GEORGE ATWELL* late Teacher of the
Mathematicks in *CAMBRIDGE*.
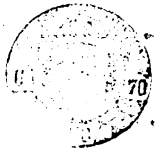
The Author to the Reader.

Courteous Reader,

Ad I fancied the giddy humour of obscure Wits, who deliver their *dry Notions* as dubiously, as the *deceitfull Oracles* did their *Responses* of old ; lest by speaking too plain their shallownesse be made manifest to all men: I might have spoke as little sense in as few words to as little purpose. But (leaving these to their folly) I never accounted their design either prudent, or politick ; who, having enlarged their stock of knowledge by the good Improvement of their opportunities, deliver themselves so darkly to the world, as if they had a mind onely to satisfie it what they could do, not what they should. I like *Pythagoras* his counsel, Χρὴ ζιγᾶν ἢ κρείασονα ζιγᾶ. λέγειν· *Either speak to purpose, or hold your tongue*: and, methinks, his counsel pleases me better; when I remember the curious *Naturallist's* observation, *That men have a double fence to keep in this slippery member*; which insinuates thus much to us, *That one had need be wary,*

..Πολὺν

To the Reader.

Hom. Odyſ. γ. v.230.

—Ποῖόν σε ἔπος φύγεν ἕρκος ὀδόντων, *What & How* he ſpeaks.

Now to walk ſecure from the default of each of theſe by-wayes is the drift of my preſent writing: which, had not the profit of others more ſtirr'd me up to, then the profit, pleaſure, or honour I could have propoſed to my ſelf in ſuch an enterprize, it might have lain buried in oblivion: but I remembred that ſaying of *Tullie; Non nobis, ſed patriæ nati ſumus.* The Law of *humanitie* enjoyns us all with one ſhoulder to help forward any uſefull or profitable deſign, and to treaſure up our *notions* and *obſerva-tions* for the good of others.

Horat. ep. 1. lib. 1.

Condo, & compono, quæ mox depromere poſſum: I lay up, *that I may lay out:* and we never ſo well diſcharge our ſelves of our *talents,* as when we moſt largely diffuſe them to the improvement of *humane ſocietie.* Seeing then *my* lot is fallen among the *Scriblers* of this preſent age, I make a double requeſt to two ſorts of *Readers. Firſt,* to the ingenious Scholar; who may, perhaps, *nauſeate* this *homely fare* and *domeſtick language,* and may, tis not unlike, find *flaws* in the *unvvary con-nexion*

nexion of the fenfe, or *unpolifhed* contents. my *Apology* is onely this, that I write to be underftood of *all*, and fo bent my *Countrey-Stile* to the capacities of thofe I fuppofed would chiefly put the contents of it in pra-ctife.   My *Second* requeft is to the honeft countrey-*Farmer*, or whofoever he be who intends to mete his ground by my Chain : that he would go through with it, &make it his own as he goes :   for by fo doing he may find benefit affuredly. My laft requeft is to both jointly: not to reject the gronnds of it without good reafon , nor without a pair of *Spectacles* to convince experience, μητέρα τέχνχιάι, *the mother of Arts* , as the Philo-fopher calls her.   I might put this into the ballance to weigh down the cenfure of both,

ἔ-- ἄμρω δὲ πατέρη ἴσιν ἐμέϊο.

But I forbear; left I fhould tire the *Reader's* patience with too tedious a Prologue, let-ting Truth ftand on it's own bottom: and commend it in general to the well-im-provers of it, and reft thy friend to ferve thee,

GEORGE ATWELL.

The Author to his Book.

GO, little Book, and travel through the land :
Nane will refuse to take thee in their hand.
Fear neither Momus mouth, nor Zoilus quill :
Assuredly, there's none, can do thee ill.
Both simple, gentle, Barons, Lords, and Knights,
Will take thee for their chiefest of delights.
Thou teachest them to measure all their ground;
Which, certainly,, will save them many a pound.
Plain-table, and Pandoron with it's sight,
Circumferentor, and Theodelite,
Quadrat, Quadrant, and Chain alone : with these
Thou'lt teach them for to measure with great ease,
Some give a penny to a fire that's past :
But, thou giv'st pounds, for to prevent the wast.
Thou cleanest water, flow'st and drain'st their grounds,
And bringest water plenty to their towns ;
Thou teachest also to enrich their mold :
And i'th mean while to fill their chests with gold.
Thus doing, thou shalt never be forgotten,
But thou shalt live, when I am dead, and rosten.

<div align="right">G. A.</div>

Upon his worthy Friend, Mr. *George Atwell*, and this his exact *Method* of *Surveying*.

SO, *now the Press ha's a new labour past,*
Which shee'l her best acknowledge, if not last.
Ne're did her letters such a posture show,
So advantageous, since they first did know,
T' instruct the world how they their Acres *should*
Cast-up *and* measure *by the* perch *or* rood.
'Twas but of late, since which applause we view'd
Some labours in this kinde, and thought them good:
But they themselves will now no more aspire
To further praise; but all consent t' admire
Content, since thou art come. So when we spie
A curious piece, that entertains our eye
With livelyness, w' approve't; yet, when we part,
Forget it in a livelyer pieces art.
    Me thinks, I see how with a glance men lay
Others aside, and by their longer stay
Speak their contentment of thy book, and stand
Surveying that as thou of late their land;
With such exactness. -- Here thine art s by thee
So rais'd, that truth *meets with* facility.
Before we did by Sines *and* Tangents *go,*
Theodelete, Circumferentor *too;*
Wayes, that I sigh to think of: which at th' sight
Of th' marshall'd figures able were t' affright
An unassured eye: who without fear
'Gainst such a rallied *number dar'd appear?*
Armies of figures in the field then stood,
Fore-sight it was (though without fear of bloud)
To reach an * *herb; a sign we could not know*
T' or'ecome that bed, where lately it did grow.

* Her-
bam por-
rigere.
Prov.

* *

This

This by thy chain alone *thou do'st; and we*
Admire thine art, admire thy brevity.
    Men of thy *temper, and that* own a *mind*
  As thine, so searching, we may seek, not find:
  At thoughts of it we can securely crie;
  Th' acutest mind still ha's the piercing'st eye.

John Hutchinson, *Trin. Coll.*

To his honoured friend, M^r. *George Atwell,*
on his *Faithfull Surveyour.*

S Ee the stile alters; Poets did but feign:
  *Counter-*Pandora ~~with her box again.~~
Sals^tbury-stones, that pos'd the baker's *loaves,*
Might here have set themselves in these thy groves.
Thy hand hath meted, *and be sure to try*
There's nothing in't but squar'd *by* Geometry.
But found thy Art, and teach us how to get
Some lands, as thou hast taught to measure *it:*
For, while we other's mete, *our spirits rise,*
And in their *acres we but* Tantalize.
Yet, 'tis too true, estates *take no* degree
I'th Confines of our University.
He, who was ask'd, Where our possessions lay,
Might well have thus resolv'd, In Terr' Incognita,
Or, In the Isles, *that well may bear the date,*
From their unlucky seat, Infortunate.
Help out, invention; and assist, ye hands:
'Tis Scholars fate, you see, to have no lands.
If any they appropriate *will have,*
They must, Ben-Syra-*like, mete out their grave:*

Or

Or else, if all plots *fail, may try their skill*
To take the angles of Parnaſſus *hill:*
But wee'le ſuſpend our judgment, and not dare
To queſtion, till we ſee thy Finis *there.*
The Welſh-mans *ſentence was content to ſtay*
The Apoſtles *leaſure till the* Judgement-day:
And, ſhall not me with patience wait to ſee
The true Effigies *of thy Art and thee.*
Till then wee'le try our skill, no ſpirit raiſe,
Without a Charm, *t'encircle thee with* bays.

<div align="right">

I. Charles, *T. C. Philomath.*

</div>

To the praiſe of the Ingenuous Book of his
honoured friend, Mr. *George Atwell,* call'd
his *Faithfull Surveyour.*

On the Authors name,

GEORGIUS ATWELL.

Anagram.

AGROS E VULTU LEGI.

THis *book's thine own, none need to fear,*
Each leaf thy picture *in't doth bear.*
It's the Idea *of thy mind,*
And face *to both are here conjoyn'd.*

On his Book.

I *Do not wonder that* Meduſa's *head*
At ſight could render living *mortals* dead;
Since the peruſal of this book (whoſe vein
The richeſt gems *of wiſedome doth contein)*
I ſeeing wondred, *wondring* dead *I fell,*
To view ſo much *lockt in ſo ſmall a ſhell.*

<div align="right">

On

</div>

2

On the Author.

WHat splendour can, or Jove, or Saturn add
   (who borrow all) to Sol most richly clad
In golden vestiments? to Sol, whose rays
Each morn foretells to all their Halcyon days?
     Muse. T'averre he wants no praise.

WHat glory then (dear Muse, I prethee, tell)
   To him (whose name subscrib'd shows all's done well)
Ought we to give? to him, whose pregnant wit
Shall live, while others may in silence sit.
     Muse. On earth there's none, that's fit.

ON earth there's none, that's fit? then soar the skies,
   Brave George! whose fame beyond the clouds doth rise.
In spight of envies Clog, and does aspire
Heavens Canopie beset around with fire.
     Thither thy self retire.

               D. Ienner. A. B. Trin. Coll.

To his much respected Friend, Mr George Atwell, upon his Book Of Surveying, &c.

TO dress my lines in praise of Thee, my quill
   I'de wish to dip, where Poets once did fill
Their versing pens; whose thoughts when they'd rehearse,
Like metall in a mould would run to verse:
I de shew my self then gratefuller to Thee,
Then these detracting times could spitefull bee.
Here you the Curtain draw, and let us see
The now-known worth of conceal'd mysterie.
'Twas Nature form'd the Earth, gave treasure:
But how to give the price, and measure

                             With

With lines unparalled th' embroidred ground;
To GEORGE alone his praise it must redound:
'Tis ATWELL gets the start of Fancies rais'd;
They at HIS publisht work may stand amaz'd.
Let all the BOOK now view; give her the praise,
That made the tools: but reach to him the bays,
That is the Artist, and who undertook
To make himself the Author of this Book,
To dissolve Riddles, make Ænigmaes plain,
Which have requir'd an OEdipus his brain.
Envy, be gone, Apollo; be their guide:
To see what Gordian knots are here unty'de;
And couched handsomely what might in short
Please both the Learned and the Vulgar sort.

H. Rich, *A. B. Coll. Gon. & Caii.*

The Contents of the Chapters in
The Faithfull Surveyour.

The Contents.

XXXI. *Of*

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The Contents.

The Contents of the Chapters in the *Appendix* to *The Faithfull Surveyour.*

Addenda & Emendanda.

Gentle Reader,

I defire thee to take notice of thefe my *Additions*,
and *Emendations*, before thou readeft my
Book.

<div align="right">G. A.</div>

Page 9. l. 8. for firft, *read* where. *page 14 line 12. put out* not. *page 21. for* fub-tendents C X 674, *and* 756. *which are at the top of the third column, fet them at the bottom of the firft and fecond columns.* p. 17. *againft line* 21, &c. *fet in the margin, To bring links into acres and poles.* p. 28. l 5. *for* 7. *read* 77. p. 36 l. 23. *after* quadrant, *read* book or paftboard. p. 37. l. 2. *read,* tran viz. *from the* line drawn. p. 42 l. 10. *for is,* r. in. *and line* 15. likewife you may. *and* l. 33 r. to the line. p. 43. l. 11. r. a fp:nny of wood. p 45 l. 21. r fave onely If In meafuring you have any forry bound book or paft-beard: *and againft* line 23. *write, How to fet out a perpendicular into an angle with the chain onely,* p. 57. l. 28. *for* mark r. work. p. 63. l. 19. r. the whole angle B. p. 64. l 10 r. A, I finde. *and* l. 13. at D, I finde. p. 65. l. 7. *for* 10, r. 16. *and* l. 11. & l. 13, *for* L. r. lin. p. 69. l 12. *for* edge, r. eye. *and* l 29. r. 100 of the Quadrate. p. 70. l. 34, *for* you, r. I. p. 72. l. 9. *for* declination, r. the angle of the wall and Sun. p. 73. l. 10 *put out,* As the Radius to the fine of the Suns greateft declination 23. 31. *and write it thus;*

As Radius

To fine of the Snns greateft declination 23 31.

<table>
<tr><td>So is the fine of the Suns diftance from the neareft Equator</td><td>26</td><td>960080 -</td></tr>
<tr><td>To the fine of the declination defired 10 4</td><td></td><td>964184</td></tr>
<tr><td></td><td></td><td>924254</td></tr>
</table>

p. 74. *there is a better figure in pag.* 51. p. 78. *the commaes fhould be left out, and l.* 10. *for* lines, r. times. p. 85. l. 33. r. a foot and an half long. *and* l. 36. r. feriles. p. 96. l. 29. *for* tre-fqle, r. trefoot. p. 112. l. 10. *for* 32 82, r. 23 82.

In the *Appendix.*

Page 130. *line* 12. *for* fquare, *read* ftroke. *l.* 15 *diftinguifh* 4t thirds *at l.* 16. at that. *l* 25. *for* fines, r. fives *l* 30. r 5, 10, 15. *l.* 33. *for* ;8 r. 30. p. 135. l. 31. *for* 2. r. 12. p. 141. l. 20. *diftinguifh at* 8. p. 142. l. 9. *for* fet, r. get.

The Faithfull Surveyour.

CHAP. I.

Of errours in Land-meafure.

Ivers are of that opinion, That if two pieces of land are of equal peripherie, that thofe two pieces are both of one and the fame content. But that is eafily difcovered falfe; for let one piece of land lie in a true fquare; being a quarter of a mile fquare, or 80. poles fquare, *viz.* a mile in all; the content is juft 40. acres. For every one knowes, that 40. pole long, and 4. pole broad, or 80. pole long and 2. pole broad, make an acre. Therefore 80. pole long, and 80. pole broad, muft needs make 40. acres, and that 80. times 80. is 6400. pole, which divided by 160. (the poles in an acre) is juft 40: acres. But in a Circle of a mile about, *viz.* 320. pole, if (according to *Archimedes*) we multiply the Circumference by 7. which is 2240. and divide it by 22. it gives 101 $\frac{44}{22}$ the diameter: now then, if we multiply half the diameter 50 and $\frac{10}{22}$, or 50 and $\frac{10}{11}$ by half 320. the Circumference, *viz.* 160. (which are alfo the poles in an acre) firft 160. by 50. is 50. acres: then multiply 160. by 10. *facit* 1600. which divide by 11. it gives 145. pole and $\frac{3}{11}$. fo that the Circle contains more then the fquare by more then a fifth part. And as in land, fo in timber; and therefore that muft needs be a falfe way of meafuring round timber, to gird it about, and to take the fourth part thereof for the fquare, as plainly appears in this; that, when they have hewed it, they make more of it then they made before. Alfo a fquare is more capacious then an oblong; for every Shepherds boy can tell,

A   that

that if he hath but 24. hurdles in his fold, and that it goes
upon a rood, where he hath but one at each end, and 11 on
each fide; his fheep will lie thicker a great deal, then if his fold
goes fix on each fide, and end : though he knows not the pro-
portion, yet he perceives a fenfible difference; and fo well he
may, as being more then three to one ods. For it is as 11 to
36. for once 11. is but 11, and fix times fix is 36. And for
want of this knowledge many furfeit their fheep in fummer,
by lying too hot. If I may advife, they fhall never lay fheep
thicker, then to allow 20. foot of ground to each fheep, fo
that if you have rod hurdles of 8. foot a piece, *viz*, 64. foot;
in one hurdle fquare I would not put above 3. fheep and ½;
nor in flat hurdles of nine foot long, above four fheep; and fo
doing, if your 24. nine foot hurdles go fquare, it may hold 96.
fheep, and your 24. eight foot hurdles 84. fheep.

Another great errour I have known maintained by a great
Rabbi Surveyour ; that in meafuring a triangle, it holds good
to take the half of any fide for the bafe, and the whole per-
pendicular from the angle oppofite to that bafe, to the middle
of that bafe, *or vice verfà*, and their product to give the con-
tent. But this is demonftrated to be falfe thus. In this oblong
figure A B C D, let the two fides A B, and C D be 30 a piece,
and the two fides A C, and B D 40 a piece, fo 30 multiplied
by 40 gives 1200 the content of this oblong, which is divi-
ded into two rectangle triangles, by the Hypotenufe A D,
which two triangles A B D, and A C D are both equal ; for
that the fides A B, and C D are equal by conftruction, alfo the
A C and B D are equal by conftruction, and
A D is common to both; therefore the two
angles B. and C are equal: likewife the two
triangles A B D, and A C D are equal, *per
4. prop. Element* the 1. *Axiom.* the 7. *Quæ
ejusdem funt dimidia, inter fe funt æqualia:*
therefore either triangle muft contain 600.
Now in the triangle A C D, to difcover the
falfhood, we muft firft finde the length of the
line
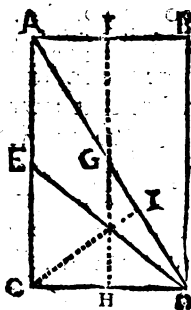
line ED thus. First, square the line CD, 30, *facit* 900. also square CE, 20, *facit* 400; then C being a right angle, and we seek ED, the Hypotenuse, we must adde 400, and 900, *facit* 1300, whose square root is ED 36 ⅑, multiply this by 20, the half of AC, *facit* 721, ⅒, the content, too much almost by a sixth part, being it should be but 606. and so you shall finde it, if you multiply AC, 40. by half CD, 15. for the oblong AFHC, is equal to the oblong FBDH, therefore it is the half of ABCD. Also the triangle DGH, which is taken out of the triangle DCA, is equall to the triangle AFG, added to it.

Or if you will, make AD the base, upon which you may let fal a perpendicular from the angle C; but then it must not fall on the middle of the line, except it be the base of an Isosceles triangle; but if you will needs finde the true place of the field where the perpendicular must fal, I know no instrument you can work by, be it plain-Table, Theodelete, Quadrant, Circumferentor, no not so simple as the chain alone, but you may set out a square by it; therefore set up your instrument in the station-line, going forward streight in it, till you ghuesse that a line out of the angle will cut your station-line squire-wise, which if you think you are far enough, set up your instrument there and first let it behold the mark you came from; if it doth not then behold also the mark you go to, you are out of your line, and must remove it side-wayes which having rectified it that way, then see if it look right into the corner: which if it do, it gives you the place in the station-line desired, which is 32 from A, and but 18. from D, *viz.* at I, which is thus made good. As the base 50. is to 70. the summe of 30, and 40 the two other sides AC, and CD; so is the difference of the same two sides 10, to 14, which 14 being taken out of 50, the whole base, the perpendicular shall fall on the middle of the remain 36, the half whereof is 18, to which adde 14, it makes 32 from A to I, as afore; and that taken out of 50 leaves ID, 18, as afore. Now to finde the length of the perpendicular CI, if you measure it in the field you will finde it 24 pole, which is thus proved. Take the square of the side AI, 32, which is

1024. out of the square of A C, 40, *viz.* 1600, refts 576; whofe fquare root is 24, the perpendicular defired. Now if you multiply 50 the whole bafe by 12. the half perpendicular : or 25. the half of 50. by 24, you have 600 , as afore. Thus you fee it double proved, that this way of taking the middle of the bafe for the fall of the perpendicular, is for the moft part an extream falfe way: and the fixth part of the ground and more may be eafily got and loft hereby: infomuch that I have known by this very errour above twenty pounds got and loft in one day between the buyer and feller, feverall times, and by feverall men. But whether *Balls* of *London* ufed this way, or worfe, I know not, who was fent down by the Lady *Morrifon*, to furvey a Farm at *Hardwick* near *Shefford* in *Bed-fordfhire*, whereof fhe had let a new leafe for 21 years to one *Childe* at five fhillings the acre. *Balls* makes of it 400 acres juft: *Childe* thinks himfelf wronged, fends for me, defiring me to meafure it, not faying a word to me upon what terms, or that it had been meafured before. I fet to work, and having done, I give in mine account for 322 acres. He asked me if I would juftifie it. I told him, I accounted him as my friend, I would ftay for fatisfaction a twelve-moneth; let him keep my plats, if in that time I were difproved two acres, I would have nothing for doing it. Whereupon he works to the Lady to fend another to meafure it; but durft not let her know he had meafured it, but that his reapers, and mowers, nor his feed never gave it for fo much. He prevails with her, fhe fends another; he meafures it, knowing as little of any mans meafuring, as I did of *Balls*. Upon his account we two differed but one rood in the whole thing, which he had made it leffe then I did, by reafon I meafured half *Shefford*-brook more then he did. So I fav'd him 19 pounds ten fhillings *per annum*; which if it had been yearly payment, at ten in the hundred, as money was then, compound intereft came to above 1200. pounds, but being half yearly payments, nine pounds 15 fhillings, half yearely, 42 payments at five in the 100, which was the common reckoning both then and now ftill for half a year, comes

to

to above 1300 pounds, a good Farmers estate. Therefore it behoves every man that hath, or may for himself or friend have occasion to let or hire, buy or sell land or timber, not to go on other mens legs, nor to see with another mans eyes, that have such easie means to attain the skill of it themselves. I make no doubt but that there are many Gentlemen, who have spent much time in the Universitie in Musick, yea, and other studies too, do wish at this day, (and more would wish, if they could see it) they had at least spent some of that time in the Mathematicks; whereby they might have benefited both themselves and their Countrey: which in commendations of it, *Pitiscus* in his Preface to his book *Geodæticorum* saith , *Socrates hunc principalem Geometriæ finem esse statuebat, ut agrum planum metiri, dividereque possit.* I have seen some spend eight years in learning Musick ; if they would bestow but two years in the Mathematicks , it would have done them more good, and they might have done the Common-wealth good. Of all the seven liberal Sciences that may best be spared, as least beneficial to a Common-wealth; and for my part, I had rather (if you will believe me) that my feet could pace 1000 acres of land of mine own, then my fingers to play 1000 lessons on the best Lute in the town, though I might have it for my labour; and he that is not of my minde, it's pitie, if ever he have 1000 acres, but he should change them for a fiddle. Recreation, I confesse, is good; but I would not have it made an occupation. They will account it small recreation hereafter to be able to say,   *Post habui tamen illorum mea seria ludo.*

Divers such falsities I have seen; but I am loth to digresse too much.   Divers other false wayes there are ; but I had rather I were come to lay down true wayes , then to discover errours. Therefore that we take not a false way to our purposed end, we will ride streight on to the next town; *viz.* the uncertain wayes : where we must stay a little, and give our pen drink too, that so we may the easier finde the true way in such uncertain wayes.

First, it is no certain way to lay a great deal of land upon a
                              A 3   little

little paper, as to work by the scale of 32. as many do, whereby upon each inch of paper they lay six acres, one rood, 24 pole; and it is an easie matter for a good Artist with good instruments to fail an acre in an hundred, much more with so small a scale, and blunt compasses: neither is there any that ever I knew use so small a scale, that can or dare say, that he is able to distinguish a quarter of a pole, whereby oft-times there is six in the hundred got and lost, not in a year, but in a day.

Secondly, To trust onely to the needle in any graduated instrument, as Circumferentor, Theodelete: and partly for fear of a loadstone near; and also it is a hard matter by an ordinary needle, though of four or five inches long, to distinguish a degree, much lesse five or six minutes.

Thirdly, For over-curious ways, such as if I shall spend so much more time then ordinary, that the gain or losse will not countervail the time bestowed on it : therefore as upon buying and selling there is some land of 20 or 40 pound the acre : some I have measured where every man in the town hath hired the tythe *communibus annis*, for two shillings *per* acre ; others have undertook plowing for 2 shillings six pence, others have let for five shillings, as the Lady *Morrison* aforesaid. Now I will not stand so curiously upon that of five shillings *per* acre, nor work by so large a scale, as for that of 30 or 40 pounds the acre. This comes to five shillings the pole, the other very little above half a farthing a pole. Two pole got or lost in the first is the Surveyour's ordinary dayes wages; whereas five acres of the other will but do it. Again, as there may be curiosity in measuring, so there may be in casting : but let the same rule be the guide in both : and although *Pitiscus* hath done exceeding learnedly through all his book, as like a Mathematick-Professour, and well skilled in the doctrine of triangles ; yet he that shall seek out his sides, bases, and perpendiculars by Sines, Tangents, or Logarithmes ; or cast them up by Logarithmes, as some others have taught of late : yet neither *Pitiscus* nor his followers have shewn themselves practitioners; neither of them ever measured, plotted, and cast 900 acres in

three

three days, whereof for a mile together the side was as
streight as *Hockley*-brook, as the Proverb is: (for it was *Hock-
ley*-brook it self,) yet platted and cast every crook; and so did I
Shefford brook also: and M^r. *Wingate* hath measured 1000 on
a day near *Bigglefwade* in *Bedfordſhire*.   I denie not but theſe
men may and have good skill in the Theorie, but as little in
the Practick as the *Londoner*, that asked the countrey-Malt-
ſter if malt did not grow upon trees. Such a *London* Mathema-
tician (perhaps) was *Balls* aforeſaid, a perfect Surveyour, but
never saw acre of land meaſured, so that he miſſed but 78
acres in 322.

CHAP. II.

Of making and keeping the field-book, and meaſuring
paſture by the plain-Table.

§. 1.   **I**F you intend to practise Surveying, make you a book
of a quire of good ſtrong paper, so folded, that the
breadth of the leaves may be in *octavo*, and the length thereof
may be the length of two quarters, well bound with vellum,
that you may lay it on your left arm to write : and if it be your
firſt book that you have filled, write on the cover a great (A).
If the ſecond (B). On the third (C). &c. Then page your
firſt part of your book (A), all but some 12 leaves at the lat-
ter end, on each ſeverall page whereof you ſhall write a ſeve-
rall letter of the Croſs-row in Alphabetical order, and ſo your
book is ready to go to work.

How to chooſe their firſt ſtanding in Paſture-ground
for the plain-Table.

§. 2.   As soon as you come into the field make a mark, as
some hole with a paddle-ſtaff, or ſtick up some paper, or both,
at the firſt corner you come at; which if it be adjoyning in that
place to another paſture, then chooſe your ſtation or hole (if
be poſſible) that it may be right againſt some gap, gate, or
ſtile

ftile (which commonly in all paftures there are near the cor-
ners, or elfe you will be forced to cut an hole through the
hedg with a bill, that fo from that ftation you may fee to the
further fide of that ground, or fo far as you can, to ftrike a
line. But let that hole or mark be fet four or five foot from
any hedg or ditch, fo that you may fet up your inftrument, and
have firm ftanding to fee in a ftreight line to the further fide
of the ground you are in, both on your left hand, and on
your right : fo that you touch not upon the hedges, nor in-
cumber your felf with wood, bufhes, houfes, nor waters,
though you are driven to go nine or ten poles off at one end,
and but nine or ten links at the other. Whatfoever others bid
you always go parallel to the hedge, regard it not; for if you
do fo, you fhall have work enough till Wednefday. What will
thefe men do when they come at *Huckley*-brook? It will hold
them a week to meafure a furlong ftreight, and they have no
way left, but onely to equal one place with another by ghuefs;
neither, alas poor men! do they know which way to go about
to plot it; whereby though they do hit the true quantitie by
chance, as the blinde man may fhoot and hit a crow, is that a
true plat of the form? and who knows not but brooks, ri-
vers,& the very feas themfelves alter in time, witneffe *Hercules*-
pillers? and how can they go pa-
rallel by this whim-wham? Be-
fides,that by the plain-Table they
do plot all as they go, fo that they
had need have a great deal of fair weather, no dewie mor-
nings; and becaufe they know neither how to meafure nor plot
fuch a piece, we have not had one that hath wrote of Sur-
veying thefe thirty years, but have been all as mute as fifhes
in it.

CHAP. III.

How to set down your notes in your Field-book, and to draw
your station-lines by the plain-Table.
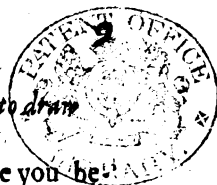
HAving made choise of your first station, before you be-
gin to measure, take your field-book, & on the top of the
first page write the name of the Parish first the ground lies in.
Secondly, the year and day. Thirdly, the name of the close.
Fourthly, measured by me, and for *I. R. contra W. R.* or if
you are indifferently hired on both sides, write *inter I. D. &*
D. I. Fifthly, your directour. Sixthly, your helper. And
Seventhly, which way you went forward, whether *cum Sole*,
or *contra Solem : Cum Sole* in a pasture is, when the hedge is
on your left hand ; *contra Solem*, when on the right.

Then in your field-book about two inches from the left side
of the leaf, draw a line with your pen streight down to the bot-
tom of the leaf, and on the left side about an inch from the line
write **A**, signifying the first station, or the mark you stand on,
and close to it on the same side, write **O**, signifying the begin-
ning of the line ; then if you intend to go *contra Solem*, mea-
sure how many links are to the hedge or ditch on your right
hand, and set them down right against **A** on the right side of
the line ; so all your lengths, as you go in the station-line, must
be set down on the left side of that down-right line, and all
the breadths on the right side.   Yet before you go forward,
you must know these several things.

Prolegomena. First, That always a ditch must be measured
with that ground on which the hedge standeth.

Secondly, That you never need set up your Table at **A**, un-
lesse there be another close adjoyning, which you are also to
measure ; nor yet at the last angle : so that if the ground have
four angles, you need set up your instrument but at the second
and third ; neither is there necessitie of setting it up at the
third, if you be sure you have measured all the station-lines
right, calling your Angles **B C D E** in order, &c. by reason
you may set out the two last station-lines of any ground what-
soever by the scale and compasses, by tranning the first of

<center>B</center>   them

them, and pricking the laſt, as ſhall be ſhown more at large, when we come to ſpeak of meaſuring by the chain onely.

Thirdly, If one of your ſides be buſhy, woody, watery, &c. that you cannot come at the hedge for ſuch things, leave that for the laſt, ſo that it be a ſtreight ſide; for your plot will give you that ſide: ſo that, if you have done all right thitherto, you cannot fail in that, neither need you meaſure it, ſave for triall ſake.

Fourthly, You muſt know, that whereſoever you have two cloſes to be meaſured joyning together, the ſtation-line in one cloſe ſerves alſo for the other, and the additions in one cloſe are the ſubtractions from the other.

Fifthly, If a fair plot in colours be required, you muſt ſtill, as you go in your ſtation-lines, take notice and ſet down in your field-book all Churches, houſes, rivers, ponds, gates, ways, paths, ſtiles, arbors, wind-mills, great ſingle trees, woods, &c. which fall within compaſſe of your plot or ſquare, and ſet them down in your diſtance from the ſtation-lines. If they be not on the ſame ſide of the ſtation-line that the hedge is on, mark them with a croſſe, and draw them all in your fair plot in proſpective in their proper colours, with their manner of ſituation, Eaſt or Weſt, North or South, and your needle in any of your inſtruments will help you always, making the North-ſide of your plot the over end, as you may ſee in plots of countreys; and at the bottom ſetting a ſcale of poles beautified with compartiments, and a pair of compaſſes: but your ſcale for this plot may (if the ground be very large) be ſmaller then that you meaſure by.

Sixthly, Before you begin you muſt make choiſe of your ſcale, wherein you are to conſider the bigneſſe of the ground, the bigneſſe of your paper, and the price or value of the ground, and whether on purchaſe, or hiring, and that for a longer or ſhorter time; yet howſoever it is good, though it be upon letting, not to be too careleſſe in it: for I have been imployed upon letting between Sir *John Crofts* and Sir *William Bryars*, yet before they concluded, they agreed on a purchaſe

by

by the acre upon the same measure ; therefore I seldome measure upon purchase with a scale more then 8, never above 10 in the inch; nor upon hiring seldome above 10, never above 12.

Seventhly, Before you begin, you must consider whereabouts of your ground you begin, that so turning the length of the Table to the longest way of the ground, and beginning at the like place of the paper as you do on the ground, you may (not taking too small a scale) lay all that ground upon that sheet of paper, or (at least) all that you can measure that day; for it is somewhat troublesome to shift your paper in the field, or to fall beside it for a piece of a close; for which, if you do, we will give you these five remedies.

1. If it be but a small matter, and presently comes on again, you may lift up the rulers, and that paper which they hold down cut it so, that so much as you need may lie upon the rulers.

2. If that will not be enough , you may make your station-line that you came, or else do come on, shorter then indeed it should be by 10 or 20 pole, taking the next angle upon the same line as if it were the end of it; and then making a new plot at home, your own reason will direct you better then I can shew it : for it is easier perceived upon triall in the field, then expressed by word or scheme ; but then you must lay down none but station-lines and angles.

3. The most common help that Surveyours use is to remove the paper nearer one end of the Table, and then with a piece of mouth-glue, which they usually carry with them, they glue on what paper they think they shall need, and then fasten it down with the rulers again.

4. If your plain-Table be also a Pandoron, or have a semi-circle, or a Quadrant, you may at any time, either in this case or case of moist weather, take off your paper, and help your self thereby, as shall be shown hereafter.

5. By the chain onely and your field-book ; whereof also hereafter in its place.

Eightly, Before you begin you must know, that both at the

beginning and ending of every station-line, and every crook
of the hedge, both inward and outward, you must measure the
neareſt diſtance between the ſtation-line and the hedge (for
all breadths muſt cut the ſtation-line ſquire-wiſe) and ſo make
two right angles at the ſtation-line, and that is the beſt way :
and ſo doing, all the pieces on the out-ſide the ſtation-line
will be either rectangle triangles, or elſe compounded of an
oblong and a rectangle triangle : the *area* of both which is
found by adding the breadth at both ends together, and take
$\frac{1}{2}$ of it for the common breadth, which multiply by the whole
length, and you have the content. And ſometime your beſt
way to finde the ſhorteſt diſtance into an angle, is to ſet up the
Table right in the ſtation-line : if ſtanding at the fore-mark
you ſee by the edge of the Table the backer mark, and then
ſtanding at the backer end you ſee the fore-mark, then are
you right in the line. If now withall one or both of your o-
ther ſides look right into the angle, then are you right. And
all theſe lines muſt be entred into your field-book, which fall
perpendicular upon the ſtation-line, every one in their order on
the right ſide of the line, and on the left ſide right againſt each
of them their correſpondent lengths, how far each of them is
off from the laſt ſtation. Or elſe you may ſtrike a ſtation-line
into the angle, and ſo make *ſcalenum* triangles, but that is not ſo
certain, and asks more labour.

　Ninthly, Before you go forward you muſt propound to your
ſelf a mark to go upon on the farther ſide the ground, or if
it be quite beyond the ground, though it be a mile, it matters
not : ſo that ſtanding at A you may ſee it clear from the hedge,
yet as near to the hedge as you can ; whether it be parallel or
no, care not. If you can ſee no ſuch mark neither near the
further ſide, nor beyond, then either you muſt ſend one before
to ſtick up a ſtick with a cloth or paper on it, or to ſtand there
till you come, with ſome white before his breaſt. And more-
over ſee, if you can ſee ſome other mark between him and you
right in the ſame line, be it either flower, weed, graſſe, dung,
&c to be a guide for the fore-man, to keep him right in the
line, that carrieth the fore-end of the chain.　　　Tenthly,

Tenthly, Whereas you muſt have ten ſticks about a foot long apiece, whitled and ſharpned at the great end, let two take the chain, one at one end, the other at the other : let the former take the ſticks , and let him be ſure to lead ſtreight in the line, which for his guide therein he hath theſe helps. Firſt, he muſt always be right in the line with his two marks *How to* before him, till he comes at the firſt. Secondly, after he is *ſet them-* come at the firſt, let him every time he ſticks down a ſtick, *ſelves* look backward to ſet himſelf right in a line with thoſe two *right in a* And thirdly , if there be no middle-man, let the hindmoſt *line.* ſtanding at A guide the foremoſt right in a line to B: and af-ter the firſt chains length, let the hindmoſt guide the foremoſt, and the foremoſt the hindmoſt: for if the hindmoſt ſee the foremoſt right in a line between him and B , and the fore-moſt ſee the hindmoſt right in the line between him and A, then are they both in the right line between A and B. Then, to go forward, let the foreman take all the ſticks , and tell them at the beginning at each change, and at the end (for the moſt common miſtake is the loſing or mis-telling of a ſtick) and carry all ſave one in his left hand, and that one and the chain in his right, and let him go on ſtreight in his ſtation-line, not looking behinde him till he feel the chain check him, then ſtick down that ſtick, and away as faſt you can run, and as you go ſhift an other ſtick into the right hand ready to ſtick down again. In the mean time the hinder-man, firſt holding the chain in his right hand at A, let him look the chain be not tangled, and away on till he come to the ſtick, and then clap-ping his ring of the chain to the foreſide of the ſtick, let him take it up with the ſame hand he carrieth the chain, and away after his leader. And when the ſticks are all run, and that they are not yet at the end of that ſtation-line , let the fore-man run one chain more, holding ſtill the ring in his hand, and at the end thereof ſet his toe, there ſtanding ſtill; and let the hinder-man take up the tenth ſtick, and hold that ſtill in one hand and the other nine in the other, and deliver the nine to the fore-man, ſetting his toe to the fore-mans: then let the

　　　　　fore-

fore-man tell the nine, and, if they be right, away; if not, you
muſt meaſure all that courſe again, and ſeek the ſtick; for you
know not which of you loſt it; and ſo going to the end of
that ſtation-line, or within ſo much of the end of it, that
you may have libertie to ſet up the Table, and ſee to the fur-
ther end of the next ſtation-line, as you did at A, without
any incumbrances; which, if you work by a diagonall ſcale,
may be in any place ; but if by a plain ſcale, you had beſt to
have it at ſome even poles;and becauſe by *Gunther's* chain of
an hundred links(which is the beſt way) you work not by the
diagonall ſcale, by links, but by the foot chain, by the decimall
ſcale, and by poles, and parts of poles. Set that length in your
note-book, on the left ſide of the line, cloſe by the line,and a
B right under A;and on the right ſide the line write,[*ſtation*].
Then go on ſtill in the ſaid line, till you come to the out-ſide
of the ground, which in paſture will always be beyond the
ſtation ; but in woods ſhort of it. Set down that length alſo
on the left hand, and the breadth from the ſtation-line at the
end thereof, to the hedges you came by on the right ; and
then draw a line croſſe over your book, and ſo at the end of
every other ſtation-line. But you muſt not forget, that all
along as you come you take (as I ſaid before) the breadths
from the ſtation-line to the hedge, both at the beginning and
ending, and every crook both inward and outward, with their
correſpondent lengths, and to ſet them down as afore. Alſo,if
a fair plot in colours be required,it will be needfull to ſet down
the true lengths of each ſtation-line to every mans hedge that
ſhoots upon your plot, beſide the ornaments , that you may
ſhew part of their corners, as alſo in caſe they are their
grounds that imploy you in it. And ſometime alſo, if you are
to meaſure two cloſes being together, and that you would
come forth upon that point in the ſtation-line; it will alſo be
needfull to ſet it down in your note-book , and often ſave
labour marking it with an X.

Now if you begin at A, and have two cloſes lie there toge-
ther to be meaſured, then take up your Table there, and ha-
ving

ving turned the length of the Table to the length of the
ground, and proportioned the A of your Table to the A of the
ground, set up your sights with the ruler upon the Table, and
having screwed it fast, turn them upon the Table, till you see
the mark at B. Also see some mark in the close adjoyning on
the further side, or a mile beyond: and because I see juft
there begins a triangle on the right hand, which falls short of
the length of the other line, therefore I draw a third station-
line from A, representing the right-side line of that triangle;
so I leave that close till I have made an end of the other;
so having drawn my line AB, I go to measuring it by *Gunther's*
chain, and I finde at O of the line A B are five links to the
hedge, I enter them as afore. At 200. I croffe a path, which I
enter next on the left side; but because there is no crook in the
hedge right against it, therefore I take no breadth, but write
(*path-gap.*) At 437. the breadth is 60. I set them down, be-
cause here is both a crook, and right against the parting of two
closes that shoot upon this: thirdly, it is right against a gap to
come out from the further end of the first line in the second
close, whereby measuring that and 75. links of another stati-
on-line, and setting up the Table twice, that close will be mea-
sured, as shall be seen anon : fourthly, it will be a good place to
make choise of, to save us some labour in teaching to measure
by the chain onely, as shall be shown in it's due place. Hence
I go on to 900. there I choose my next station, both because
if I do go further, my next station-line, B C, will be incumbred
with the hedge, as also I shall have no ground to set the Ta-
ble on; but here I take no breadth, being the hedge goeth out
streight to the end : onely I set down 900 station, and then
measure streight on to the out-side 907. where the breadth
is 8. so I set down 907. on the left hand, and 8 on the right,
out, that is, without the ground. Then having finished A B,
I strike a line croffe the book, and set up my Table again at B,
and having made choise of my scale, which I made no use of
till this second station, I take off 900. with my compaffes from
the scale, and set it in that first station-line from A, where I
                                                              make

make a prick, and a little roundle round about it, as also at **A.** And here I write B; and now that which was forgotten at **A,** do now: *viz.* one thing was, to take notice what degree the South-end of the needle bore upon at A: for if there be no errour, it will bear upon that degree quite through the plot, unlesse you remove the paper. And a second thing is, if you are to give in a fair plot in colours, it will be needfull to strike a meridian-line through the plot, unlesse you lay the North-end of the needle upon the *Flowre-de-lice,* which, in case a fair plot be required, I confesse, is the best way : for so you shall draw your plot in the field according to the four windes, whose borders shall be parallel to the edges of the Table.

Now having set up your Table at B, lay your ruler with sights upon the line A B, directly placing your self between the Table and the end of the line, and your face toward A, in such a posture as if you were discharging a musket, and winking with one eye, having both your hands on the two corners of the Table next you, turn the Table till through the sights you see the mark at A : then scrue the Table fast, that it turn no more, and turning your back to the hedge you came by, having propounded to your self another mark to go to at the further side of the ground, by the next hedge-side, as you did at A, lay your ruler close to the prick B, with that end next you, and keeping one point of your compasses, or needle, or scriver, in that prick with your right hand, and the ruler close to it, lay your left hand, being spread, upon it, and turn the further end of it, till through both the sights you see that mark at C, and then holding it stedfast with your left hand draw that station-line B C also. Now if when you were at A, you had set up a mark at C, and another at D, and stroke A C and A D: and thus now also you had here at B struck B D, as well as B C, being the close hath but four angles; you need not have set up your Table any more, no, though you had but struck A D, nor yet have measured any more of it, if you be sure the hedges be all streight, (which is seldome seen in antient inclosure) and that the marks at C
and

and D be set juſt in the angles. This way, I confeſſe, is ſome-
thing quicker then to go round about, but not ſo exact: yet this
way one Mr. *Sheppard of Maldon* in *Bedfordſhire* uſed, who
formerly was my Scholar, and who ought *Redburn*-Parſonage
in *Hartfordſhire*, letting every man his tythes at two ſhillings
per acre *communibus annis*. He took me along with him, and
each of us a plain-Table, and finding almoſt all, four-corner'd
cloſes, and ſtreight hedges, we meaſured but one line in each
ground. And indeed, where breadth and lengths are near
equal, there will be no great danger; but where there is much
odds, they will make ſuch acute angles, that there will be no
truſt to them, the lines running ſo one in another, as it is hard
to ſay where they cut; and therefore ſuch as have ſtufft their
books with ſuch whim-
ſies, ſhall give me leave
to laugh at them. Some
ſhew how to meaſure
the depth of a Well (but
that is not well) by the
plain-table; others teach
to meaſure a piece of
ground at two ſtations,
9 or 10 pole aſunder,
in the middle of the
ground; but there is no
truſt to any of thoſe
ways, that give ſuch a-
cute angles. Let the talk
of never ſo many ways,
this one way of going
round is *inſtar omnium.*
Whether they take the
line A B or C D in this
firſt figure for their ſta-
tion-line, they ſhall ne-
ver make good work of it. And what will they do in ſuch a
figure as the ſecond?
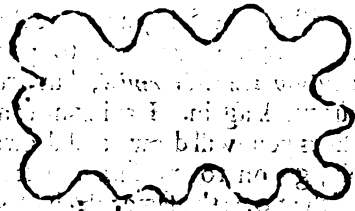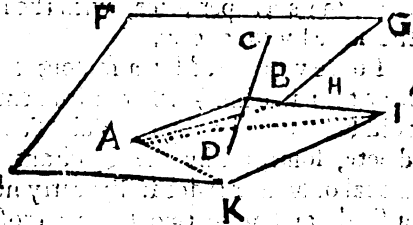
I con-

I confeſſe, in ſuch a caſe as the third figure, if there be a *trapezium* on the out-ſide of my ſtation-line, ſuch as C D E F; & ſuppoſe my ordinarie ſtation-line to be A B, ſometimes I uſe this way. Right againſt the hedg C D, I ſet up the Table at A, and having placed the Table in his right ſituation, I ſtrike theſe three lines, A D, A E, and A F, and then meaſure on from A to B, and then ſet up again, and then again I ſtrike B C, B D, and B E, and never meaſure any of thoſe ſix. And after the ſame manner, if I have a good large triangle on the out-ſide of my ſtation-line, if my ſtation-line be one ſide thereof. But in this caſe, when I come at home, if I determine to keep my note-book and to draw a plot of it 20 or 30 years after; I then draw the like figure in my field-book in its proper place, with the length of each line, and the ſcale I wrought by.

I once was asked by a famous Mathematician (but I forbear to name him) what inſtruments I uſe to meaſure by? I told him, ſometime by the plain-Table, ſometime the Theodelete, ſometime by the Quadrant, &c. Quoth he, There is a deal of lumber indeed: I'le carry nothing but an high ſtool a field, and with two ſticks a croſs I'le ſtand upon that in the midſt of the field, and take the diſtances to every angle, and I'le meaſure three acres to your one. I gave him his ſaying: *riſum teneatis amici*, but truly I could not. But let us to our work again. Having now at your ſtation B drawn all the lines you will draw, and drawn a line croſs your field-book, go on to meaſure the ſtation-line B C, where the breadth at o. is the ſame which was your diſtance in your laſt ſtation-line between 900. *the ſtation*, and 907 *out*: *viz.* 7. ſet it down on the right-ſide of the down-right line under the overthwart line in your book, and o. in the left-ſide, then go on at 100 o. at 350 o. at 560 *a ſquare ſtroke into the angle* 30. at 563 *a ſtation* C 568 *out*. Now having finiſhed this line, take again the diſtance between B C, 563, upon the ſame ſcale you took your 900, and ſet it on your plot from B. Then if you did not ſet up at A, or if you did not draw the line D A

when

when you were at A, but that there wants two outside-lines
to draw still, then set up your Table again at C, and laying
your ruler on the line B C, turn the Table till through the
sights you see the mark B, which if you do, then see if the
South-end of the needle do strike the same degree it did at A
and B: if not, there is some fault, which most commonly is in
the last line save one, and must be rectified before you go
further.

But there is a second way of triall infinitely better, which
is this; Having placed C B-line right upon B, lay your ruler
upon the two pricks C and A, if then through the sights you
see A, all is right; if there be a fault, it is commonly in the
length of the last station-line save one, which if you came
contra Solem, and your sights look on the left hand of A, your
book is more then your plot, *& vice verſâ*. If you have re-
ctified it, set out your next station-line C D, and measure as
afore, and make your station, if you can see A, at the very
end, and can go free from all impediments: else make it short
as afore. And then begin to measure that C D line, having
drawn a line crofs the book, say at o, 5. at 200 40, at 200
10, at 656 *out ,ſtation* 12. Where you see, becaufe I need not
to set up my Table any more, for there is but one line more to
meafure;therefore I drive the station-line C D to the very out-
side; fo I take the whole length of the line where my breadth
is 12. This length 625. I set on the plot from C to D, where
I make a prick within a little circle, and write D: then before I
meafure the last line D A upon the ground, I meafure it firſt
upon the plot,fetting one foot of the compaffes in D, and the
other in A; and then applying that diſtance to your ſcale, that
will give you the true length of the line D A, before you mea-
fure it. So that when you have meafured it, if the line on the
plot and the line on the ground agree, then all is right ; and
this we call the true fhutting of a plot, which if it agree with-
in a pole, or 20 links, moſt Surveyours count it well fhut : I
think it too much, neither do I remember that ever I miffed fo
much in all my life. I once meafured a wood called *Horſley-*

wood in *Luton*-Parish for Judge *Crawley*, where one Master
Lawrence was my Antagonist for Sr. *Robert Napier*: he puts me
to measure it, and he goes by and takes the angles as I drew,
and set them down in his field-book; but seeing that we were
forced to make 14 station-lines, and hilly ground too, he
offered to wager five shillings, that I should not shut within
five pole; I offered to accept it: in regard whereof at the last
station, I giving him the distance on the plot, would needs set
my Table to try what hopes that gave me, and finding it stroke
right upon my A, I then offered to take his wager, to shut
within a yard; but I miss'd not a foot. We two had been four
times Antagonists for the same men before, one after another,
and our greatest difference was never but five pole at a time in
sixty or seventy acres.

An Example.

We will give you now an example of the Field-book, and
plot of three closes lying together, partly reall, and partly
supposed.

Chesterton, Cambridgeshire, June 21. 1656.

Measured by me G. A. three closes, called *Church-closes*,
I for *A: B*, *John Dampot* for *C. D.* upon purchase, S. L. di-
rectour. I begin with the East-close at North-West, going
contra Solem.

Links

Links in length.	Links in breadth.	Subtende.		
		C X	674	
		D X	756	
A 0 5		N. W. close enters at 5 from A		
206 a path.	14137	Westward.		
X right a-435 60		A parallel by the North hedge		
gainſt a		of 15 next ſtation-line A E.		
hedge.		Next ſtation-line A F G.		
B 900 ſtation		A	0 0	
907 out 7	15742	F	650 50. ſtat-lin. F E
0 7		G	825 60	
100 0	350		850 out 0.	
356 0	00000	G X		I
560 into angle 30.	315c	Turn South.		
C 563 ſtation		G	0 30	
568 0 out	120		75 25. 3ᵈ cloſe en-
0 5				(ters.
200 40	450	3ᵈ cloſe enters,		
200 10 theſe 2 breadths			75 25	
are both in one place.			400 25	
D 656 out. ſtation 10. 4560.		X	900	
A 0 0			1200 140	
5c00	0000		1500 200	
740 meets A 15.	1837	H	1550 ſtation.
745 out. the N W. cloſe			1575 out.	
enters.			0 25	
all the borders : 40346			300 160	
			500 160	
		I	800 ſtation 56
			956 out 0	
			0 156	
			300 60	
			860 againſt C	
			1340 out 0. againſt X
		Subtend from out, to X 1090.		
C 30		thence to I. 947.		
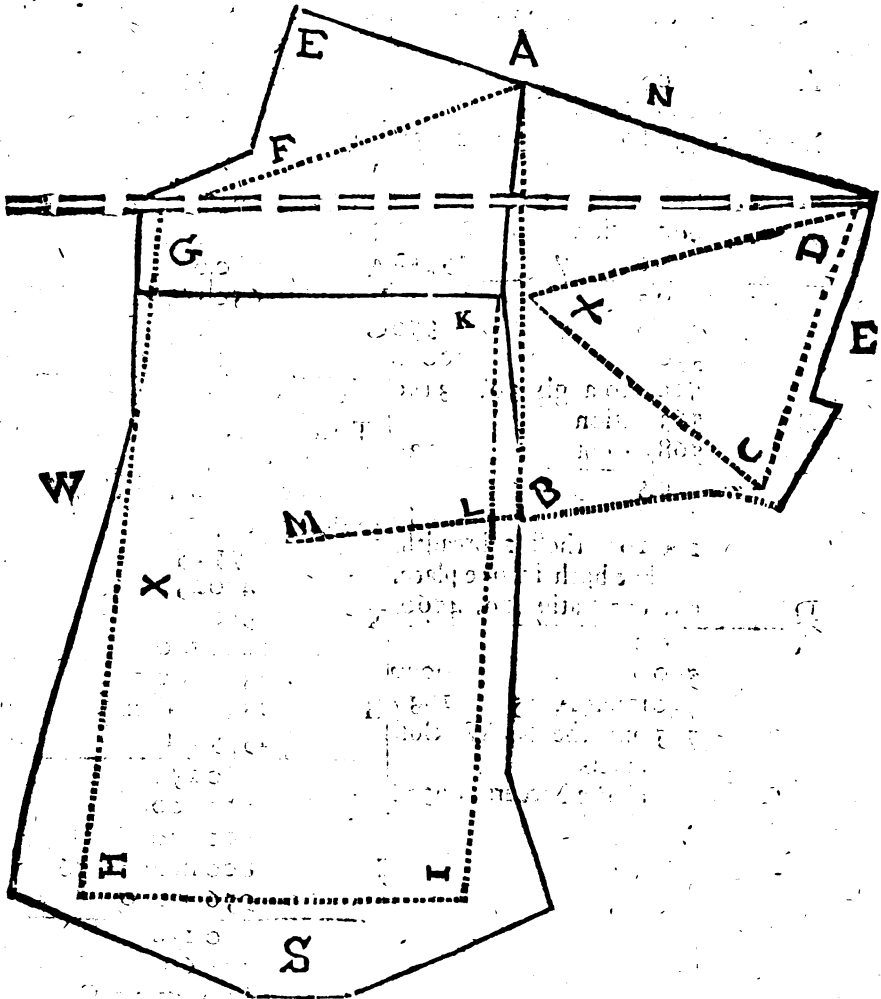
Here you see in this plot, the station-lines, being pricked
lines, are not drawn parallel to the hedges, or out-sides of the
ground: if we should do so, how many stations should we
make

make in stead of that line I L ? Likewise we must make three
for C D; yet these are nothing to *Hockley*-brook.

Besides, in working this way my station-lines cut one ano-
ther more perpendicular, then any other way whatsoever,
which is much to be regarded in working by the plain-Table.
The onely way to take an acute angle, is with graduated in-
struments to take the quantitie of the angle, and to calculate
it by sines and tangents by the doctrine of triangles; but he that
goeth that way to work, may chance to measure ten acres,
whilest another doth an hundred. Adde hereto that I can
more easily see every crook in the hedge in going round, then
any other way.

CHAP. IV.

Of plotting at home, and of severall ways.

THey that use to go parallel to the hedges do seldome use
any field-book, but plot as they go by the plain-Table, be-
cause they suppose themselves to go in the hedges, and there-
fore allow a parallel from the hedge; but if at any time they
cannot go parallel, by reason of houses, waters, bushes, or the
like, then they are much troubled, and must of necessity plot as
they go; for want of a field-book: whereby they spend much
more time abroad, both they & their helpers, then they need,
& which they themselves might do in half the while at home,
besides that, the least mist drives them out of the field : for
though they could measure by the chain onely (, which I am
sure was never heretofore published by any, but hath ever been
thought a thing impossible to plot and prove a plot by : of
which (God willing) hereafter ;) yet can they no way help
themselves for want of a field-book also; the form whereof
being already laid down unto you, together with the plot to
which it belongeth, being compared together will direct you
better then many words ; yet because I desire to make all
things so plain, that we may be sure you can stick at nothing,
we will lead you through one line, and then turn you foot-
loose.　　　　　　　　　　　　　　　　　　　　First,

First therefore, if you have not yet done in the field, and the weather serves, & your helpers are ready, then take your plot off your Table, and cover it with a new sheet of paper, and away into the field; lose no time there, especially if you are far from home; for you may plot & cast at all times at home, but you cannot always measure in the field. But if otherwise, then take your Table from his foot, & the socket from the Table & your plot still upon it, lay your field-book before you, and take your scale and compasses in your hand, and begining at A, both of your book and plot, seeing 5 (which signifies 5 linkes in breadth) is right against A on the right-side of the line, and that you go *contra Solem*, which gives the hedge you go by to B on the right hand; therefore take those 5 with your compasses from off the same scale you laid down your station-line by, and set them from A to the right hand, which although you work by a scale of 8 or 10 in the inch, you cannot take with your compasses, therefore ghuess at them, and then make a prick. Next take with your compasses your next length on your left hand, which is 200, that set in the station-line from A, that is set one foot in A (as you must doe likewise with all the other lengths) and the other where it falls in the said station-line toward B, but because there is no crooke of the hedge, either inward or outward, save only the path, which shewes that there you cross'd the path, therefore onely draw a stroke, or two if it be broad, cross the station-line. Then take your next length 435 and set it likewise in the station-line from A towards B, and for that right against it you have 60 breadth, therefore take 60 and set on the right hand of your station-line, and because I see also (*hedge*) it tells me that a parting hedge of two closes shot right against that 60, therefore I give a little touch with my pen, till I come to set out the rest of it in the other closes. My next length, being my station 900 B, is set out already. Lastly, because my last length is 907, that is 7 beyond 900, and that the breadth against it is 7 also, therefore take 7 with your compasses, and set it both forward and on the right-side,

and

and thus have you pricked out the hedges against this station-line. Now you must draw lines with your scale and compasses from pricke to pricke, and then with ink: so these parcells between the line and the hedge must be additions to that within the station-lines to this first close; but subtractions from the other where one station-line serves to two closes, as that part of A B from A to 435 doth both for this and the next.

CHAP. V.

Of calculation or casting up.

THe figures or parts to be measured are either squares, oblongs, triangles, or *trapezias* such as are compounded of an oblong and a triangle. For the square, and the oblong, one rule may serve both, *viz.* multiply the breadth in the length.

Triangles are of divers sorts, we make use onely of two the rectangle and the *scalenum*, the rectangle without the station-lines, the *scalenum* within. For the rectangle and *trapezium* one rule will serve both, at least those *trapezas* which have two right angles at the station-line. Add the breath at both ends together, take half for the common breadth, & multiply it by the length these breadths and lenghts our book will give us. For *scalenums* within the station-lines the way is thus. Look how many angles your station-lines do make, so many triangles will there be save two, by drawing diagonall lines from corner to corner; these diagonalls are fittest for your bases: unless if it be a single triangle, then commonly the longest side. Take the length of your base therefore with your compasses, and apply it to your scale, and what it gives set it down, take also the shortest distance between the angle opposite to that base and the base it self, apply it also to the scale, and what it gives set down also; now take half the base and all the perpendicular, or half the perpendicular and all the base, and multiply one by the other, so have you the content of that triangle. But commonly where there are more angles then three, one base will serve two triangles, and add both perpendicu-

lars together, and take half of both and the whole bafe, or half the bafe & both them, and multiply: fo have you the contents of both triangles.

And thus fhall you caft up all your out-borders, juft as you found them by the chain; & many times the bafes of your triangles alfo. So that by this way it is impofsible to fail much,if any heed be taken; whereas by the common way of plotting without a field-book it is almoft impofsible, to come near the truth; efpecially working by fo fmall a fcale, as I have known fome do, mixing thofe crooks without with the triangles within: fo that they lofe wholy the benefit of their meafuring by the chain; not taking one line as they meafured it, they truft rather to taking up their out-fide lines by the fcale and compafses, then to their chain: & yet they will confefs, that with the fcale of 32 in the inch (which I have known a famous Artift ufe in no great ground) that they cannot diftinguifh a quarter of a pole. So a quarter mifs'd at laying down, and a quarter at taking up, there is half a pole mifs'd in the length of each perpendicular, and as much in each bafe; and thefe multiplyed, I fee not, but a man may pafe a ground as near the truth as they. And thus in general.

We will now come to the particular parts, and firft of the outfides. We fhewed even now how an oblong muft be meafured by multiplying the breadth by the length; and likewife the rectangle triangle, and *trapezia*, by adding both ends together and taking the half for the mean breadth.

Now therefore in the firft clofe begining at **A** fubtract the firft length o out of the next,againft which you find a breadth viz.435, there remains the length of that rectangled *trapezium* 435, and for the breadth of it, add the firft breadth 5, to the next 60, it makes 65, the half whereof is 32 ½, which multiplied by 435, gives 14137, the content of that *trapezium* to be fet againft the latter of the two numbers or breadths 60. Where note by the way, that you fhall never have any other fraction to multiply by but ½,and for that you muft work from the left hand to the right, faying, Half 4 is 2, half 3 is 1,
<div align="right">half</div>

half 15 is 7, as here you see.

Then again take your laft length 435 out
of 907 (for you have no breadth at 900)
refts 472, the length of that *trapezium*, al-
fo add your two breadths, 60 and 7 toge-
ther make 67:(for every middle breadth of
each ftation-line muft be twice added, fave

```
      435
       32  2
      ─────
      870
     1305
      217
     ─────
    14137
```

where you have two feverall breadths fall in one place, as in
the line C D, where you have the length 200. twice together)
the half of 67 is 33 ½, by which multiply 472, *facit* 15742
to be fet againft the latter breadth 7. Then go to the fecond
line B C, where the firft length is 100, the common breadth
3 ½ gives 350, and fo go on according as the example gives:
then if you add all thofe primes or fquare links into one
fumme, you fhall finde it to be 40346, that keep till you have
caft up the triangles within the ftation lines, and likewife all
the other flabs. Therefore I draw a diagonall from A to C,
which will be the bafe to both triangles, and half the length
is 504. the perpendicular falling from B is 514, that from D
is 494, the fumme of both is 1008. then thefe multiplied, the
fumme of both perpendiculars by half the bafe, or the whole
bafe by half of them, it gives 508032, which added to the
fumme of the borders 40346, it makes that firft clofe to give
548378 fquare links in all. Now to bring thefe links into
acres, you need but onely cut off the five right hand figures,
the reft to the left hand are acres, *viz.* five acres: the reafon
is, there are 25 links in the length of a pole, that fquared gives
625 fquare links in a pole, and that multiplied by 160 (the
poles in an acre) gives 100000 links, by which divide your
fumme of your links, or for the five cyphers cut off five pla-
ces, the reft are acres; and the five fo cut off are the numera-
tor of a fraction of an acre, whofe denominator is 100000.
So 548378 gives five acres.

Now to bring thefe five figures into poles, you may either
divide them by 625 the primes in a pole: or elfe multiply thofe
two of the five next the left-hand always by fix, and fet them

a place nearer the right-hand, and then add thofe two which you multiplied, and the two which are under them together, and increafing them fo many unites as are fixes in the next two, and you fhall have 7 pole and 253 links..

If now that when you have caft up a clofe you have more then half 625 primes remaining; ordinarily it is accounted for a pole: if leffe, then for nothing. But if you have more clofes adjoyning, you may reckon it with the next clofe. Suppofe your ground hath the out-fide of this form, whofe ftation-line is A D, you may fet it down in words thus in your note-book. At A it is 10 to the brook from the ftation-line o, at B where I have gone 20 pofe in the ftation-line, there is a fquare line to a crook ftroke with the edge of the table, in which at 15 on the left hand is 20, at 28 is 25 on the left hand, and 15 on the right hand; at 44 is 28 on the right hand,
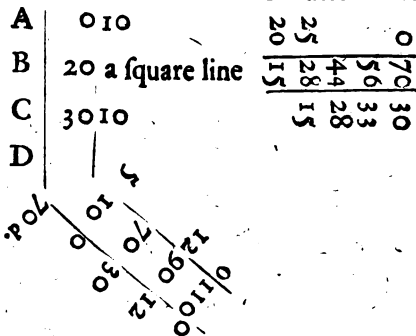
at 56 is 33 on the right hand, at 70 is o. on the left, and 30 on the right hand : then at 30 in the ftation-line is 10, at which 30 alfo I ftrike a ftation-line forward, which when I have ftroke it, I finde the fore-moft acute angle by my fcale of chords to be 70 degrees, that alfo I enter in my book: by help whereof and a diagonall line from angle to angle, I can draw the plot of any ground, though many years after, without going to it again.

And after the fame manner you may plot and fet down fingle lands in the common-field, or a clofe that is narrow and long.

CHAP.

CHAP. VI.

Of measuring a Wood.

THe difference of measuring a wood and pasture is in these two things: First, in pasture you measure on the in-side, but woods on the out-side. Secondly, in pasture all your *trapezia* are to be added to that within the station-lines, unlesse your station-line be in the close adjoyning ; but in this to be subtracted.

CHAP. VII.

Of dividing or laying out of ground.

OF this there are three degrees, each more difficult then other. The first is when the length of a ground is given, and a given quantity desired ; as if you would lay out two acres of grass in a pasture which is 36 pole long, and you desire the breath : First, I turn my two acres into square links, it is 200000, which I divide by 900. (for 25 times 36 is 900) it gives 224 ¼, the which if you divide by 25, the links in a pole, it gives 8 pole 22 ¼ links in breadth, and this needs no plotting. Or, if you would do by the foot-chain, say two acres is 320 pole, that divided by your length 36, gives 8 pole and $\frac{8}{36}$, which abbreviated is $\frac{2}{9}$: and to know how many half-feet that is, because there are 33 half-feet in a pole, therefore I multiply 33 by 8, *facit* 264, that divide by 9, gives 29 half feet, and $\frac{1}{9}$ or $\frac{1}{3}$, that is, 8 pole, 14 feet, 8 inches.

Secondly, In pasture-ground, suppose a pasture with crooked hedges is equally to be divided between two men. First I plot it and find it 52 acres, 2 roods, 10 pole, that is 26 acres, 1 rood, 5 pole a peice: I ghuess as near as I can to strike a line over the middle of my plot, but measuring one end upon the plot, I finde it wants 264 pole of his due; therefore I measure the length of the dividing line, which I finde to be 56 poles. Now to work by the decimal chain, I multiply 264, my poles

wanting,

wanting by 625, the square links in a pole, they make 165000
likewise I multiply 56 pole, the length, by 25, the links in a
poles length, they make 1400, by which divide 165000, it
quotes $117\frac{6}{7}$: that is 4 poles 17 $\frac{5}{7}$ links. But by the foot-
chain, if you divide 264 by 56, it quotes 4 poles and $\frac{40}{56}$: which
to bring into half-feet, multiply the numerator 40 by 33 the
$\frac{1}{2}$ feet in a pole, *fasit* 1320, which divide by 56, it gives 28
half-feet and $\frac{16}{56}$ of a half-foot, *in toto* 4 pole, 14 feet, 2 inches
almost. And so much must you remove your dividing line at
both ends: and this may be done as well on the out-side as on
the in-side,

Thirdly, To divide a standing wood of 200 or 300 acres,
and to drive a streight line from a mark on one side thereof
to any mark on the other, though the wood be twenty years
growth, and a hill in the midst; A rare secret.

Be sure to plot and measure enough, or more, then you de-
sire to take out of it, and where you intend your dividing-line
shall come, there, in your station-line, on the first side set a
mark, keeping also good marks at every station, so going on
till you be sure you are far enough on the other side also. Then
draw your dividing-line by ghuess, keeping one end thereof
still upon the mark in your station-line, then measure that part
upon the plot, as in the former ground, and add or subtract
from your dividing-line as before; save that here you need not
remove the further end, if the difference be but small, but dou-
ble the breadth at the last. But if you rather think fit to re-
move both ends, your best way is to do it first on your plot,
and make that perfect, and then draw your new line quite
through to the station-line on both sides. But there is the
mysterie, how shall I give directions how in my absence to
drive a streight line cross the wood from a mark in this stati-
on-line to a mark in the other on the other side, through
standing wood of 20 years growth, and a hill in the midst, as
once I laid out 60 acres of *Wilsteed-wood* being 160 acres be-
tween Sr. *Thomas Hillersden* and Sr. *Oliver Luke*; and ano-
ther time in a wood at *Hytchin.* But not to detein you. If you

work by the plain-Table, look which side is cleareſt from im-
pediments, that you may go ſome 10 or 12 pole outward from
the wood,then ſet up your Table at that point in your ſtation-
line, that your dividing-line falleth upon, & laying your *in-
dex* on the laſt ſtation-line, turn your Table, till through the
ſights you ſee either your laſt ſtation before that, if it be not
too near, and having lengthned out your dividing-line as far
as poſſibly you can, lay your *index* upon that lengthened line,
turn your back to the wood, & ſending one before ſome 10
or 12 pole, let him there move to and fro ſidewiſe as you ſhall
direct him by looking through the ſights, and then at both
your ſtandings drive good ſtakes, or lay ſtones, or make holes;
ſo a line driven through the wood continued ſtreight with
theſe two will carry you to your firſt mark in the other ſide,
if you did not remove that end; or if you did, then to that
mark,where now you muſt ſet it: ſo that look how much you
removed it forward or backward in the plot, ſo and ſo much
muſt you remove it here alſo; and then ſet a good mark here
alſo. But if when you have placed your Table on your ſtation-
line as before, there is but little ſpace left to draw your direct-
ing-line, you may, and indeed far better, lay your *index* all
along your dividing line and by it direct your man.

CHAP. VIII.

To meaſure arable-common-field-ground.

IN divers countreys much arable lying in common fields ly-
eth in ſmall parcells, ſome places an acre, ſome places half
an acre, and ſome places a rood, and that ſo crooked, that
none will deſire a plot of ſuch ground; yet, for as much as a
man in time may have his rood grown to half a rood, by his
neighbours plowing of it away, and to find at any time af-
terward, if it be ſo diminiſhed or not, and in what place: you
ſhall ſet it down in your field-book in this manner.

  " *Cheſterton. Eaſt-field* in *Broad-oake-furlong.* Begin on
  " the Eaſt-ſide of the furlong three lands *per* eſtimate three
                                                    " half

" half-acres. T A on the Eaſt, G D Weſt, coppy of Dame
" *Anne:* begin North at 0,106 at 400 163. at 400 more 101,
" at 346 *out* 100, conteining 134500(that is)one acre 55 pole
" 125 links.   One rood more in the ſame furlong. R N. Eaſt,
" J. D. Weſt, free of S. *John's*: begin South at 0, 24 at 400,
" 27, at 300 more 28, at 244 more *out* 30. Content 25526
" (that is) one rood, one pole *feré*.

Note that in this kind of ground where we ſay (at 0) we
mean two or three pole within the lànd's end : for there is no
certainty in taking the breadth at the very end, for the turning
up the plow will get or loſe egregiouſly.   Moreover in ſuch
ground the beſt way is, the leader to take all the ſticks anew,
every time you take a breadth, which had beſt be nor above
400 or 500, eſpecially by the foot-chain, at 16 or 17 pole, as
eaſieſt for account , unleſs the meaſure or decreaſe of the land
requires otherwiſe.

C H A P. IX.
Of hilly-grounds.

IF a ground have the bottome and top-lines both level, and
both ſides riſing alike, it is to be accounted but as a decli-
ning levell, and to be meaſured as a level ground.

But ſuppoſe a ground be level at one end, and both ſides,
and riſing in the middle, and a hill riſing along up the middle,
as the Lady *Farmer's Waſhrods-wood* in *Weſtoning*-Pariſh in
Bedfordſhire: or perhaps two hills riſing,one towards one ſide,
and another towards the other, and a levell run through be-
tween them; this is far more troubleſome.   For if you ſhall
begin to meaſure and plot your two levell ſide-lines, and levell
end-line firſt, and then meaſure your line at the other end,
it will not lie between the two ſide-lines by a great deal.   A-
gain, If you ſhould ſhove out thoſe ſide-lines, that you might
lay that line at the length you meaſured it, you would drive
the hedges into the adjacent grounds, and make them too lit-
tle:as ſhall apear.   But if you are to give a fair plot of a
                                                        Lord-

Lordſhip, where divers grounds border together, your plot
muſt be according to the form , and yet you muſt write
down the true quantitie too. And becauſe we cannot repre-
ſent a round ſolid upon a flat paper, therefore we muſt content
our ſelves onely with the lines of level for our plot: which
how they are obtained we will here ſhew three ways.

Firſt, by a Quadrant, or a ſemi-circle (chooſe which you
will, they work both alike) made for the ſame purpoſe: (made
by Mr. *Hayes* at the *Croſs-daggers* in *Moore-fields*) the uſe of
it is thus. Suppoſe you ſtand at the foot of an hill, and ſetting
a mark at the top of equal height with your eye to the
ground, ſetting it level on your Table, by help of the plum-
met, you ſee through the ſights the mark at the top of the
hill, you then look what degrees are cut in the limbe, which I
finde, ſuppoſe 34, then I meaſure up ſo far as the hill keeps
that ſcantling of riſing, ſuppoſe 35 pole, keeping the edge of
the ſtandard at the 34 degree of the limbe. I finde that
35 of the ſtandard cut to the 29 line of the plate, which is
the line of level that you muſt plot, though you have gone
35: all theſe I enter into my field-book. If the hill ſtill riſe,
you muſt ſet again, and as it riſes, or falls, ſo you muſt alter: ſo
far as it goes level, plot it as level; and what is hilly plot it as
hilly. And what is here ſaid of going up, the ſame under-
ſtand of going down.

But never go about to caſt up by this plot, though you have
ſhut it never ſo true: as indeed in ſuch a caſe it is very ticklish;
therefore in this caſe we may well allow to miſs a pole or two
in ſhutting, and yet account it well done too. But for caſting
it up, this way that it is meaſured helps not to the finding the
true quantitie, though the extending that laſt line doth come
near to the truth, and may indifferently ſerve in caſe of let-
ting, becauſe it always is a little under the length, as will ea-
ſily appear in this diagram.

E   Sup-

Suppoſe this trian-
gulated figure A B E
H G F to be one half
of the fore-ſaid wood,
& that ſtanding at A,
I ſet up my Table with
the fore-ſaid Qua-
drant upon it, and
looking up to C I
finde it to aſcend 34
degr. meaſuring from
A to C, I finde it 35
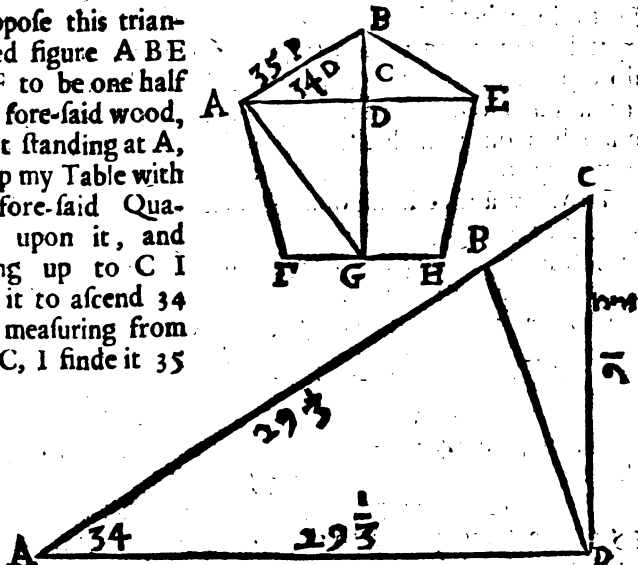
pole: ſo then keeping the ſtandard at 34 of the limbe, 35 of
the ſtandard gives you both 29 ⅓ for your line of level, and
19 ⅔ both upon the plate at once: *viz.* A D, the line of level,
and C D the perpendicular; now if you add A D, and F G, to-
gether, being right angled at G D, and multipſy the half
thereof by D G, you ſhall fall ſo much too ſhort, by how
much the multiplication by your D G, is ſhorter then it ought
to be: for in as much as F H is level, and A D ſo much riſing
as D C, it muſt needs follow, that G D riſeth up to C, as ap-
pears in the other figure. For it is the Hypotenuſe to G D, a
line of level, and C D a perpendicular. For ſuppoſe G D and
A C in the firſt figure to be both of one length, *viz.* 35 pole
a piece, and G D in the firſt figure, and A D in the ſecond be
all one, as if it were the line of level; but now if you lift up
A D to A B, it will not reach to C, by the diſtance of B C
in the ſecond, *viz.* 5 ⅔; for if you ſubtract 29 ⅓ out of 35
which is A B, there reſts B C, *viz.* 5 ⅔: ſo that your triangle
G A D in the firſt is leſs then the triangle A D C in the ſe-
cond,

cond, by the triangle B C D in the second, which comes to
near 50.pole in that triangle. But hereby you see, that having
this level plot, and your degrees afcending, and lengths of
your lines afcended, you may finde out your perpendiculars:
and by them, and the lengths of fuch lines as fhoot upon them,
I mean, having the height at both ends, which you fhall al-
ways take in going round, you may both finde the afcents of
thofe crofs lines, and lengths of them alfo by your Quadrant,
without meafuring them by the chain. For this inftrument ha-
ving the angle of afcent (whofe complement is the angle of
defcent) and any one of the three fides of a rectangle tri-
angle doth give you both the other, always making the ftan-
dard the Hypotenufe, and having any two of the fides, it
gives both the angles of afcent, and defcent.

Secondly, To work this by the limbe of any common Qua-
drant. Take the angle of afcent as before, and meafure the
afcending line A C, let the angle be 34, and the line 35, as be-
fore; and I defire firft the line of level A D: fecondly, the per-
pendicular D C. Firft, draw the line A C upon the centre A,
making the angle A 34 degr. which is done after this manner.
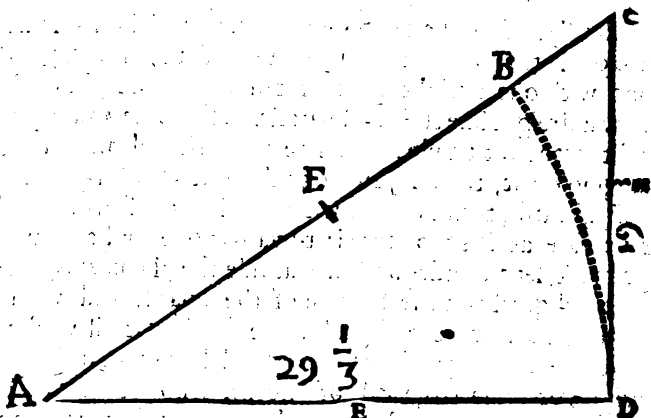
Take 60 from the fcale of chords, with that widenefs fet one
foot in A, and with he other ran the arch D B, and take off

34 d. from the same scale of chords, and set it in the said
tran from B to D, then draw the line A D, then take 17 ½
being the half of 35, and set from A to E, and again from E
to D, making pricks in E and D. Keep one foot of the com-
passes at E, and with the same wideness make a prick at D,
and another at C. so shall A D be your line of level, and D C
the perpendicular; both which if you take with your compas-
ses, and apply to your scale of equal parts, you shall finde
A D the line of level, to be 20 ¼, and C D 19 ¾; as afore.

   If an hill run streight along a ground, if by one side it will
be a mere declining level, if through the middle it will be two
declining levels, and that line so running along the top will
be a line of level, and equal to the line of level under it, there-
fore if you add both ends together, as you measured them, by
the chain, and multiply half of them by the length of that
line you have the content, if it be of equal height at both
ends. But if it be unequal at both ends, though it be a decli-
ning level, and have more then three angles, your best way is,
to part it in severall triangles, whose Hypotenuses and per-
pendiculars you may finde by either of the two former ways,
without measuring them by the chain.

   Thirdly, if you have no Quadrant, nor plain-Table at all
save onely the chain, and any board of a foot or 14 inches
long with one streight edge of ten or eleven inches broad;
draw a streight line close and parallel to that side, and near one
end thereof stick a pin in the line with thread and plummet
hanging on it; then if you are at the bottom of the hill, and
look upwards, turn that end with the plummet from you; but
if you are at the top, turn it towards you; and as you espie
the mark, let a stander by (on that side the plummet is on) lay
his hand gently on the bottom of the board, and with his
thumb press down the thread, there holding it till you have
made a prick right under it, in a good large tran first drawn
with 60 of some large scale of chords, whose center shall be
the hole where the pin sticketh, then take with your compas-
ses the distance between the said prick in the said tran, and the
<div align="right">begin-</div>

beginning of the said tran, and apply it to the same scale of
chords you drew the tran by, it gives the complement of the
angle ascending, *viz.* the degrees of the angle descending.
But if you are at the top, and look downward, it gives the
complement of the top-angle, and degrees of the bottom
ascending. But if you will but erect a perpendicular upon the
same center, and take the distance between the prick and it,
it gives the contrary.

CHAP. X.
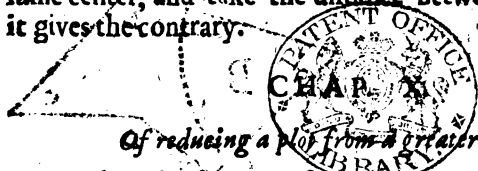
Of reducing a plot from a greater to a lesser.

ALthough there are several ways of performing this, as
likewise of a lesser to a greater (whereof there is great use
in turning statute-measure into the eighteen-foot pole, &c.)
we will lay down onely this one generall rule.

First, begining at any one angle, as at A, and so go round
in order from angle to line, and from line to angle: Suppose
the plot (A) to make another, *viz.* B but a quarter so big;
yet like it both in form and content, onely it is drawn with a
scale of half that bigness; for ½ the bigness gives but ¼, because ½
of ½ is but ¼, and so ⅓ make but ¼ part so big, because ⅓ of ⅔ is ¼.
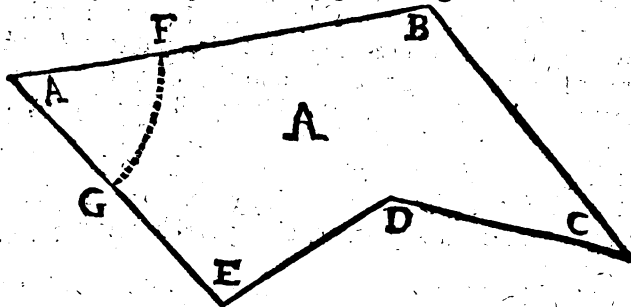
First draw the line A B of the figure B, representing the line
A B of the figure A, regard not though it be as long as it or
longer: at the end thereof make a prick for a center, and write,

or suppose (A) to be there written, then open your compasses
to any widenefs, as to F in the figure (A) and tran F G; with
the fame widenefs do the like in the figure B, take F G in the
figure A, and fet it in the figure B, then take either ⅟₂ the line
A B of the figure A, and fet it the fame way in the line A B
in the figure B: or elfe take half the length thereof from the
fame fcale the figure A was
drawn by; do the like by the
angle B, as you did by the an-
gle A, and likewife by the line
BC and fo angle after angle,
and line after line, till you have
done. And thus may you make
a plot bigger or leffer, as you pleafe, onely by changing the
fcale, yet the *area*, or content, will be the fame, as before.
But if the borders of your plot be very crooked,it wil be need-
full to draw ftreight lines, either within or without both the
plots, like ftation-lines in both the old plot and new, and to
take the crooks from thofe, juft as you did in the fild, if you
will have it æquall in bignefs to the other, and that your
ftreight lines be of like length in both, then fet the fame
widenefs in your new plot from your ftation-lines, each a-
gainft its proper length: but if your new be bigger or leffer,
then apply thofe diftances to your fcale, and take ⅟₂ or ⅟₃ or
more or lefs, according to the proportion of your two plots.
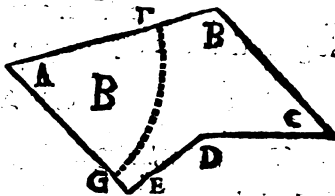
Or Secondly, If you defire a plot equall to another, you
may oyle a paper, drie it well; then put it over the other plot,
that it ftir not, through which you may fee the lines on the
neather plot, then draw them with your pen on the oyled pa-
per, then take it off to prick it, then pounch a new paper &
draw it.

Or Thirdly, Having drawn a line reprefenting A B in your
new plot, take the line A B off the old, either all, or ⅟₂ or
according to your defired proportion, & fet it on the new.
Alfo take the proportion of the line (A E) and fet one foot
in (A) and tran where you think (E) will fall in your new.

Take

Take alfo the like proportion of the diftance of (B E) and
fet in the faid tran, and fo you have (E), the fame 2 diftan-
ces will fet out (D) alfo (D and B) will fet out (C) and fo
you have all your angles, then draw their lines, and you have
your plot defired.

CHAP. XI.

Of meafuring pafture-ground by the chain onely, and that as
fpeedily and exaƈtly, as with any inftrument whatfoever,
and with lefs help though in mifty weather, & to
plot, fhut, and prove, the plot thereby alfo.

ABout the midft of one of your longeft ftation-lines,and
fome known length in the fame (as at X in the firft or
third clofe,chap. 3ᵈ pag. 22)fet up a mark, and mark it in your
book, both with its proper length & letter, then having mea-
fured round about the ground on the infide, or at leaft all but
the laft fide: if you have more then three angles, in ftead of
meafuring it from angle to angle: *viz* in the firft clofe, from
A to **C**, or from **B** to **D**, you fhall meafure from **C** to **X**, and
from **X** to **D**, fo making a triangle the more then otherwife;
which two fubtendents will eafilie be run whileft you can fet
up the Table once, fo you fhall need lefs help by one to carry
your Table, for that is wholly one bodies work, and thefe
two fubtendents muft be fet down at the latter end of your
notes of that clofe in your field-book. Then if you meafure
the laft fide A.D having plotted the reft, if that A D on the
ground, and A D on the plot agree, all is right, neither ever
need you divide any more linesthen one in the whole ground
or clofe throughout, fo that at leaft none of the ftation lines
ftrike outward, for then it muft be accounted as another clofe,
fo much of it till the laft line that ftrook inward being conti-
nued ftreight out do meet with the other plot again. See
more chap. third.

Now to plot fuch a ground meafured by the chain onely,
fuppofe it be the faid firft clofe, *(chap third)* firft I draw the
<div align="right">**line**</div>

line A X B, making a mark at X, and another at B: second-
ly you muſt either take the ſubtendent X C, ſetting one foot
of the compaſſes in X, & tranning where you think C will fall,
or elſe take the ſtation-line B C with your compaſſes and ſet
one foot in B tran at C and then take the other of theſe two
laſt lines, *viz.* X C. ſetting one foot on its proper mark X,
and with the other make a prick in the ſaid tran, and ſo have
you placed C in his right place, then draw the line B C, next
take C D with your compaſſes, ſet one foot in C, and tran
where you think D will fall, then take the ſubtendent D X, ſet
one foot in X and make a prick in the ſaid tran, and that ſets
out D, then draw the line C D, and becauſe D is your laſt ſta-
tion, and that A and D are both ſet out already; therefore,
draw alſo the line A D, now if A D on the plot and A D in
your book agree, then all is right, elſe not. So that in this
kinde of plotting there are onely theſe three poſitures. Firſt,
draw a ſtation-line ; ſecondly, tran with a ſubtendent ; third-
ly, prick with the next ſtation line.

Neverthelefs in great larg plots, it will be needfull to uſe
a good larg pair of compaſſes, becauſe you muſt take the
whole length of your lines with them. In which caſe a pair of
beam-compaſſes, with a beam of deal, willow, or ſallow, or
ſome ſuch ſoft wood, is beſt of all, of 17 or 18 inches long,
with a piece of an awl-point near one end, and a ſliding but-
ton to be moved pretty and ſtifly up and down, and to be
ſtayed with a ſcrew pin, or wedge at any diſtance, with an
other ſhort point in the end thereof.

Now we will ſhew you how to continue your plot out of
one ground into another, that ſo you may lay all the grounds
of a Lordſhip together in one entire plot by the chain onely,
and that we will do by ſeverall rules ; for the underſtanding
thereof we will refer you to the plot in the latter end of the
third chapter, as alſo in the end of the book. The knowledge
whereof conſiſteth in four rules in the obtaining the firſt
ſtation-line in the cloſe which you go unto. As for example.

Firſt, Suppoſe I would go out of the firſt cloſe at A, and
would

would plot the station-line A G : now becaufe in plotting
thefe kinds of grounds you muft always reduce all into trian-
gles, therefore ftanding at A you may meafure two chains
length in the line A F, or A G, likewife two chains back-ward
from A towards B, in the line A B in the firft clofe; then mea-
fure the diftance between thofe two lengths, and plot them
after this manner : Firft, your beft way is (though you have
meafured but two chains length a piece, yet) in ftead of two,
take the double, if the ftation-lines be long, you may triple
that diftance, fetting one foot in A, and extending the other
towards B; there make a prick in that line; and tran from
thence with that widenefs where you think the line A F, or
A G will fall : then look what the diftance was between the
two lines at the end of your two chains a piece ; if doubled
before, then double again that diftance upon your fcale, and
fet it in the tran from the line A B in the firft clofe to the line
A F in the fecond, and draw the line A F G through that
prick *ad infinitum.* Thus have you got a line in the fecond
clofe, by help of a part of the line A B , which in this kinde
you muft always take, *viz.* that ftation-line , whereof the
whole or part belongs to both the clofes. But becaufe in this
cafe you muft always mete through the hedge, from the two
chains of one clofe to the two chains of the other : there-
fore to avoid the trouble of cutting a hole through the hedge,
if there be ever a gap, gate, or ftile near unto thofe lengths,
you may take more or lefs of thofe two lines as you pleafe:
now becaufe here is a gap at two chains and an half from A,
in the line A B, you may meafure two chains and an half of
either of them, or two and an half in that, and three in the
other, as you pleafe ; and meafure the diftance upon the
ground between thofe two pricks : then you may double all
three diftances upon your fcale, as afore, and fet out the pro-
per diftances between thofe two pricks, as afore, and then
draw your line A G upon your plot in the fecond clofe.

But, Thirdly, becaufe we have meafured the diftance be-
tween A and X in the firft line, which is one fide of the trian-
F   gle

gle of that second clofe, and likewife have meafured from A
to G on the fecond fide, and have a gap alfo at X: therefore if
you meafure G X, you will have all the fides of that great
triangle, which you may ufe as afore-faid : Firft, you have
the line A X already placed.   Secondly, take the length of
A G with your compaffes upon your fcale, and with that
widenefs, fet one foot in A, and tran where you think G will
fall. Do likewife with the line G X, taken alfo upon your
fcale, fet one foot at X, and the other is the forefaid tran, and
there is your center G.

And after the fame manner may you go out of that clofe,
into the great clofe from G, by help of the line A G. Now
having the line A F, or A G, you may eafily fet out the trian-
gle A F E, as you did A X G. Likewife you fet out the trian-
gle that is between the the line X G and the hedge, between
the two clofes onely by the diftance of G to the entrance of
the great clofe.

A fecond way of going out of one clofe into another is,
when I have a ftation near the middle of a ftation-line, and
that there I would go into another clofe.   For example :
Suppofe I would go out of the great clofe into the firft
clofe, right againft the ftation-line B C in the firft from L in
the ftation-line of K; then when you come right againft B C,
the ftation line, lengthen that line B C back-ward into the
great clofe from L to M two chains length; meafure alfo two
chains lengths in the ftation-line I K, and meafure two chains
lengths from L to I back again; and meafure the diftance be-
tween two chains of the one, and two chains of the other,
and that gives you the quantitie of the angle K B C. Then
from the line L K; you may take from your fcale four chains
length, and you may tran from the line K L, towards the line
L C, or B C, with one foot fet in L, and double the diftance of
the two pricks in the other clofe, and take that with your
compaffes, and fet from the line L K, to the L C, and where it
falls draw the line L C *ad infinitum*. After the fame manner
might you have drawn a line by the South-fide of the hedge
by

by B C or L C. Also so might you at X in the first close have
gone either into the great close, or into the little close, by
drawing a station-line on which side of the hedge you will.

A third way is by continuation of such a station-line as
shoots upon the corner of a close; and thus suppose you
would go out of the great close into the little close at K, if
you had but continued your line L K to A; and this is the
easiest way of all.

A fourth way, If on the West-side of the hedge A K
there were a spinny wood of two or three pole broad all
along by the sides thereof, and that you desire to go out of
the first close into that little close, but there is no gap, save
onely you can strike a squire-line from the station-line A B, at
either end of A & K; then may you both at A and at X erect
a perpendicular into the first close ward; and then may you
continue those two perpendiculars, so far as you shall need
them, till you are free from the spinny, and may draw a line
from one to the other by the spinny side, and truly plotting
out either perpendicular from the last station-line.

<center>CHAP. XII.</center>

To measure a wood by the chain onely.

B Ecause a wood cannot be measured on the inside; and
therefore no subtendents can be taken, as they may in pa-
sture-ground, we will therefore endeavour how to do it by
taking of angles with the chain.

Now because the meeting of the station-lines gives but one
angle, which is the wood corner, or at least so near to it, that
no subtendent can be taken from any part of one of those lines
to the like, or any other part of the other, yet if you cross or
lengthen them out beyond their meeting one or two chains
length a piece, you shall then have three angles more, where-
of the opposite angle to the wood angle will be the same with
the wood angle, and either of the other will be the comple-
ment of it to 180 degrees: so that if you can but take one short
<center>F 2</center>   line

line in any of thofe three angles, you are well enough: as fup-
pofe A to be a wood, and at the angle C, I had two ftation-
lines met, *viz.* A C, and C G, I continue A C forward to D
one chaines length, or elfe fet C G backwards to F a chains
length, and likewife fet back A C to B one chain of 100 links:
now fuppofe I find F B or DE to be 60. now for that C B and
C F are each of them 100 and F B 60. I firft plot them, firft
ftriking a line, then I take 100 from fome fcale of equal parts,
as C B in the figure B. And be-
caufe C B and C F are equall,
therefore I fet one foot in C, and
tran F B, alfo from B to F I fet
60 of the fame equall parts, then
draw the line F C through C, and
it gives the ftation-line C G; Or
more eafilie, if you draw out the
line A C unto D, and make C D
and C E 100. a piece, finding D E to be 60 then may you
take 100 of any fcale of equal parts & tran D E then fet 60
of the fame parts in the faid tran from D toward E, make there
a prick & draw the line C G through
E. But if by reafon of impediments
you can neither meafure D E nor F B
at 100 a piece, you may tran C B
200, and F C 100, or either of them
what you will, fo that you plot them
accordingly; as if C E be 130, C D
100 and D E 50 : then firft fet out
C D 100 in the line C D, fecondly
take C E 130, fet one foot in C and
tran with the other, and thirdly take
D E 50, fet one foot in D, and with
the other make a prick in the tran
and draw the line from C through E as afore. Now if through
impediments by none of the forefaid ways you can meafure
neither of the forefaid angles, then fee what you can do to
the
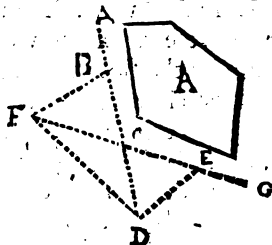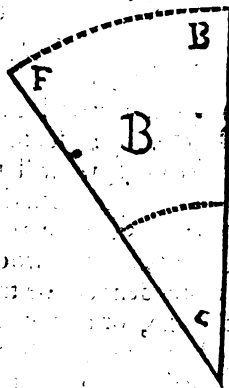
the angle F C D, or the angle oppofite to the angle of the
wood : for this therefore you muſt both lengthen A C to D
forward, & C G to F backward, each of them 100 or more
from C; then meaſure the diſtance D F, and apply it to your
ſcale of equal parts, and what it gives ſet down in your note-
book, as likewiſe you muſt do all the other lengths. Then
ſuppoſing C D, and C F to be 100 a piece, I take 100 and ſet
one foot in C, and tran from E; then ſuppoſe I had found
D F 160. I take therefore 160, and ſet from D in the ſaid
tran, and it reacheth to F; therefore draw F *ad infinitum*, and
it gives the next ſtation-line C G.

But in all this that hitherto we have ſpoken of meaſuring
by the chain onely, we would have you to underſtand, that we
have onely ſpoken ſpoken of meaſuring and plotting of the
ſtation-lines: for as for meaſuring, caſting up, and plotting
of the out-ſides, that is the ſame as before, ſerving as well to
this as to the Table.

And as for meaſuring hilly-ground, we have ſhewed before
in *chap.* 9, that alſo may be meaſured by the chain alone,
ſave onely any ſorry board with one ſtreight edge; & it matters
not greatly whether it have a ſtreight edge or no. If in mea-
ſuring the out-ſides you go upon a ſtation-line, as in the line
A F G of the ſecond cloſe, (*chap.* 3) from which you deſire
to ſtrike a perpendicular into an angle : Firſt, gheuſs at the
place, ſo near as you can, where it will fall; there ſet one of
your counting-ſticks, ſet another 80 links backwards, directly
in the ſtation-line; another at 60 from the firſt ſtick into the
angle ; then let one hold one end of the chain at the ſtick
that was ſet backward, and the other at the ſtick ſet in the
angle-line, if they two meet juſt at the chains end, (I mean
Gunther's chain of 100 links) then is it a true perpendicular
into the angle; if it fall ſhort, you are not far enough; if
gone, then you are too far.

If a ground be very large or buſhy, you may meaſure it on
the out-ſide like a wood; or meaſuring a chains length or two
of each ſtation-line, and their ſubtendent on the inſide from
the angle.   F 3   Thus

Thus have we shewed you how to meafure all manner of ground by the chain onely, for which I expect as much thanks at the instrument-makers hands, as *Culpepper* at the Colledge of Physitians. And indeed I was determined to have published it above fourty years agone, had not Mr. *Allen* and Mr. *Thomson* diswaded me from it, upon this reason, That if ignorant people see the moft famous Artifts go fo to work, they will be ready to judge, that he that goes with a plain pair of poles, and a fquare board, to fet out a fquare withall, is a better workman then he. And indeed, I cannot deny but that they judge according to their tools which they fee, rather then according to their fkill they fee not.

Whereupon I have forborn till now, confidering I am even dropping into my grave, and confidering that my Saviour would not ceafe cafting out devils, becaufe he was thought to do it through *Beelzebub*; no more will I longer forbear this, it being fo lawfull, and honeft, and beneficiall to a Commonwealth. And truly had I regarded mens fayings I muft have given over furveying long ago, or elfe to give over profeffion, for that I was judged (by no fmall fools) to work by the devil, for that I could tell a diftance before I meafured it.

CHAP. XIII.
Of taking diftances by the chain onely.

ALthough we have fhown the meafuring of all manner of land by the chain, yet fince we are fpeaking of the ufe of it, I hope you will not think your time ill-fpent to read a leffon or two more that will be effected by it.

Let there be two forts C and D of a good diftance afunder, beyond a river a mile or two broad; to tell the juft diftance how far they are afunder, how far each is from A, and each from B, and the breadth of the river: Firft, I draw the line A B 40 pole, a tenth part (at leaft) of the greateft diftance; let it run parallel, but ftreight, by the river, 9 or 10 pole off; then from A I fet out both backward from A to E directly backward in the ftation-line fix pole, and fix from A to F in A C
line

line, then E and F are four pole asunder. Also I measure from B to G, and from B to H 6 a piece, and 6 between them also; and from A toward B and D 6 piece, and they are 4 ¼ asunder, and from B toward A and C 6 a piece, they will be 3 ½ asunder: but it is best to draw your station-line with a very small scale; but let out your angles with a very great one: then draw A D and B D, till they meet at D, likewise A C and B C, till they meet at C, and a right line from C to D, for the distance of the two forts; and another from B to K for the breadth of the river, so shall you finde all your desired distances of

you
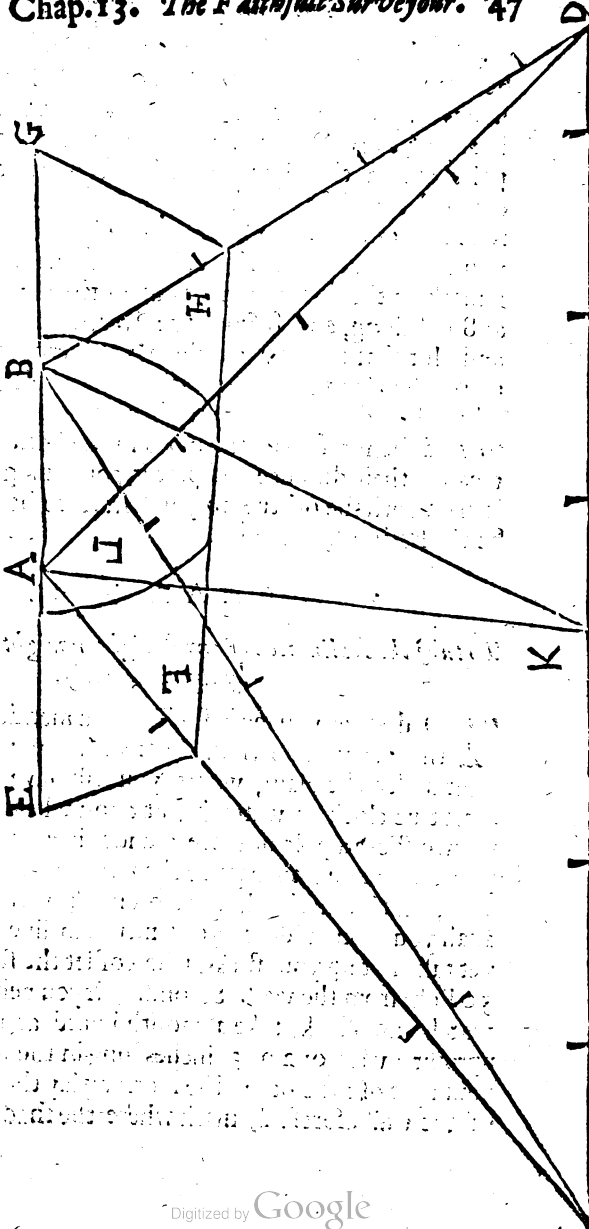
you fee them fet down upon their lines; your ftation-line A B, being your common fcale, *viz.* 40 poles : for if you take that line with your compaffes, look how oft you finde that length in any of the other, fo many furlongs, or fo many times fourty poles are in that line, and what is more, take it with your compaffes, and fet one foot at A, and the other forward in the faid ftation-line or fcale, and it gives the odd poles. But if you would onely take the breadth of the river K L, obferve a mark on the farther bank, as at K; then in your ftation-line at 8 pole long, and 8 from the river, meafure their diftance, and plot that triangle, continue your crofs-line toward your mark; then lengthen your ftation-line to a fourth or fifth part of the breadth of the river; thence alfo meafure 8 pole right toward the forefaid mark, and 8 in the ftation-line backward; meafure their diftance and plot it, continuing the mark-line till it meet with the other : fo your fcale to both the other will be the ftation-line, as afore.

C H A P. XIIII.

To take the declination of any ftreight upright wall for Dialling by the chain onely.

TO do this you muft finde out a meridian-line by any of thefe ways following. Firft fetting your back to the wall right under the plain, where you will have the diall, look by fome true clock or watch juft at noon where the fun is, and fet up two fticks a pole or more afunder in a ftreight line between you and the fun, then go to the furtheft and look back to the wall, and juft in that line make a mark on the wall: for there fhall you plumm down your meridian-line of your dial. But yet take not up your fticks, whereof let the furtheft of them be 50 links from the wall. Secondly, if you neither have help of watch, nor clock, take a fmooth board and lay it level, ftick upright a wier of 2 or 3 inches long in the midft of it, and about nine of the clock in the morning lay the board at the foot of the wall aforefaid, mark where the fhadow of the top of the

the wier falleth, there make a prick: then take out your wier,
and set one foot of your compasses in that center, and open
the other to the former prick, and there draw a circle, and
then set up your wier upright as it stood before; neither deeper
nor shallower then before; you may apply a squire to it, to see
it stand upright, or measure with your compasses from the cir-
cle to the top of the wier, if it be alike all 4 ways. If it be
right, set up two sticks right in a line between it and the Sun as
afore. Then again about three a clock in the afternoon watch
where the Suns shaddow falls just on the same circle again, and
then set up two other sticks, so that they may meet in the
same centre : divide the space between the two furthest sticks
into two equall parts, and mark that for your meridian-line.
But lest the Sun should not shine when it comes to that circle,
you may make severall circles upon the board, and stick up
marks where the Sun comes at them forenoon and afternoon.

If both these ways fail, this third way is better then either
of them. In the evening go Southward of the place, where
you would have your diall, three or four pole, turn your face
Northward, moving Eastward or Westward till you see the
North-pole and the place where you will have the meridian of
your diall both in a line, which by looking over the house you
may the better do, if you get one to hold a pole aslope with
a line tyed to the end thereof and a plummet to it. If now the
line, the meridian-place on the wall, and the North-pole
are all in a line, you are right, there stick up a stick till morn-
ing, another right behinde it; for just there is your meridian-
line.

Now to know the pole you may easily ghuess at it near e-
nough, for it is a point in the heavens in a right line between
the hinder horse of *Charles-wain* called *Alliot* and the polar-
star, so far off from the pole-star, as the pole-star is from the
next star to it: so that if *Alliot* be just beyond the polar star
then is the polar-star full North, *& è contra.*

A fourth way is this; in some plain place near hand where
you may see both ways set a mark, go South two or three

pole, then move Eaftward or Weftward till you fee the pole-
ftar right beyond the firft ftaff, there fet another, or rather
pitch two good ftones, like grave ftones in Church-yards: for
fo they will not onely ferve for this bufinefs, but alfo give the
hour of the night to a minute by knowing the right afcention
of the Sun and ftars.

The ufe we make of it here is double: firft it helps us to fet out
the meridian-line every where near hand; for if ftanding here at
the North ftone you fee the Sun right over a ftick or pole hol-
den at the South, you run prefently & fet your back againft the
wall where you would have your diall, and fet up two fticks
between the Sun and you, you have a meridian-line defired.

Now having gotten this meridian-line: to finde the acute
angle that this meridian makes with the wall, firft, meafure
with your chain one chain, or half a chain in this meridian,
and as much by the wall-fide, and their diftance for a third
fide, and plot it; then finde the quantitie of the angle of inter-
fection of the meridian and wall-line by the fcale of chords,
the complement thereof is the decli-
nation of the wall. Suppofe the line
A B to be a meridian-line, and A C to
be the wall-line, in either of which I
meafure from A to C, and from A to B
50 links, and I finde the diftance of
C B to be 24½, this I plot as afore is
fhown. Then to finde how many de-
grees the angle C A B makes, take 60
from fome fcale of chords, and fet one
foot in A, and tran D E: then take
D E with your compaffes, and apply to
your fcale of chords, and it gives the
angle of the wall, and meridian D A E,
or C A B, which is all one, to be 30 degrees, and the comple-
ment thereof 60 is the declination of the wall; which if it
were taken in the morning, it is a South-weft diall decliming
Weft-ward 60 degrees: (for always the diftance of the wall-
line
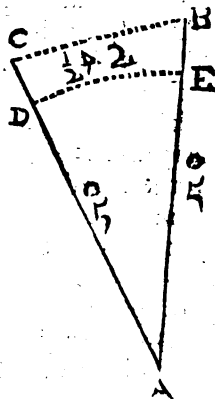
line to the Eaſt or Weſt-line is the declination of the wall:)
if the Sun ſhine on it at noon, it is a South diall; if it ſhine
longer on it in the after-
noon, then in the fore-
noon, it is a South-weſt,
& è contra.
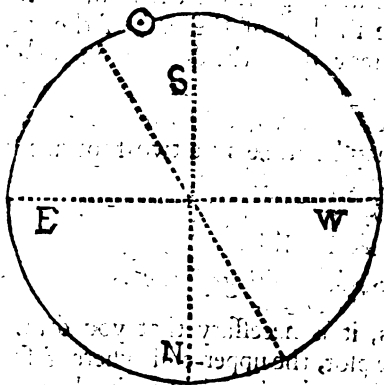
Having a meridian in
ſome open and plain
place, to finde the Azu-
meth, ſet up a ſtick at the
South-end of your me-
ridian-line, meaſure back
in it 50 links, there make
your centre A, thence
meaſure 50 forward in
the Sun-line; meaſure the diſtance of thoſe two fifties, and
plot it, then take 60 off your ſcale of chords, and do as in the
laſt rule.

Having the Azumeth, to finde the angle of the wall
and Sun by help of the laſt figure.

Sometime you are in ſuch a place where you cannot ſet out
a meridian-line, yet you may always ſet out an Azumeth, or
Sun-line, which elſwhere I call the angle of the wall and Sun.
Now finding your Azumeth, as in the laſt rule, come preſently
from thence, not ſtaying to caſt it up or plot it, but preſently
meaſure 50 by the wall, and 50 in the Sun-line, and their di-
ſtance, and then plot both the triangles, and finde the degrees
of both angles at the centre, as afore; ſo have you both the
Suns Azumeth, and the angle of the wall and Sun. Then ma-
king a circle with two croſs diameters, firſt ſet out your Azu-
meth from the South; if it was taken in the morning, then on
the Eaſt; if in the after-noon, on the Weſt. Then always rec-
kon backward the angle of the wall and Sun in the courſe of
the Sun, and from thence draw a line through the centre re-
preſenting the wall-line, (as in the laſt diagram) the diſtance

be-

tween that and the East and West line in the circle is the declination of the wall desired.

And although the Sun be newly gone off the wall, or not yet come on, by help of the shadow of the end of the wall, and these former helps you may finde the declination. Onely in stead of setting your Azumeth backward, you must set it forward in the course of the Sun, if you take it before it shines on the wall. And all this may be done by a two-foot rule or yard, or a boyes cat-stick.

CHAP. XV.

Of colouring and beautifying of plots.

IN beautifying of plots, it is necessary that you draw a square round about the plot, the upper-end whereof shall represent the North-side, the nether line the South; the right-side line the East: but you must help your self to these by taking a meridian-line first in the field, and drawing a meridian-line through the first plot.

Secondly, Examine your former plot, how many chains or poles your plot reacheth from North to South, and from East to West, and thereby make choise of such a scale, that you may lay the whole Lordship within the said square, according to the Northing, and Southing, and distance. Or else you may draw your plot, first, by what scale you will, and then draw the square afterward.

Thirdly, Fill the out-borders between the square and the demeans, at least such as border next to the demeans, with the bordering hedges, and names or owners names of the grounds.

Fourthly, Whatsoever you write, write it from West to East: unless it be the proper name of some river, or high-way, or such like. For if the North be upward, the West will be on the left hand.

Fifthly, Describe all houses, ways, rivers, Churches, wind-mills, arbours, great lone-trees, gates, stiles, &c. that fall within your plot, as also the Lordship-house, with other edifices

ees in a corner by it felf, and the Lords coat in another cor-
ner : the houfe being drawn in profpective.

Sixthly, Defcribe at the bottom the fcale that you drew it
by, adorning it with compaffes, ovalls, fquares, and comparti-
ments, &c.

Seventhly , Having drawn all your feverall grounds,
and diftinguifhed them with their hedges , it will not be
amifs firft to pounce over the paper or parchment with
fome ftanifh grain, and burnt Allome, and a double quantitie
of pounced rofen, both finely fearced, and lightly pumiced,
thereby to preferve the paper or parchment from through-
piercing with the colours.

Then lay on your colours in manner following, being firft
ground and bound with gum-water. very thin and bodilefs.
Arable for corn you may wafh with pale ftraw-colour made of
yellow-ocre and white-lead. For meadows take pink and ver-
digreafe in a light green. Pafture in a deep green of pink,
azure, and fmalts. Fenns a deep green, as alfo heaths of yel-
low and indico. Trees a fadder green of white-lead and verdi-
greafe. For mud-walls and ways mix white-lead, and ruft of
iron, or with ocres brown of *Spain*: for white-ftone take um-
ber and white: water or glafs may be fhown with indico and
azure, or black-lead: for feas, a greenifh sky-colour of indico,
azure, fmalts, white-lead, and verdigreafe.

CHAP. XVI.

*To meafure all manner of ground by the Pandoron,
or any other graduated Inftrument.*

THe Pandoron is an Inftrument compounded of, Firft, an
ordinary foot, with three legs for a plain Table. Second-
ly, a Table and folding-rulers like it, fave that it is a true fquare.
Thirdly, the box and needle. Fourthly, it hath on one corner
a centre, in which is a fcrew-pin, on which a moveable ruler
with fights turneth. Fifthly, in the two out-fides furtheft from
the centre is drawn the Quadrate for terreftrial altitudes and

diftan-

diftances. Sixthly, next to it is the limbe of the Quadrant, both
for celeftial and terreftrial altitudes and diftances, whether
upright, flat, or aflope. Seventhly, *Gunther's* Quadrant for
your own latitude for houres both of night and day; and Aſ-
zumeths, and divers other problems. Eighthly, *Fale's* Qua-
drant for Planetary houres. Ninthly, a circle and fcale for
finding the declination of a plain. Tenthly, a neck of 14 or
15 inches long, to put on the top of the ſtaff, the Table be-
ing taken off, with a pin on the fide to hang the Table on, to
take all manner of altitudes and diftances aflope. Eleventhly,
a beam of 6 or 7 foot long about two inches fquare of deal,
and a trough on the top, gouged all along half an inch deep,
to fill with water for a water-level, having a fight at each end,
having a lath crofling the beam in the middle above and be-
low 6 foot long, faftened with fcrew-pins and brackets above
and below, with an hole in the bottom of the middle of the
beam, in ftead of a focket to ftand on top of the three-foot
ftaff. So that there is nothing that all or any obferving Inftru-
ments can do; but this doth it. By this you meafure land as by
the plain-Table, then if the weather be moift, or in hilly
ground, you may uncover the Table, and work by the Qua-
drant, whereby you may fave the charge of hill-ground fights,
which are as coftly as all the reft of the Inftruments. Befides
which if you know how to work by the Quadrant, you can-
not be ignorant of working by the Theodelete or femicircles;
the difference being onely this, that they take onely at once,
which if it be above 90 degrees, by the Quadrant you firft
take fome part of it, and then the reft of it afterward, yet all
at the fame ftation, and then plot it by your fcale of chords.
Indeed by the Circumferentor you take all the angles by ob-
ferving the cutting of the South-end of the needle, and then
either plot the angles by a protractor, and the lines by a fcale
of equal parts, or elfe you may plot the angles either by your
fcale of chords, or by the Circumferentor it felf both which I
hold better ways then the firft. So that there being nothing
defirable in an obferving inftrument, but this giveth it, it fo
<div align="right">pleafed</div>

pleaſed M^r. *Hender Roberts*; (the Lord *Roberts* youngeſt ſon,
a Gentleman every way fitted with a genius for the Mathe-
maticks, whom I cannot name without honour,) who had
the firſt of them to give it the name of πᾶν δῶες, *omne do-
num.* So that in ſhewing the uſe of it as it is a Quadrant, we
ſhall with the ſame labour ſhew the uſe of all graduated In-
ſtruments in meaſuring of land; and as for working by it as
by the plain-Table, we refer you to the ten firſt chapters of
this book. Now therefore for working by the Quadrant, (yet
herein we will ſpeak of nothing but what is within the ſtati-
on-lines, contenting our ſelves for the reſt with that which
hath been ſpoken before in the uſe of the plain-Table,) all
the difference conſiſts in three things : firſt, the taking of the
angles: ſecondly, in keeping the field-book: thirdly, in plot-
ting.

Firſt, For taking of the angles, you need not ſet up your
Quadrant oftner then you did the plain-Table: there-
fore ſuppoſe this figure
A B C D E to be a plot
of ground to be meaſu-
red on the inſide : I be-
gin at A, not ſetting up
the Inſtrument, but finde
A B to be 20 pole,
that I ſet down in my
note-book, beſides the
breadths from the ſtati-
on lines, which I omit
here as ſufficiently ſpo-
ken of before. Then be-
ing come to B, there I ſet up the Quadrant, and finde it juſt
90 degrees, I ſet down B 90 degrees, ſo that all the lengths
are meaſured by poles or links, and all the angles by degrees:
then I meaſure B C, and finde it 28, and ſet it down: now I
come to C, I lay the ſharp edge of the rule to the line of the
Quadrant, where the degrees begin, and then ſcrew down
the
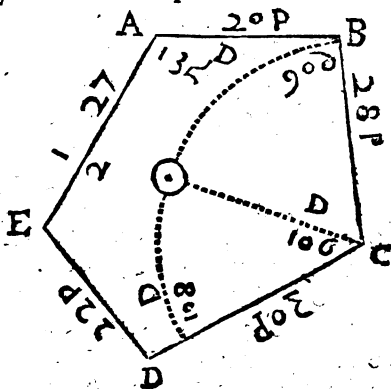
AB. 20. p.
B. 90. d.
BC. 28. p.
C. 106. d.
CD. 36. p.
D. 108. d.
DE. 22. p.
E. 101. d.
EA. 27. $\frac{1}{2}$. p

the fights for ftirring; but turn the Quadrant till through the fights you fee a mark at B, (as when you were at B you faw at A.) Now feeing that mark at B fcrew the focket pin, that the Quadrant turns not ; but turn your fights to D: but I cannot, for they fall befides the board; but I have efpied a mark at ☉ near the middle of the ground, *viz.* a tree, I turn my fights to that, and fee the fharp edge of the rule cut 60 degrees, that I keep in minde, then I lay the fharp edge of the rule again on the beginning of degrees, and turn the Quadrant till I fee the fame tree again through the fights; then ftir not the Table, but ftir the fights till you fee D through them: then looking by the edge of the ruler, I finde it cuts at 46, which added to 60 gives the whole angle C 106 : and fo of the reft.

To plot a plot taken by graduited Inftruments.

Now for your plotting it, firft draw the line A B, fet out 20 of your fcale of equal parts upon it, then take always 60 off your fcale of chords, fet one foot at the end of your 20 in B, and with the other foot tran always from the laft line, which here is A B, towards the place where you think your next line B C will fall. Then take your angle B which is 60, and fet it in the faid tran from the line A B forward, there make a prick, and from B through that prick draw the line B C *ad infinitum*. In which line fet out 28 of equal parts, there make a prick for your ftation C. Then take again your 60 of chords, fet one foot in C, and tran from the laft line B C, toward C D. Now becaufe your angle C is more then 90, and that your compafs tran at 60, therefore firft fet out that 60 in the faid tran to B, and becaufe there wants yet 46 of 106, therefore take thofe 46 with your compaffes, and fet them on forward from 60, there make a prick, and draw your line C D through it, and fo of the reft. So that there are but thefe things : firft, draw a ftation-line : fecondly, tran your angle with 60 of chords : thirdly prick out the degrees of that angle.

CHAP.

CHAP. XVII.

In measuring by graduated Instruments, to know if your plot will shut, or no.

Because in working by graduated Instruments, you always plot at home, but never in the field; and that if any thing be mistaken in the field (as oft it comes to pass to be so) then will not your plot shut at home:therefore either you must look to your needle at every plantation, or else you must measure all the angles, which by the plain-Table you need not do: therefore with such Instruments the needle is more needfull, then with the plain-Table; and yet the *Circumferentor* will hardly help you herein neither, though you work all by the needle, unless you work by taking angles by it, which is the flower way. Now having measured all the angles, if on the inside of a ground, because all the three angles of a right line triangle are equall to two right angles, or 180 degrees, and that there are so many triangles save two as are angles; therefore if you reckon so many angles save two, for each of them 180, and finde that and the quantities of all your angles to agree, there is great hope your plot will shut, else not. As if there be a triangle, they must all make 180; if a quadrangle, 360; if a pentangle, 540; an hexangle 720; a septangle 800; an octangle 950; but if you measure on the out side, as a wood, then every outward angle is the complement to 360 of its inner angle; therefore to take all those complements,is your best way both to prove and plot it by, and less labour, if you are far from your mark, and not to go to it again, it oft-times will quit your pains, lest you are forced to spend perhaps an whole days-work about that you have done, or at least would have done already, to prove your angles after this manner.

H   CHAP.

CHAP. XVIII.

To take terreſtrial diſtances by the plain-Table, or Pandoron,
as by the Table.

VVE have ſpoken of taking them by the chain onely, in
         chap. 13. between that and this there is very little
difference. We will here ſuppoſe the ſame ſuppoſitions as there:
viz. two houſes beyond a river, between which I deſire the
diſtance, alſo between each of them, and each of my ſtations:
the chiefeſt difference is this, that by this your beſt way is to
have your ſtation-line as near the river as you can, which let
be as before A B 40 pole long. Firſt ſet your Inſtrument at *A*
and turn the ſights to D C, and B, and draw their lines; mea-
ſure thence to B 40 poles, there make a prick, but lay down
your 40 pole with a very ſmall ſcale, if the diſtances be long,
ſo that the 40 pole be little above an inch long. Then ſet up
your Inſtrument at B, laying your index on your ſtation-line of
your plot turn it till through the ſights you eſpie A, then faſten
your Table and one end of your ruler turning upon the center
B, turn the ſights firſt to C, then to D, then draw lines, whoſe
interſections with the former will give you all your diſtances
deſired.

CHAP. XIX.

To do the like by the Pandoron as it is a Quadrant, or by any
graduated Inſtrument.

LEt the ſame example be propounded as afore, and let your
      ſtation-line be A B 40 pole as near the river-ſide as you
can. I ſet up the Quadrant firſt at A, where I find B A D
110 degrees, and C A D is 50 degrees: likewiſe ſet up at B,
then C B A is 104, whereof C B D 50; this ſtation-line 40
and theſe angles thus plotted extend you lines till they meet,
and their interſections will give you the deſired diſtances
as afore: yet if you will beſtow the time and pains to caſt it
                                                                        up

up by the doctrine of Triangles you may come somewhat
nearer.
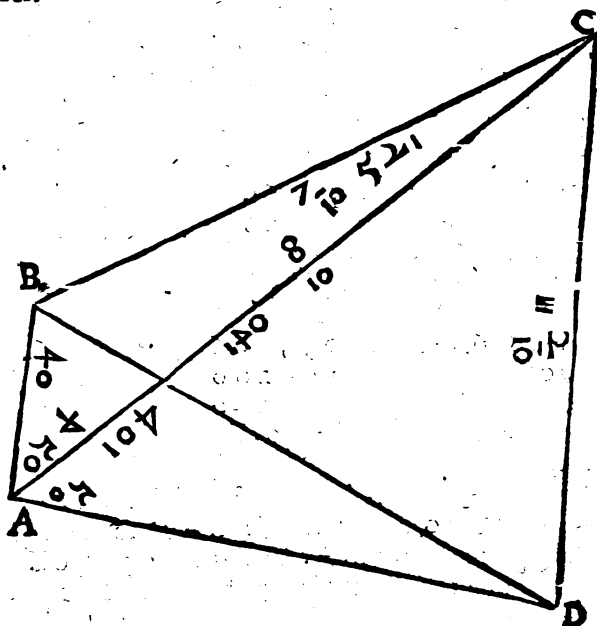
Firſt for the triangle B A D, ſeeing that B A D is 110 de-
grees, and the angle A B D 54: which make being added
164, which take out of 180, reſts the angle A D B 16 de-
grees.

Now in the ſame triangle having all the angle and the line
A B: to finde the ſide A D.

As the ſine A D B 16. Comparithmes   0 5 5 9 6 6
is to A B 40.   1 6 0 2 0 6
So ſine 110 degrees, that is ſine 70,   9 9 7 2 9 9
to 136 $\frac{1}{10}$ B D.   2 1 3 4 6 1

Alſo to finde A D,

Aſ

As fine A D B 16. Compar.   055966
is to A B 40 pole: 160206
fo fine D B A 54 degrees   990796
to 117 $\frac{4}{10}$ A D.   <u>206968</u>

Then in the triangle C B A,
C B A is 104 and B A C is 60, thefe added together make
164, which taken out of 180 leaves the angle B C A 16 de-
grees. Now to find B C.

As fine 16 d. Compar.   055966
to A B 40 p.   160206
fo is fine C A D 60   993753
to B C 125 and $\frac{7}{10}$ <u>209925</u>

   Alfo to finde A C.

As fine A C B 16. Compar. 055966
to A B 40:   160206
fo fine 104, that is fine 78 998690
C B A   <u>214862</u>
to A C 140 $\frac{1}{10}$

Laftly having the two fides A C 140 $\frac{1}{10}$ and A D 117 $\frac{4}{10}$ and
the angle C A D 50 in your triangle C A D to finde C D.

As the fumm of the fides 258 $\frac{1}{10}$. Compar. 658804
to the difference of the fame fides 23 $\frac{4}{10}$ 236922
fo is the tang. of $\frac{1}{2}$ the fum of the angles unknown 65 to the
tang. of $\frac{1}{2}$ their difference 11 degrees, 033133
which add to 65 d. $\frac{1}{2}$ *facit* 76 the greater <u>928859</u>
angle D. But fubtracted from it makes the
angle 54 degrees: and then

as fine 54. Compar.   009205
to 117 $\frac{4}{10}$:   206967
fo fine 50 degrees.   988425
to C D 111 $\frac{2}{10}$ <u>204597</u>

CHAP.

CHAP. XX.

Of altitudes and distances celestial by the Pandoron
or Quadrant.

FOr taking of altitudes and distances celestial, or altitudes
terrestrial, it is a matter of necessity, that besides your
Quadrant and three-legg'd foot, you get also a neck or piece
of close-grain'd wood, whose Diameter may be about three
inches, or somewhat more. Let the nether end be turned with
a socket, that instead of the socket of your Table you may
put on that, so that it may turn on the top of the staff as the
socket doth, having also a screw-pin in the side of it, to hold
it at any situation. Also about two or three inches below the
top turn it like a bowl, in the midst whereof bore an hole
with an inch-wimble, to which fit a pin of the same wood, so
hard both driven in and glewed in that it stirs not, but let one
end thereof be so big and so long as to fit the brass socket,
that the socket may turn very stiff about it; and let the little
end of the pin reach past the hole of the bowl, almost the
depth of the socket, and then you may fit that end of the
pin either to that or any other Instrument, by glewing upon it
a piece of its own wood, turn'd like a little salve-box; then
upon this pin put the socket of your Instrument, and work as
followeth.

To take the altitude of the Sun.

Take the string of your plummet in your hand, and apply
it to the edge of your Instrument, and hang it plumb: then
screw it fast, then move the ruler with sights up and down, till
the Sun shining through the sight next the limb, the shadow of
the thread run streight along the rule, then look how many
degrees are between the edge of the rule, and the bottom of
the limb, so many degrees is the height of the Sun: and this
you may do by setting it on a stool.

To take the height of a star.

To do this, having hanged your Instrument on the pin of

the

the neck, and plumbed one edge by the light of a candle, look
by the edges of both fights, moving the ruler till you fee the
ftar defired in a ftreight line with them both, then fcrew the
ruler, and take down the Table, accounting the degrees from
the bottom to the edge of the rule for the height of the ftar.

To take the diftance of two ftars howfoever fituate.

If both be near the Horizon and near of one altitude, and
within 90 degrees of each other, you need not ufe the neck at
all, but onely lay your ruler on the beginning of the degrees,
then fcrew it, and turn the Table till by both fights you fee
one of the ftars; then faften the Table, and move the fights
to the other ftar, and the degrees on the limb of the fiduciall
edge of the rule gives their diftance.

If they be both in one and the fame half of a vertical cir-
cle, take both their heights as afore, fubtract the leffer altitude
from the greater, you have your defire. If they are in feverall
halfs of the vertical circle, take the complements of both their
heights, and add them together, *& actum eft.*

But if they lie aflope, and yet are within 90 degrees one of
another, then befides the foot and Quadrant, or Pandoron,
get you two round fticks as big as your thumb, about fix foot
long apiece, fharpen their little ends, and nayl their great ends
together within five or fix inches of the top, with one nayl
onely, that they may open and fhut like a pair of tongs; alfo
you fhall take a joynd-ftool and cufhion, and having put the
neck upon the foot, and the Pandoron on the pin of the neck,
clofe the three feet together with your right-hand, and lay
them on the cufhion, and with your left hand under-fet the
neck with the tongs, opening and fhutting them as need is, or
fetting them nearer or further from you as need is, all with the
fame hand, and turning it aflope with the right hand. Then
having firft placed the fights at the beginning of the degrees,
turn it till by the edges of both fights you fee one of the ftars
you defire; then keep the Table faft there, and move the fights
till by them you fee the other ftar, *& voti compos eris.*

<div align="right">CHAP.</div>

CHAP. XXI.

Of taking of altitudes terrestrial by the Quadrant.

THere are divers ways whereby thefe altitudes may be dif-
covered, whether they be perpendicular, as properly they
fignifie, or Hypotenufes, or bafes : for all of them are com-
prehended under the notion of *Altitude*, becaufe the bafes
may be as well found by the help of the perpendiculars, as per-
pendiculars by the help of bafes, and any of thefe may be
found feverall ways by the Pandoron, either as it is a Qua-
drant, or as it is a Geometrical Quadrat: of either of which
we will lay down fome Problemes, and firft as it is a Qua-
drant.

Probl. I. *A diftance being given and the angle of the bafe,*
to finde an altitude.

Meafure the diftance A C 200,
and the angle A 29 deg. 40 min. by
your *Pandoron* , the Complement
wherof is the angle B 60 d. 20 m. *ergò*
as fine A B C 60 d. 20 m. 993898
is to the line A D 200. 230 03
fo fine B A C 29 d. 40 m. 969496
to C B 114 (03. 205700
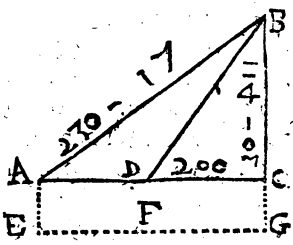
II. *Likewife the height C B given , to finde A C the*
diftance.

As B A C 29 deg. 40 min. 969496
is to C B 114 (03. 230103
fo B 60 deg. 20 min. 993898
to A C 200. 230103

To finde either of them by the fcale and compaffes, having
the angle A, and diftance A C.

Firft draw the line A C, fet from A toward C 200 of fome
fcale of eq all parts, upon C erect a perpendicular, and upon
A make an angle of 29 deg. 40 min. which line will meet
C B,

C B, and you fhall finde C B 114 *feré*. So meafuring the height C B, and the angle B, and plotting it, you fhall have A C 200.

III. *The height B C and angle A being given, to finde the Hypotenuse A B.*

As A 29 deg. 40 min. to B C the height 114 (03: fo A C B 90 deg. to A B 230 (17. *To finde it by the fcale.* Draw the line A C let it be 200 of equall parts, upon C erect the perpendicular B C, and on A make an angle of 29 deg. 40 min. fo the Hypotenufe A B wilbe 230 (17.

The part of the diftance D A in the fame diagram being known to finde D C or A C. Let A D or E F be 90 foot and I defire F G or D C, but I cannot meafure it for impediments, therefore firft take the angle of altitude B at both ftations A and D, at A I finde A 29 deg. 40 min. fo that the angle C B A is 60 deg. 20 min. at D I find the fame angle D 46 deg. and D B C 44 deg. fubtract 44 deg. from 60 deg. 20 min. refteth A B D 16 deg. 20 min. then fay, As fine A B D 16 deg. 20 min. to A D 90 foot: fo is B A D 29 deg. 40 min. to D B 158 ⁴⁄₁₀. Then again, As 90 to B D 158 ⁴⁄₁₀: fo is D B C 44 deg. to D C 110, which added to 90 A D makes A C 200, as afore. By the fcale thus, draw the lines A C and A B *ad infinitum*, making the angle 29 deg. 40 min. then fet 90 feet from A in the line A C to D where you found the angle D B C to be 46 deg. becaufe the angle C D B is 44, for they are the complements one of the other, therefore plot the angle B D C and it will be 46 deg. and the B D 158 (4: then from B let fall a perpendicular upon A C, and it cuts it at C making D C 110 and A C 200 as before. To let this perpendicular fall divide either A B or D B into two equall parts, and with the compaß at that widenefs fet one foot in the interfection and the other in the line D C at C and there falls the perpendicular B C and the end of the line A C.

Likewife any part of the altitude being known, the reft of it may be found by turning the height into the diftance, and the diftance into the height.

Any

Any part of the diftance being known to finde the Hypote-
nufe. In the former diagram, fubtract the angle B D C 46 deg.
out of 180 deg. or (which is all one) add D B C 44 deg. to
C 90. there refts the obtufe angle B D C 134, to which add the
angle B A D 29 deg. 40 min. they make 163 deg. 40 min.
whofe complement to 180 is the angle A B D 16 deg. 20 min.
Now fay, As fine 16 deg. 20 min. is to 90 feet: fo is 134 deg.
which becaufe it is obtufe above 90 deg. you muft fubtract it
from 180, refts 46 deg. the acute angle B D C, and they give
the Hypotenufe A B 230 (17. And for D B fay, As fine A B D
16 deg. 20 min. to 90 feet: fo is fine D A B 29 deg. 40 min.
to D B 158 (4. for the plotting, if you mark how it is done
in the laft probleme, you cannot fail in this. But as (for ta-
king all thefe Altitudes aforefaid, confidering they are onely
to be taken upon plain ground and that the chiefeft ufe of this
skill is to take fuch altitudes as ftand upon an hill: (For al-
though feverall writers talk of taking the heights of Caftles,
Towers, Forts, &c. yet they defcribe them all as if they were
upon plain ground, whereas it is a common thing to finde a
Caftle on hilly ground: fo that I know not one Author that
gives any rules how to find the height of a Caftle ftanding
on the top of an hill.) I have therefore here in this diagram
demonftrated the fame. Let A C F be
an hill on which the Caftle C D ftand-
eth; I fet up my Quadrant at A and
I finde the line A C which is the a-

scent of the hill to the bottom of the Castle 28 deg. of height,
and the angle F A D 31 deg. to the top, the difference is
3 deg. which is the angle C A D: then I measure up in the
line A C to B 200 foot: where if you suppose another hori-
zontal B G parallel to A F, then must the angle G B C be
28 deg. as before, by *Euclid, prop.* 28. *Element.* 1. there also I
take the top line by my Quadrant, *viz.* B D, and finde the al-
titude thereof G B D 32 deg. the difference is 4 deg. which
is the angle G B D and that taken out of 180 deg. leaves the
angle D B A 176 deg. by *prop.* 13. *Element.* 1. to which add
C A D 3 deg. *facit* 179 deg. that taken out of 180 deg. leaves
A D B 1 deg. also add C B G 28 deg. to C G B 90 deg.
they make 118 deg. which taken from 180 deg. rests 62. B C G
prop. 49. *Element.* 1. and the same 118 deg. is the angle
D C B, for which in the analogie we take 62 the acute angle,
or complement to 180 deg. for the obtuse. Now to finde the
sides, say.

As sine A D B 1 deg. Compar.　1758144
to A B 200.　　　　　　　　　2303010
so sine C A D 3 deg.　　　　　8718800
to B D 600.　　　　　　　　　2777974

　Secondly, As sine D C B
118 deg. *vel* 62 deg. Compar.　9954164
to B D 600.　　　　　　　　　2777974
so sine C B D 4 deg.　　　　　8843588
to C D 47½ the Castles height.　1675726

　But this will not be found very exactly by plotting, by reason
of the meeting of the acute angles, & the lines running so far
one in another, especially A D and B D, that you cannot di-
stinguish their intersection, and thus also we have not onely
found the height of the Castle 47½ but also the rest of the hill
line by measuring A B 200 a part of the same line, and up an
hill also, for if you add B C D 118 deg. to A B D 4 deg. they
make 122: which subtracted from 180 deg. rests 58 deg. the
　　　　　　　　　　　　　　　　　　　　　angle

angle $C\,D\,B$. Then fay,

As $C\,B\,D$ 4 deg. Compar.   1 1 5 6 4 1 6
to $C\,D$ 47 ½: 1 6 7 5 7 2 6
fo $C\,D\,B$ 58 deg.   9 9 2 8 4 2 0
to $B\,C$ 776 (2.   2 7 6 0 5 6 2

which added to A B 200, gives the whole line 976 (2. And
now if you intend to begin your mine at B, your beſt way is
to go 10 or 12 foot. firſt in B G line, as you ghueſs half the
breadth of the fort to K, and thence draw the line K L paral-
lel to B C, which two lines are of equal length. *Elem.* 1. *prop.*
26. and then keep that line up to the top; for that muſt be
your line of direction, that if by occaſion of ſome rock, or
other impediment, you are forced to raiſe, or ſink, or go ſide-
ways, you may by help of this line drawn on paper with a large
ſcale, keeping account ſtil how far you are gone in the ſaid line,
and by help of the Quadrant at each ſtation, be able to plot
how much you are above or below your line of direction, and
by help of your Needle to finde how far you are gone ſide-
ways ; but your beſt way is to draw one line for aſcents and
deſcents, and another for variations ſide-ways, beſides your
line of direction, and it will not be labour in vain alſo, beſide
both theſe lines to ſet down in a note-book the inches raiſed
by themſelves above the line of direction, and the fallings by
themſelves, that ſo you may ſubtract the ſumm of the leſſer
from the ſumm of the greater ; juſt as in conveying of water,
whereof we ſhall ſpeak anon. Likewiſe ſet down the variati-
ons on the right-hand by themſelves, and thoſe on the left by
themſelves, and againſt what part of your directing-line each
of them is. Thus when you come within ten or twelve foot of
the floor, there begin your Oven.

I 2   CHAP.

CHAP. XXII.

Of taking altitudes terreſtrial by the Quadrant,
or the Pandoron.

THE ſides of the
Quadrat S K,
& K L (of which S K
is called of *Pitiſcus*
the right ſhadow, &
K L the contrary)
are nothing elſe but
the natural tangents
of arches leſs then a
Quadrant; which if
each of theſe ſides be divided by decimal diviſion, they will
agree with the Tables of natural tangents, either of *Blunde-
vil,* or *Pitiſcus,* which holds in the contrary ſhadow; but be-
cauſe the contrary ſhadow is not continued ſtreight on, but is
turned again at 1000 therefore there it begins to be reckoned
back again to O, as Mr. *Wingates,* or Mr. *Gunthers* rule is. So
that now if you turn A S down-ward, then K L will be the
right ſhadow.

   But to diſtinguiſh the right and contrary ſhadow, you
muſt firſt conſider whether your Quadrant goeth with a
moveable rule and ſight upon it, as *Pitiſcus* hath it; if ſo,
then one edge is always plumb'd, then the right ſhadow is the
horizontal above, and the left ſhadow is perpendicular; which
if the ruler falls on it, the thing ſeen is lower then 1000 parts
by his account. But by *Gunthers* Quadrat, which is with a
plummet onely, and the centre upward, the plummet falls in
the right ſhadow, when the thing is ſeen lower then 45 degr.
of the Quadrant, or a 1000 of the Quadrat. But Mr. *Gun-
ther* hath (in my judgement) expreſſed himſelf in doubtfull
terms, in defining right and contrary ſhadow, where he ſaith
that the right ſhadow of a Quadrat is that which is neareſt

to
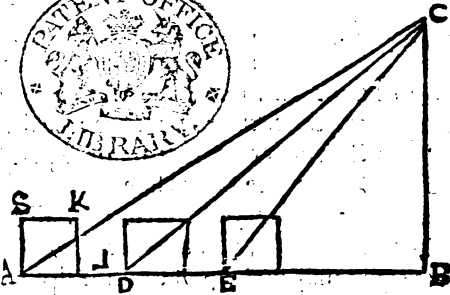
to the horizontal. May I not well ask what horizontal line
he doth mean ? or where is there an horizontal line in that
kinde of Quadrat ? Certainly there is none at all ; what doth
he then mean ? he meaneth that that is the right shadow, that
in taking any height lieth most level, and so it agreeth with
Pitiscus: and although *Gunthers* rules are fully sufficient for
his Quadrant, yet will they not serve to *Pitiscus* without some
alteration. We will therefore beg leave of Mr. *Gunther* to
borrow his rules, and to fit them to both.

1. *Any point being given to finde whether it be level with the edge,* by Gunthers, *thus.*

If looking through the sights, and seeing your desired
mark, the plummet falls in the the down-right line next to
you, then it is right and level with the eye. But by the other,
fix the ruler on the lower side to the beginning of the degrees;
then plumb the other edge next the centre; if then by looking
through the sights, you espie the mark, then is it level with the
bottom of the Table; or if you see by the top, then it is level
with it.

2. *To finde an height at one observation* by Gunthers.

If looking through the sights and seeing the mark, the
plummet falling on 100 of the Quadrat, or 45 degrees of the
Quadrant, then the distance between the mark that is level
with your eye it self, is equal to the height above the said
mark. But if the plummet falling there, you see below it
through the sights, then go further off; if above, then go
nearer.

By the other, First, fasten your sights on 100 or 45 degr.
of the Quadrant; then having plumb'd the side next you, go
further off, or nearer, till you see the top desired through the
sights of the ruler: then by looking by the over-edge of the
Quadrat, see some mark by it also : so the distance from it to
your eye shall give the height from the mark to the top desi-
red. And what is here said of 100 of the Quadrat to give
the true distance, understand the same, the plummet falling on
50 of right shadow, and the ruler on 50 of contrary, then to

give a diftance double to the height: if 25, the height is but a
quarter of the diftance; if 75, then three quarters: for as of-
ten as the plummet falleth on the parts of the right fhadow,
or the ruler in the other on the contrary fhadow, as 100 to
the parts on which the thread falleth, or rule cutteth; fo is the
diftance to the height required: and contrarily, as the parts cut
by the thread or ruler in the faid fhadows are to 100, fo is the
height to the diftance. But when the thread fhall fall on the
parts of the contrary fhadow, or the ruler on the right; if
they fall on fiftie parts, the height is double to the diftance; if
on 25, it is four times as much as the diftance : for as often as
the thread falleth on the parts of the contrary fhadow, or
the ruler on the right , as the parts cut by the thread or ruler
are to 100 ; fo is the diftance to the height; and on the con-
trary, as 100 are to the parts cut, fo is the height to the di-
ftance: and what is here faid of the height and diftance, the
fame may be underftood of the height and fhadow.

To finde the height or diftance at two obfervations by Mr. Gunthers way, by the Quadrat.

As if the place which is to be meafured might not otherwife
be approached, and yet it were required to finde the height
B C, and the diftance: Firft, I make choife of a ftation at E
(in the laft diagram) where the thread may fall on 100 parts
of the Quadrat, or 45 degrees of the Quadrant , or the ruler
cut the like parts, the diftance E B would be equal to the
height B C: then if I go further off in a direct line with the
former diftance, and make choife of a fecond ftation at D,
where the thread may fall on 50 parts of right fhadows , or
the number 50 of contrary fhadows, the diftance B D, would
be double to the height B C. Wherefore if I meafure the dif-
ference between the two ftations E and D, and this difference
E D will be equal both to the diftance E B, and to the height
B C: or if you cannot make choife of fuch ftations, I take
fuch as I may, one at D, where the thread cuts 50 parts of right
fhadow, and the rule 50 of the contrary; the fecond at A,
where they fall on 40 parts of their like fhadows. Then fup-
pofe

pose the height B C to be 100 (for easiness of calculation, though it be but 16) I finde, as 50 parts are to 100, the side of the Quadrat; so 100 the supposed height to 200, the distance B D. And as 40 parts at the second station unto 100, so 100 the supposed height to 250, the distance B A. Wherefore the difference between the two stations D and A should seem to be 50, and then if, in measuring of it you finde it more or less, the proportions will hold; as from the supposed difference to the measured difference; so from height to height, and from distance to distance : as if the difference between the two stations D and E being measured were found to be 30; As 50 the supposed difference unto 30, the true difference; so 100, the supposed height, to 60 the true height ; and 200 the supposed distance to 120 the true distance, and 250 at the second station to 150 the distance B E.

CHAP. XXIII.

To take the situation of a plain for a dial, viz. the decli-nation and reclination thereof by the Pandoron.

APply one edge of your Pandoron to the plain, and the plummet to the edge next you; if that edge be upright, the plain is upright : if it recline, take off the ruler , and apply one of the edges next the centre that are not divided to the plain, so the degree cut by the thread gives the inclination. But if it recline, then turn the centre downward, and holding that thread in your hand, moving it to and fro with your thumb upon it a little above the limb, till the thread fall on the centre (so the degree cutting the line, shall be the reclination. Or you may put on the rule, taking out the sights, turn the centre downward , and one of the sides next in to the plain, turning the rule till the thread fall in the middle of it, then the fiducial edge thereof will give the degree of reclination. But for the declination : Although you may go some-what near by help of your needle and card, if there be no

iron

iron near you, yet work as exactly as you can, I will be loth
to truft it, but rather I will go further about, and finde it by the
Azumeth; which to do, I muft firft by my Pandoron take the
angle of the wall and Sun, thus: Apply one of the edges
thereof next the centre to the plain, and turn the ruler till
the Sun fhews the fhadow of the thread of the fight next
the Sun, along the midft of the rule, then fhall the fiduciall
edge of the ruler give the degree of declination. But you
muft mark whether it be taken in the fore-noon or after-noon,
and likewife the moneth and day of the moneth: likewife you
muft at the fame moment take the Suns altitude, thus; Either
hang the Pandoron on the pin of the neck, or father fet one
of the undivided edges on a ftool, and plumb the other; then
turn the edge of the Table to the Sun, moving the ruler up
and down, till the fhadow of the thread in the fight next the
Sun fhine ftreight along the middle of the rule, fo the fiducial
edge gives the Suns altitude in the degree of the limb. Now
knowing thefe things, you may finde the Azumeth either by
calculation, or by your Pandoron, if you have *Gunthers*
Quadrant drawn on it. Firft, by calculation having the
moneth and day, you know the Suns place by this rule:

10	10	11	11	13	13	13	13	12	11	10	9
Mar.	*Apr.*	*May.*	*June.*	*July.*	*Aug.*	*Sept.*	*Octob.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*
♈	♉	♊	♋	♌	♍	♎	♏	♐	♑	♒	♓

2 tens, 2 elevens, 4 thirteens, 12, 11, 10, 9. Thefe are the
days of each moneth the Sun changeth his figne, beginning
with *March.* If the day you feek the Suns place be after the
change day in any moneth, fubtract the change day out of the
day you feek, and you have the degree of the figne of that
moneth. *Example.* I defire the Suns place *April* the 25. 16₅6.
I finde by this rule *April* 10, the Sun entred ♉, take 10 out
of 25, refts 15 : fo I conclude, the Sun is in the 15 degree of
♉ that day.

But if the day you feek be before the change day in any
moneth, then firft you muft fubtract that day from the change
day, and then the remain always from 30. So *April* the fifth
take

take five out of ten, there remaineth five; and that taken from
30, there rests 25 degr. which being it is Leap-yeare, you may
make it 26 of ♈, of the moneth preceding.

Then you muſt ſeek the Suns declination either out of ſome
Table for that purpoſe, or by this analogy: as the *Radius* to the
ſine of the Suns greateſt declination 23 degr. 30 min. ſo is the
diſtance from the neareſt Equinoctial to the declination deſi-
red. Suppoſe *April* 5. the Sun in 26 degr. of ♈, that is 26
degr. from the neareſt Equinoctial; ſay, As the *Rad.* to the ſine
of the Suns greateſt declination 23 degr. 30 min.

23 degr. 30 min.	960070
26	064184:

ſo is the diſtance from the neareſt Equinoctial to
the declination deſired 10 degr. 4 m.   924254

which becauſe it is in a Northern ſigne, as ♈ ♉ ♊ ♋ ♌ ♍,
therefore it is North declination, and is ſo much nearer then
90 degr. to the North-pole, as the Suns declination is, *viz.*
79 degr. 56 min. Now add this diſtance, the complement of
the altitude, and the complement of the latitude, all three to-
gether, and from the half ſumm ſubtract the diſtance from the
pole, and note the difference. Let us ſuppoſe the Suns altitude
taken about nine of the clock in the morning for the latitude
of 52 degr. 15 min. took by the Quadrant as you are direct-
ed in *Chap.* 20, to be 32 degr. then proceed thus; The Suns
North declin. 10 deg. 4 m. diſtance from the pole 79 d 56 m.
latitude 52 degr. 15 m. complement   37   45
the Suns altitude 32 degr. complement   58   00

Now ſay , As the *Radius* 90,   Summ   175   41
to ſine of the compl. of   half ſumm   87   50
  altit. 32 d. *i.e.* S. 58. d.   992842.   hence take   79   56
ſo coſine 52 d. 15 m. or   difference   7   54
  S. 37 d. 45 m.   978690.
to a 4ᵗʰ ſine 21 d. 17 m.   971532.

K   As

As this fourth fine 21 d. 17 m. Comp. Ar.   028467
to the S. of the half fumm 87 d. 50 m.   599969
fo is the S. of the difference 7 d. 54 m.   913813
to a feventh fine   15 d. 20 m.   ─────────
                                               1942249
Add to it the *Radius*, the half   (971124 30 d. 58 m.)
thereof is the mean proportional, being the fine of 30 d. 58 m.
whofe comp. is 59 d. 2 m. that doubled is 118 d. 4 m. the
Azumeth from the North.

Now fuppofe you had taken the wall and Sun 40 deg. that
muft always be fet backward in the courfe of the Sun from the
Sun or *Azumeth*: *viz.* from Weft to South, from South to
Eaft, &c. fo then our angle of wall and Sun being taken in
the morning, the Sun muft needs be on the Eaft-fide of the Me-
ridian line, and being found 118 deg. 4 min. from the North,
that is 28 deg. 4 min. beyond the Eaft, now if I fet back 40,
that is take 28 deg. 4 min. out of 40.there refts 11 deg. 56 min.
from the Eaft toward the North; and there
was the Sun when firft it fhone on the wall
thence draw your wall-line through the
centre, and always the diftance between
the Eaft or Weft-line and the wall-line is
the declination defired 11 deg. 56 min. as
afore in *Chap.* 14. Now becaufe the Sun
fhines on it at noon: therefore it is a South diall, and becaufe
the Sun fhines on it longer in the fore-noon then in the after-
noon, therefore it is a South declining Eaft-ward 11 deg. 56 m.
But if having the day of the moneth *April* 5, you take it in
the morning and the Suns altitude 32 deg. and the angle of the
wall and Sun 40 deg. as afore, and you have *Gunthers* Qua-
drant drawn on your Quadrant for your own latitude, and
that you have your line of the Suns declination drawn on the
ruler as well as on the left-fide of the Quadrant. *And* thus
you defire to know all things by it without any calculation;
Firft lay your ruler on the day of the moneth, fee what degree
of declination is cut by that 12 of clock hour which is proper
to the time, whether it be fummer or winter, carrie that de-
gree
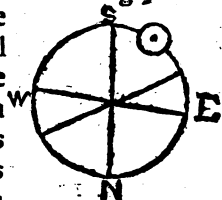
gree to the Ecliptique and you have the Suns place. Also carrie
it or take the same degree in the declinations on the left side,
it gives the time of Sun-rising in the fore-noon-hours and the
setting in the after-noon. Lay the ruler on the deg. of the Suns
altitude in the limb reckond from the left-hand, and your
deg. of declination gives the hour of the day:carrie it to the
right-side and reckon the altitude from thence, and the same
deg. of declination gives the Azumeth either for summer or
winter: but not from the North, but from the South. Then
may you cast up your declination of the wall, having your A-
zumeth as you did before, or else finde it by help of a scale of
chords drawn toward the top of the Quadrant on the right
hand with a circle of the Suns *Radius* divided with two cross
Diameters, and marked with East, South, West, North, and
thereby with your compasses take your distances from your
scale and set them out upon your circle. Further if you bring
your deg. of declination upon your ruler to the Horizon, you
have the Suns Amplitude in the Horizon also lay your rule on
the place of the Sun in the Ecliptique it gives its right ascenti-
on. If you bring your deg. of declination to the Horizon, the
edge of the rule shewes in the limb the Ascentionall difference;
which known, turn this Ascentionall difference into time, al-
lowing an hour for each 15 deg. and 4 min. of an hour for
each deg. it shews how long the Sun riseth before six of the
clock in summer, and after six in winter. If you bring the de-
gree of the Suns declination in summer to any of the winter
hours,and for morning hours of the one take the afternoon
hours of the other, it gives in the limb the depression of the
Sun below the Horizon. Bring the ruler to 18 deg. of the
limb, and see where in summer the deg. of declination cuts
the winter after-noon hours, and that hour is the break of the
day: but in the fore-noon hours for day-light shutting in and
the contrary; lay your ruler on the day of the moneth, make
a mark upon the rule, where it cuts the sixth hour in *Faelr*
Quadrant, then lay your ruler on the Suns altitude in the limb
and your mark,which give you the planetary hour. But it was

not my purpose to shew all that may be wrought by the Pandoron, so I may have work enough for a good while; but onely to shew the use of it in measuring of land, taking of altitudes, & conveying of water. They that desire more of the making & use of it in these things, let them see *Gunthers* book it self, or for the use of it let them see a little book thereof by it self sold by Mʳ. *Moxon* at the signe of the *Atlas* in *Corn-hil*, together with printed papers of the said Quadrant for *London*-latitude onely. But if any desire the making of it for other latitudes, let them peruse my *Fale redivivus* or *Sun-shine of shadows*, wherein they shall finde *Gunthers* first chapter touching the making of this Quadrant explained, with Tables to make it for all latitudes throughout all *England*, and also Tables for all Horizontall dials, and for all erect South and North, East and West, and all decliners from one deg. to 90 for each whole deg. as also for all Polars, and all these for nine severall latitudes from 50 to 56, as also divers others curious dials Quadrants and Nocturnals.

<center>CHAP. XXIV.</center>

<center>*Of conveying water.*</center>

I Find great difference among our best Authours concerning the odds or difference between the true and water-levell. Mʳ *Hopton* in his 24ᵗʰ chapter of his *Topographical-glass* saith, that after the ordinarie manner to bring it in pipes, the ground must be lower by 4½ inches for each mile, then at the spring-head: so that I suppose his meaning is, if it be 10 miles, it must be each mile alike, *viz.* ten times 4 and ½ that is 45 inches, or three feet nine inches; but neither demonstrates it nor gives any reason for it. Again Mʳ *Diggs* in his *Pantometria* (*lib.1.chap.3.*) saith that in ten miles distance, the water-level is below the true nine paces, four foot eleven inches: which if every mile give a like we have five foot in a mile. And because there is such a vast difference, I will lay down both *Diggs* his rule to finde it, and his example, as he calculated it in his own words:

words: his rule is thus. First it behoveth you to get the diſtance of the fountain from the place whither you will convey the water, which diſtance you ſhall multiply by it ſelf, adding the off-come to the ſquare of the earths ſemidimetient, and from the ſumm extract the ſquare-root, and out of which root ſubtract the earths ſemi-diameter, the remain is the difference deſired. His example is this. Admit the diſtance BE
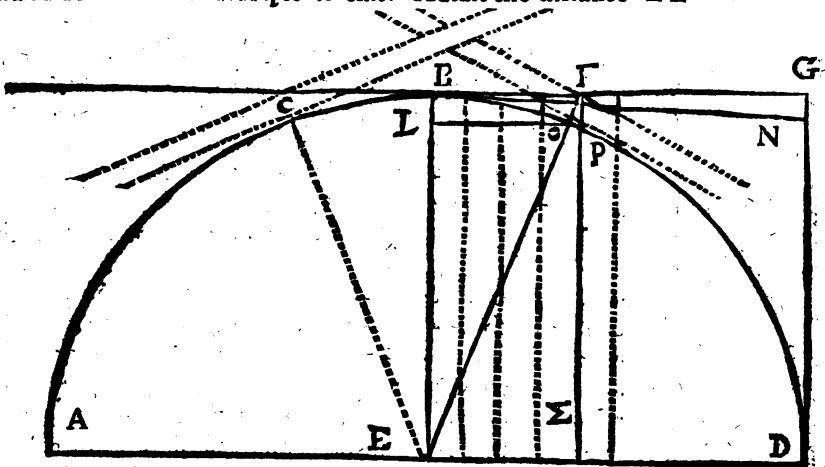
10. miles. The ſemi-diameter of the earth E B 5011 *Itali-an* miles. But how the ſemi-diameter can be 5011 *Italian* miles, I cannot imagine: for if the ſemi-diameter be 5011, the whole diameter muſt be 10022, which multiplied by 22 gives 220484: that divided by 7 gives 31498 the circumference, which divided by 360 deg. gives 87½ *Italian* miles to a degree.

Now becauſe an *Italian* mile is 1000 paſes, and an *Engliſh* mile 1056, ſay, As 1056, 1000:87½. 82. So that by this account there ſhould be 82 *Engliſh* miles to a degree, which was never heard of; our common account is but 60. our modern Artiſts hold 66, the moſt that ever was reckoned of is leſs then 69, but this is 13 more.

But ſuppoſe the ſemi-diameter to be, as he ſaith, 5011 and
K 3   the

the diftance 10 miles, each mile 1000 pafes, each pafe five
foot; the fquare of 10000 pafes, that is 10 miles, the diftance
is 100000000, and the femi-diameter in pafes is 5011000,
the fquare thereof is 25. 1101, 2100, 0000, add both thefe
fquares together, they make   25110221000000

hence extract the fquare-root, it is 5011009 $\frac{9801919}{10012019}$

If hence you fubtract the femi-diameter in pafes 5011000,
there refts 9 $\frac{9801919}{10012019}$ or 10 pafes *ferè*, that is 50 foot,
whereas *Hopton* hath 10 lines 4½, that is 45 inches, or 3 foot
9 inches; fo 40 miles diftance requires 48½ poles. Now whe-
ther we reckon the femi-diameter 5011 *Italian* miles, or 3436
Englifh miles, 60 miles to a degree, or 3780 *Englifh* miles,
66 to a degree, that decides not the controverfie, whether of
thefe either *Hopton* or *Diggs* is right, or either of them both,
or neither of them both.

    Firft for *Hopton* I cannot think him to be true; for that he
fheweth no reafon, nor demonftration of it: and although 4
½ inches may ferve the firft mile, yet I cannot think every mile
is alike, for this water-level muft of neceffitie be fuppofed to
be a right line drawn, or running from the top of the earths
hemifphear, there making an acute angle with the tangent, and
running between the faid tangent and the earths Perimeter,
fuch as the tangent-line B G in the laft diagram. Now there
may be infinite fuch lines fuppofed between the faid tangent
and the earths circumference, and is there not as good reafon
for all, as for any, for one as for another; there muft be a
terminus ad quem given, as well as a *terminus à quo*.

    Befides all this, all thefe lines will be in the aire above the
earth; but the water muft not run above the earth (that is
Gods decree) but in the earths Perimeter.

    Therefore this difference of levels muft needs be a line fal-
ling from the tangent-line, that runneth from the top of the
earth to any diftance defired, which (according to *Diggs*) is the
excefs of an Hypotenufal above the *Radius*, or earths femi-dia-
meter, running from the centre of the earth to any diftance of
                          miles,

miles, poles, paſes, or feet deſired ; or it is the natural ſecant of the arch which it cutteth in meeting with any diſtance of the ſaid tangent aſſigned.

In the former diagram, let A B C D repreſent the upper hemiſphear of the earth, E the centre, E B or E D, or any of the pricked parallels falling on E D, conceive them all to be ſemidiameters of the earth, B the top of the earth, B G the tangent line , B N a line in the aire between the tangent and the circumference of the earth : now for that it is impoſſible to make his example to appear to the eye out of the ſaid diagram, both by reaſon the ſaid ſecant falls ſo near the ſemi-diameter E B ; and that there is no apparent difference between the ſaid tangent and the earths Perimeter, let us ſuppoſe the ſemi-diameter of the earth both E B and B G, to be either of them 100 miles, and let the diſtance B F be 40 miles, then the ſecant or Hypotenuſe is E F, which for that it is longer by F O. then E B; therefore F O. is the difference of the levels found, as is before declared.

And although *Digs* neither doth ſet down the reaſon of his finding it after this manner, yet it is eaſily perceived of every one that hath any underſtanding in triangles : for it is but the finding out of the Hypotenuſe of a rectangle right-line triangle, having the two leggs given, and it may alſo be wrought by the Logarithmes; but with little leſs labour.

Some think alſo that the line F P is the difference of the levels : but ſince the difference in 100 miles is almoſt inſenſible between thoſe two, we will onely demonſtrate it to you, and then let every man uſe his own diſcretion.

Let
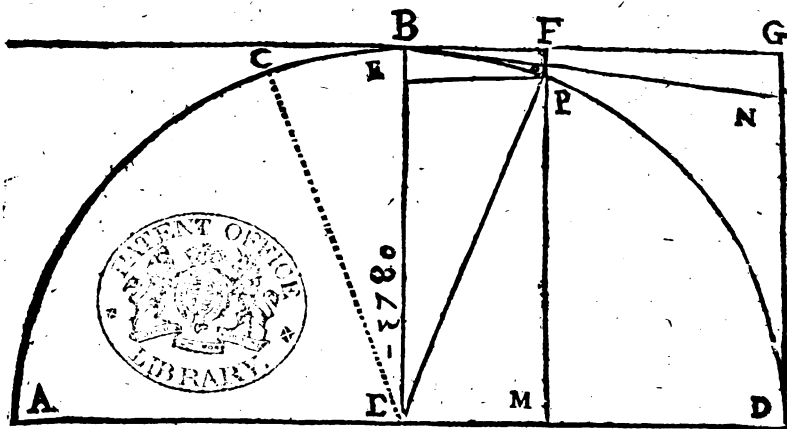
Let us suppose in this diagram **A B F D** the upper hemi-sphear of the earth, whose semi-diameter E B is 3780 *English* miles, 66 to a degree, to which is equal both B G, and F M, and E D: for E D is equal to E B, *Element. 1. Defin. 15.* and B G and E D. *Element. 1 Prop. 36.* therefore it is equal to E B, *Axiom. 1. Element. 1.* and F M is equal to E B, *Elem. 1. Def. 15.* and B G, and ED *Elem. 1. Prop. 36.* therefore equal to E B, *Axiom. 1. Elem. 1.* and M E is equal to F B, *Elem. 1. Prop. 36.* And because in the other example we could not distinguish one thing from another, because of the near-ness of things one to another; therefore we will take the di-stance B F, which suppose 1500 miles, which (to save labour) we will keep still in miles.

First therefore, to find E O, E F, and O F, first E O is ⹀ to E B, *Elem. 1. Def. 15.*

for E F square E B, 3780. it is   14288400.
also square B F, 1500, it makes   2290000.
these added make   16538400.
whose square root E F is *English* miles   4066 $\frac{2}{4}$.
Whence take E B, equal to E O. *Elem. 1. Def. 15.*   3780.
resteth O F, *English* miles   286 $\frac{2}{4}$.
               Then

Then to finde B E F.

As 3780 Comp. Ar.   642250
     is to *Radius* :
so is 1500   317609.
     to tangent 21 d. 39 m. of B E F,   959859.
whose arch is B O, whose natural tangent B F is 39694 parts,
and that is equal to L P. *Elem.* 1. *Prop.* 36. which is sine of
23 d. 24 m.   for as   3780   3,577-92.
                        to Rad. So 1500   13,176091.
                        to S. 29 d. 24. m.   9,598599.
whose complement is 66 degr. 36 m. and the sine thereof M P
91775, and the versed sine thereof F P is equal to L B 8225
parts.

And to reduce them into miles, say, 100000. 9225 : : 3780.
311. F P. whence take O F 286 $\frac{1}{4}$, the difference is 24 $\frac{1}{4}$ miles
difference in 1500.

But how can we do so ? since M^r. *Frost* (then Manciple of
Emmanuel Colledge in *Cambridge,* since Sword-bearer to the
Lord Maior, and since that a Secretary to the Council of State,
a man beyond all exception for integrity of life, an excellent
Mathematician, one that brought the water from the Spittle-
house to *Emmanuel,* and thence to *Chrifts* Colledge,) told
me, that he came upon a time (by mere accident) in the Fenns
to a place where an old river had run down some four miles,
and was brought four miles back again in a new cut, and when
they met, the water in the old was but four inches above the
water in the new. Now the question is this, Doth not this
confirm, or rather out-vie *Hoptons* tenent of four inches and
an half to a mile, seeing here is but four inches in eight miles,
which is half an inch for a mile ? Truly I think not , for
wheresoever you conceive your self to be, there is the true top
of the earth: if there you are withall neither above nor be-
low the true circumference of the earth, such as I conceive the
Fenns for the most part to be, having formerly been made le-
vel, as being part of the sea, I see not but that the water may

L   run

run both ways as well as in the sea, if not all four ways, as well as the four rivers in the garden of *Eden*. And by this means if the meeting place was not some bowing of the earth of four inches thick, why might not they have met of equal height.

Every one (I suppose) will confess with me, that I being at B, the water will run to C, and to o; and if you turn C uppermost, will it not run from C to B as well? are no places uppermost but B, because I am not there: certainly I am some wonderfull vertuous fellow: well, I will get thither, and then it will run thither. If any dislike this answer, let him give us a better.

CHAP. XXV.

Of Instruments for conveying of water, and their use.

IF your distance be not above an 100 poles or thereabouts, you may hang your Pandoron or Quadrant on the pin of the neck, and then set up a staff, or rather let one hold it upright, with his face toward you at the head of the water, moving a sheet of paper up or down, as you, standing 8 or 10 pole off in the water-way, shall direct him by the signe of your hand, till you having there set up your Instrument, and plumb'd it truly level, you see either through the sights, or over side of the Quadrant, the nether edge of the paper; having first screwed the ruler fast, and placed the thin edge thereof precisely upon the upper Horizontal line of the Instrument: now take not your stations above 10 pole at the most from your standings, both in regard of the refractions of the air which will deceive your sight, as also for that though your Instruments be never so true, yet if you fail either in your plumbing it, or in laying your ruler but one tenth part of an inch false, (which is easily done) you will fail so many tenths as are Tables lengths between your Table & your staff; which if your Table be 18 inches *Radius*, and your station ten pole, will come to eleven inches in that distance, enough to marr your whole work.

Now

Now he having placed his paper, let him bring it staff and all to you without stirring it, and then you having a two-foot rule, and a stick in your hand about four foot and an half long, measure first the height of your sights above the ground, also from the bottom of his staff to the nether edge of the paper: if both be alike, then those two places are level; if not, then see which is most, and how many inches there are odds: if his be more then yours, then your ground is risen more then his, so many inches as the difference is ; but if you are more then he, then you are lower, and then the water will run, or else not. For it will never run higher naturally upward, unless your former falls do countervail your rise.

Having thus found the difference, you must in a note-book make two Tables, one for the risings, and another for the falls at each station, with their titles of rising and falling over them, and the number of inches at each station, and the number of the stations on the left hand : and you may do well also to measure the distance with a chain, and set down on the right side the distance from the spring-head, and at each station to observe some mark. And having all done, you must cast up the Tables each by it self, the inches of the falls by themselves, and the ascents by themselves : then subtract the lesser total from the greater; if the descents be most, it will run, so that there be no station in the way that is higher then the spring-head : which if you suspect, cast up both your Tables onely so far, and you may easily know. Yet if it should, that will not cut you off altogether : for though you cannot help your self by digging deep; yet it is hard, if you cannot by going about.

Having thus measured and found the difference, you may for triall-sake exchange places, and let him stand where you stood, and do you stand at the fountain. If there you finde the descent to be the same as you did before, all is right: and that you will hardly do, unless your Instrument be both very large, and very exact.

But now you must know, that there is a difference between

your being between the spring-head and him, and his being between it and you : for now, if he be most, he is lowest, for always he that is most is lowest.

Now if you will, you may either your self go on forward, and let your assistant stand; or rather your self stand there still, if you remove not to prove, as I said, and so you may take two distances at one station ; especially, if you have two assistants, and all you three are in one direct line: so if you keep your work in a streight line, if two assistants stand in the water-way, if you stand in the middle in a' right-line, if you see to one of them, you see to the other without stirring the Instrument any ways.

Again, so far as you go in a direct line, if you have once set two marks level, you may easily by them set up a third and fourth as far as it goeth in a streight line, and when it turns then use your Instrument as afore.

Also it so falls out that water is to be brought out of some pond or level water: if you bore holes in two boards like trenchers, and sharpen sticks of equal height with white papers on them, if the boards lying in the water, two assistants hold the sticks that you may set up a third in a streight line with them, with a mark upon it agreeing level with the other marks; if they are too high remove them lower, but both alike, or your own higher, *& contrá*: onely take just notice how high the two are above the water, and then go on with a fourth and fifth so long as you go in a streight line, and then use the Instrument as afore.

Also it may happen that you desire to bring water from some spring or head, but you have neither level, nor level water, nor streight water-way, but you suppose it will run, and the way is not long, and you would willingly try ;

First then begin at the head, and make a little trench of three or four pole long towards the way that it will run streight, whether this be streight or crooked it matters not, then let run so much water as may onely fill this trench : if you finde it dry, or shallower of water at the head, then at the
other

other end, it shews the ground to be falling; then do the like
with three or four poles more, still making the water to fol-
low you, till you be gone three or four pole in your streight
line, then having fill'd it that the water may stand level at both
ends, stick up two sticks, one at one end, the other at the o-
ther, of equal length about four foot above the water, then
go on 10 or 12 pole in the same line, where set up a mark, so
that you standing behinde it, and looking to the middle mark,
either all the tops or all the bottoms, according to which you
measured your equal heights, may agree, then if that stick be
longer beneath the mark then the other two, it shews descent:
if any rising places be in the midst, you may easily finde their
rise by setting up a stick, and measuring it as before.

But for long distances, although I have fully shewn the use
of it already in the Pandoron, yet because of the shortness of
the lines, there is as little reason for to use that in doubtfull
cases, as for one to shoot at wild-geese a furlong off with a
pistol, or to take on observation with a Quadrant of 3 inches
Radius. I will therefore here give the making of a most ex-
cellent Instrument, soon made, and cheap enough. First, let

A B be a piece of deal, or some
light and soft wood, about two
inches square, or inch and half,
and seven or eight foot long: in
the upper side thereof let there
be a groove or chanel made
with a round plane, like the
chanel for a bed-cord, about an
inch wide, and of like depth:
likewise let E D and F D be two
pieces of an inch broad a-
piece, and a foot long, and half an inch thick a piece; to make
brackets to be lapp'd one over the other at D, and likewise the
beam with screw-pins made of pieces of old keys, to screw
onely into the wood, without any forils at all, and likewise an
other piece D G of six foot long, a quarter of an inch thick,

*For find-
ing how
high you
may set
your cock
in a house,
see the last
page of
this Book.*

and an inch broad, with a jage-stroke down something
toward one side of it, that you make the screw-holes beside
it: this must be screwed together with the two brackets, within
an inch of the end, all three with one pin. Also you must
screw it to the beam at C, that the jage-stroke may be exact-
ly perpendicular to the beam: this hole must be bored close
to the bottom of the groove, and in the bottom of the
beam you may glew on a piece of some eighteen inches long,
in the middle, of two inches broad and an inch thick, to
thicken it; because just in the middle you must make an hole
so big and so deep, that it may fit to go on the top of the
three-foot staff, or foot of the Pandoron, when both it and
the neck are took off; yet you must take heed you bore it not
quite to the groove, and let it go on as stiff as you can possi-
bly. Also at either end glew on a piece of an inch thick, eight
inches long, and of the breadth of the beam, or nayl them
on to the beam, and cut the bases true and square : then get
two thin sights made after the manner of this figure, eight
inches long, and nayl them on to the ends at A B, so
that the sight-hole of the one may look over the flat
of the other, and when you will use it put it on the
staff, and put on a plummet and thread of the length
of the jage-stroke ; then set it up and move it by the
feet till the plummet hangs right with the jage-stroke,
then fill the groove with water ; if it be truly plumb'd
and that set perpendicular to the beam, then may you fill the
groove so full of water, that it will rise so high above the
wood at both ends, that you may thrust a needle through
it close to the beam, and yet the water will be above the
needle.

CHAP. XXVI.

Of flowing of grounds.

Mine intent is not here to describe the manner of making
engines, sluces, *Cochlea*, mills, &c. to mount the wa-
ter

ter withall, as being too great a charge for a small piece of
ground of nine or ten acres: for it often falls out, that if a
piece of ground be ten acres, yet all of it will not be over-
flowed; so that, if you bestow any great cost, we may say
—*materiam superabit opus:* yet this I have seen in one of these
dry years in a meadow near *Hartford*, that one man, having a
piece of ground encompassed with the river, flowing it made
five pound of an acre of his first crop, where his neighbour
made scarce twenty shillings an acre of the ground adjoyning;
although naturally in other years before as good. Yet this is
not comparable to land-flouds; for these, partaking of a slimy
and muddy substance, being brought into meadows or pastures
in the spring, either by drains, dams, turning of town-dit-
ches, sewers, high-ways, streets, filths, do both moisten and
fat them; wheras the river-water fats nothing so much; as
Virgil hath it,

    — *huc summis liquuntur rupibus amnes,*
  Declivémque trahunt limum. —

And in another place,

  Et cùm exustus ager morientibus aestuat herbis,
  Ecce, supercilio clivosi tramitis undam
  Elicit, illa cadens raucum per levia murmur
  Saxa ciet, scatebrisque carentia temperat arva.

And doth not all the world know how the river *Nilus* fats
with his slime the whole land of *Egypt*?

But now having by drains and dams brought your water to
the highest part of the ground that you would flow, you shall
cut a little trench, as level as you can ghuess by the eye, which
in your ground let not be above nine inches broad, and seaven
or eight inches deep; so going not above a pole at once, laying
your turves on the lower side of the trench and close by it
with the grass downward; that, if you think good, you may
put them in again, or carrie them away: and now let in so
much water, as will fill up that trench. If you have the water
run over at the last end a little, it is the better; that so, stop-
ping your trench with a turf, your water may run over in any
                                    place.

place. But if you are risen so, that the water will not follow
you, then you should have a spade for the nonce with a long
crooked handle crooking up like a fire-shovel, that there-
with you may deepen your trench, and take out the moulds;
and then go a little lower the next time, still making the wa-
ter to follow you as you go to the further-side of the ground:
then according as the ground falls you may make a cross-
trench, one or more, in the middle, or at ends four or five
pole downward, and at every four or five pole make trenches
the same way you did at the first, till you have done: so that
you shall need no water-level for this work, unless perhaps
you need it to try whether it will come to the ground or no:
  If you are to bring it over some ditch or brook, where the
water is lower then your water-way; then must you either
make a bridg over it, or else shoot four boards, and nayl them
together, and make a trough, which may lie both under the
ditch, and through the mounds of the ditch.

CHAP. XXVII.

Of drayning of grounds.

THe drayning of grounds is often found to be as advan-
tageous and profitable, not onely in arable, but also in
low meadows, and woods, and bogs upon hills, as the flow-
ing of them: if not far more, by reason more grounds, for the
most part, will be drained, then flowed, both in less time and
with less charg.

  The Instruments for this work may be a plow, spades, sco-
pets, shovels, and bills, and forks.

  In some Parishes they have a town-plow, that will hold
eight or nine yoke of oxen, and a couple of horses afore for
boys to ride on to guide them, and three or four horses
with drivers on them, others to hold the plow (one one
while, another another while) booted up to the middle, o-
thers following with bills, forks, spades, scopets, shovels, that,
if any grass, or turf-ground fall in after the plow, some may

                                                      cut

cut it to pieces with their bills, and others throw it out with
their forks; but in plowed grounds with spades, scopets and
shovels: thus yearly, about *All-Saints*, do they serve their
pease-ſtubble, barley-ſtubble, and low meadows; eſpecially
commons. But this plow muſt have a piece of wood either
ſcrewed or cotered to the right-ſide of the beam ſomewhat to-
ward the fore-end of it, to make another coulter-hole; that
in ſward-ground you may put in another coulter, that may
cut both ſides of the furrow: and let the ground-wriſt be five
or ſix inches broad, and the broad-wriſt be longer, and ſtand
out broader then the ground-wriſt by an handfull, to throw
both earth, and turf a good way off. But, if you are in clay-
ground, you may make a broader point then on ſtones or gra-
vel; but howſoever let there be a whole pan and a finne-ſhare.
  Thus if you will make any new drain, ditch for quick-ſet-
ting, brook, or river: firſt ſet up your mark at each nine or ten
pole on both ſides for the riders to guide on the horſes, then
plow once all over that breadth, and throw out the moulds;
then ſet your horſes ſingle, and with any other lighter plow
plow again and throw out, till you are deep enough: thus
may you do more in an hour then in three days otherwiſe.
  Likewiſe, I have known divers high-ways, where one fur-
long hath abutted upon them, and another run long-wiſe by
the ſide of it, where the way hath not been above a pole
broad, that the plow continually carrying out moulds upon it
hath ſo rayſed that linſy-ſide, that it hath been ſo linſy that
not a loaden cart hath gone on it in harveſt or hay time ſince
the memory of man, yet the moſt neceſſary harveſt-way, this
have I mended, and made level with mine own plow and mine
own people in two hours, a quarter of a mile together; and
the like have I done to raiſe a road-way in the middle by
plowing and throwing up both ſides.
  Alſo I have known one M^r. *Field* of *Aſpley-bury* in *Shid-
lington* pariſh in *Bedfordſhire,* who there with his plow made
a larg moat onely by plowing and throwing out the moulds,
and making a ware for the horſes to go in and out.

<div align="center">M</div>

<div align="right">The</div>

The same man also being at an especial friends house in *Hartfordshire*, his advice was requested about cleansing of a brook, which was filled with stones driven down the hill by land-flouds; neither could they dig it with spades, nor strike in a mattock; if they did, the water would fly in their faces, and the cold water overflowed the banks winter and summer, and spoiled all about: he gets a strong plow with a narrow-pointed share, and plows one hour in the fore-noon, and gets good store of labourers with forks and shovels, and throws out what the plow had raised, and then to plow another hour in the afternoon: and thus made quick speed without trouble or let.

Another time the same man stock'd up a wood; and having onely stockt up the wood, he makes a plow, whose neck and handle were both one piece: with this plow he plows this ground, and never digged at all, onely he had two following him with mattocks, that if the plow was hanged in the middle of a great root, that the horse could not break it, then they cut it in sunder.

And lastly, one exploit more was by a plow done by Mr. *Taverner* of *Hexton* in *Hartfordshire* Esquire, Lord of the Town, who (because their high-way to *Luton*-market was up an extream steep hill for two or three furlongs space, and of-ten-times both in frost and rain so exceeding slippery an horse could scarce stand, being all a rock of hurlock;) gets a plow, and the neighbours willingly bear him company: they plow about in a spiral line, and so plowed furrow after furrow, all one way, turning all the moulds down the hill; and so when they had plowed it broad enough once over, then they begin and plow two or three furrows of the moulds twice over, and the highest side deeper: thus doing, till they had made the highest side lowest onely by plowing; so that they can now draw five quarters of wheat more easily up that hill with three horses, then up the other with five.

And thus have we the way to drain such grounds, wherein you may have the help of the plow. It follows now to speak

of

of thofe that muft be done either chiefly by the fpade, or one-
by the fpade. Chiefly by the fpade, called water-furrowing,
that is, when you have new fown any grain whatfoever, then
prefently water-furrow it, either with plow or fpade, or both.

But if it fall out that in a floud the water goes not away fo
faft as it comes, though within two or three days after it will
be clean gone; yet you are never the near, it hath done alrea-
dy what hurt it can do, your grain is drown'd, and the fault is
in the main drains; yet not in their depth, becaufe they will
be dry within two or three days after, but in their breadth.

Now, if this had been a new drain, you might have made
it with the plow, as was faid before: or if you will deepen this
old one with the plow, it may be you may; but to make it
broader you cannot, if it be either very deep, or very nar-
row in the bottom: therefore you muft widen with the fpade
onely.

And for that where cattel go over fuch drains, they com-
monly tread in the earth, and ftop up the water, therefore to
prevent it, get good oaken timber, hew two fides of each
piece, which let it be eleven or twelve inches Diameter, flit
thefe in the middle, let them be two or three foot longer then
the breadth of the ditch, lay them edge to edge, the fawn fide
upward, nayl ledges on the out-fides, and lay gravel or earth
on the top, and ftop up with bufhes, or ditch up, or both, the
old going over.

For bogs and quagmires.

Thefe for the moft part come of fpewing fprings that are in
a vein moft commonly of gravel, near the fuperficies of the
ground, and drawn ftill more upward by the heat of the Sun;
or elfe in fuch places as formerly have been all water, as the
Fenns fometime have been, and fo growing of weeds at firft,
they rotting have turned to earth, and the crop thereof every
year turning to earth, in procefs of time fwells and grows up
to a great height: as is manifeft by divers rivers formerly navi-
gable, now quite grown up. I have feen in *Maldon*-moor the

roots

roots of two willow-trees in the bottom of a drain, about a
yard deep in moorish ground, within three pole of the firm
ground, where one might see the ſtroke of the axe that felled
them to this day : this ground about was excellent good turf,
and on a ſudden perfect ſound, and ſo all along for twenty
miles long, and in ſome places 30, 40, 50, 60 pole wide, it is
good turf-ground: which makes me judge all was a navigable
river in times paſt; as alſo the Towns names bordering upon it,
as *Temsford-Iſlands, Seaford, Fleet-haven,* and *Fleetwick.* Se-
condly, one *William Quayt* of *Maldon,* who yet is or late-
ly was living, plowed up an anchor in a field called *Wick-
bam*-field, adjoyning to the river. Thirdly, there is evident
mention of a very ſtrong Caſtle, at a place called *Bedlow,* ſitu-
ate upon a firm rock of hard red ſtone hard by this moor-ſide,
and now it groweth daily more ſolid by draining, and I per-
ſwade my ſelf will ere long come to be firm paſture: yet I do
fully perſwade my ſelf it will ſcarce be ſo profitable then to the
owner, as now it is. I remember before cutting of turves was
known, a man might have bought in *Weſtoning*-moore in *Bed-
fordſhire* an acre of meadow the free ſtate for ten ſhillings:
nay it was ſo bad, that ſcarce any man knew his own, they ſo
little regarded it; yet ſince they have made fourty pounds of
an acre, and yet have their ground ſtill, which in 30 or 40
years they make as much more. Now if your bogs be ſo ten-
der, that one cannot go on them, then at the upper part where
it firſt riſeth make a large & deep ditch, ſo deep that it may be
lower and deeper then the ſprings by a foot or two. This con-
vey ſo, that no water may ſtand in the ditch, ſo that the water
of the ſprings may ſo be cut off; making a ditch, though not
ſo big, round about: and when it hath drained thus a while
that you can go upon it, then dig drains with turf-ſpades
aſcue up the hill, as deep as you can, and ſome twenty foot
aſunder. And thus (in ſhort ſpace) you may have either
good turf-ground, or hop-ground, or Orchard, or paſture at
your pleaſure.

                                    CHAP.

CHAP. XXVIII.

To cleanse a ditch, whether it be full of flaggs, or mud, and not empty out the water.

IF it be full of weeds, get a drag or dung-rake with three teeth, and drag out the weeds: likewise for the mud get a mud-pan, which is made of the back of an armour, make a socket, and slit the little end forked, and flat it, and spread it four or six inches, and rivet it on the plate, then rivet another round piece, both close by the socket, and also into the bottom of the plate to strengthen the forks, setting it coming toward you as your drag rake doth. Then, if there be much mud, draw out some of it first all along the ditch, and when that is hard, so that you can go upon it, then draw out more. Thus may you go to it when you will, and leave when you will, without dressing you, or damming the water. And thus one man will draw out as much in an hour, as three men will throw out with scopets.

CHAP. XXIX.

Of cleansing a Pond six or seven pole broad being grown over with a coat of weeds, that it will near bear one, without abating the water.

YOu shall for this purpose get a boat and a haling-line, good store of drags, cutting-knives of both sorts, such as they cut mows or hay-stacks with, both like sithes, and stabs, also wheel-barrows, and half-inch boards of six or seven foot long apiece. If this coat of weeds be very soft, you were best to nayl two boards together, with ledges like a door: but if it be any thing hard, let them go single. Then begin with your crones or drags, and cleanse the out-sides with them first as far as you can reach, and let the barrows carry it away out of your way: then take your boat and spret, and for want of a boat take a Brewers cooler, and let two folk go into it, and row your selves to the crust, and laying

your boards on it, and you ſtanding on them, cut with your
ſithe pieces as long and broad as the board, then take up that
board as you ſtand on the other, and remove it beyond it,
then take you the crones that ſtand on the bank, and having
faſtened your haling-line both to the crone and to the
ſtale of it, by knitting a knot at the handle-end; let them on
the bank draw out thoſe pieces which that they may do the
more eaſily, they may level a place about an handful above the
water, and pull them thither, and then cut them ſmaller with
their ſtabs, and then draw them up.

Now then having thus gone round, and cleared it from the
ſides round about, pitch all your crones into one ſide of the
core or cruſt, and trie if you can draw it to the bank-ſide (for
theſe kind of cores never grow to the bottom, eſpecially if the
water be deep), which if you ſo draw it, then may you ſtand-
ing on the bank finiſh all with your crones. But if you cannot
move it, then with your ſithe-knife, and help of your dores
and boards, you may ſlit it all along, either in the midſt, or as
much as you think you can move at once. But now becauſe
you muſt move your boards and dores end-long, (which is
harder to do then ſide-ways) your beſt way is to have a hook
at the end of your haling-line, and make a mortes at one end
or both of each board, and thus put the hook in the mortes
of the hinder door, and raiſing it a little at the end with a cou-
ple of chiſils, or ſuch like, draw it till it is entered upon the
neather dore, then having a board lie by the ſide of it, ſtay
your ſelf on it, till the hinder be drawn along upon the other,
and lie foremoſt, and thus may you divide and draw piece af-
ter piece till you have finiſhed.

CHAP. XXX.

Of cleanſing of water.

SOmetime you are to bring water to an houſe, but you have
none but ſuch as comes from noyſome places: now to puri-
fie ſuch water, if you make a trench of a foot and an half deep
                       and

and three or four pole long (the longer the better) and fill it
a foot deep with hurlock or clunch cut in pieces, as it were for
the lime-kiln, then fill it an handfull higher with pebles, then
fill it up with gravel or earth; it will so purifie it, that it will
be fit for brewing, or the pot, or laundressing, or any thing else:
if you cannot get hurlock, content your self with pebles. Also
it greatly mendeth water in a pumpe or well, first to cleanse
out the mud, and then to put in clunch into it. It will likewise
punifie the water very much, if you would lay clunch or hurlock
as high as the water riseth in your well, in the same form that
they use to lay their bricks: so will the water cleanse it self by
draining through the body of the clunch.

CHAP. XXXI.

Of quenching an house on fire.

THe Instruments for this purpose (not to speak of the wa-
ter-squirt, which will throw a whole hogs-head of water
to the top of an house at once, for that such are scarce to be
had save in some great Towns or Cities) are pikes, spits,
mawkins, pike-staves, forks, wet-blankets, ladders, buckets,
scoops, pails, &c. and the materials, water, coal-dust, turf-
ashes, wood-ashes, sand horse-dung dust, dirt, and in extre-
mity even draff-grain it self. I know you will think it strange
that I should mention pikes, and spits, dust, sand, and ashes,
but I speak on often experience, that four men, that know
how to use these things, will sooner quench a fire, then 100,
that go to work with ladders and buckets to strip houses, and
hooks to pull them down. It's a misery to speak it, when the
rude multitude are once come together every man will have his
own way. If it be a dwelling-house, some will busy themselves
to carry out brass, pewter, but their chief aim is at the mony-
chest, whilest others wait to take it of them, and carrie it away:
others perhaps, of more honesty but less wit, will be ripping
the house, and so let the fire have the more air to burn the
more violently, that, wheras they think thereby to save other
houses,

houfes that are near to it, they ufe (for the moft part) the
onely way to fire them: for the greater the flame is, the
more is the danger, and the farther the fparks of fire will flie.
And now, if you will vouchfafe the reading, which is no great
labour for you, I fhall endeavour (God willing) to give you
fuch directions, whereby you may with leaft lofs, leaft help,
and moft fpeedily quench any fire, wherefoever it begins, or
howfoever it comes.

The firft rule is this. If it be in houfe or chimney, do not
by any means open any vent to let it out, efpecially upwards;
but rather ftop all the holes you finde. If the foot of a brick
or ftone-chimney be on fire, difcharge a piftoll twice or thrice
upon it ; fo foot and fire and all falls together. If it be a
wooden-chimney, and that all the timber, both ground-fells,
ftuds, mantle-tree, beams, and all are on fire at once; then firft
with your pike-ftaff, fork, or fpit, rub down all the coal, then
throw on water, and then afhes, and all is done. And thus did
I my felf, all alone, quench a fire at *Weftoning* in *Bedfordfhire*,
where coming that way accidentally; and meeting a woman
coming out of a yard wringing her hands and crying, I afked
her the reafon, but fhe gave me no anfwer; (whether it were
for that I was a ftranger to her, or whether for grief fhe could
not fpeak, I know not:) but away fhe runs as faft as fhe could.
I fearing fome fuch matter ran into the yard, but finding the
door lockt, and hearing withall a fluttering of fire, I took up
an hogs-trough which lay there, and ran againft the door, and
broke it open, and went in; where I found a buck of clothes
ftanding on a tre fole, and a great many turves under it almoft
burnt out; yet the buck had no hurt, but they had fired the
end-groundfels, ftuds, and all the timber of the chimney. I ha-
ving been at the Fullers earth-pits, not far from *Oburn*, to fur-
vey them, had the foot of my plain-Table in my hand, where-
with I rubbed down all the coals, and then took the buck-
cloth by all the four corners, and threw up the afhes into the
chimney, and finding a pail, I ran and fetcht turf-afhes and
water together, and quenched all quite in a quarter of an
hour.

hour. All this while not one body came; so I was going thence, and as I was going out at the gate, there came near half a score, which she brought out of the field from haying: with these I went back again, fearing lest they should do hurt, so presently some of them get ladders, and to pulling off the thatch; but I prevailed with them with much ado to let it alone, and willed them by all means to keep it into the chimney: if they found any holes that it could come out at, to stop them up with dirt or cow-dung, and throw dirt or cow-dung on the thatch if they would, and if they saw any more fire in the chimney, to cover it with a wet blanket.

If it be within a dwelling-house, on any ground-sels, or studs, it is easily quenched, doing as afore.

If it be between parget and loft-boards, wheresoever it breaks forth, lay on wet woollen-cloths, hair-cloths, cow-dung, or horf-dung, with water, ashes, or sand.

If it be on the inside of an house either thatched or tiled, between the parget and the roof, cover the out-side with wet blankets, hair-cloths, &c. that neither the flame get out, nor air get in. And on the inside be sure there be no vent in the parget, but stop it with cow-dung, &c.

If it be on the out-side of a roof, cover it with wet woollen; or on the top of a mow: and throw no water, but ashes, sand, horf-dung, &c.

If it be on the inside of the roof of a thatcht house, cover the out-side with wet cloths as afore. If there be no parget, your onely Instrument is a scovel, or mawkin, or mop often wetted, and with them sweep down the fire. And thus I and a boy with a scopet, throwing in mault instead of ashes, did at *Tame* quench a thatcht-house adjoyning to another in the market-place, which was on fire in eight places at once on the inside, hard by the eavs; yet being new thatch and hard, it glaunced up to the roof, and broke not out, till it came at the ridge, where were on the out side as many people as could stand on ladders, ready with water, that no sooner could a flake of fire peek out of the ridge, but streight they saluted it

N   with

with a bucket of water: but for all that, so soon as the fire had broke out at the eavs, (which had been, had not we two asswaged it,) they must all have sought a new way down, or else have gone through the fire.

If it begin likewise upon hemp, or flax, cover it with coverlets, blankets, hair-cloths, &c. and throw on ashes. If it be on the side of a mow, hang wet hair-cloths, or woollen-cloths before it, and cover it at the top, that no flame get out, holding the fore-side-cloths as close to it as possibly you can. Thus have we shewed the ways, how to quench fire in any house, where or howsoever it shall begin, without pulling down. Now to prevent fire coming from another house, cover it with hair-cloths, coverlets &c. and throw on them water'd ashes, dirt, dung, &c. Also if an house be pulled down, by no means let it lie there; but, be it what it will, timber, or grain; hay, or straw; quench it throughly, and get carts and away with it into the field, and there spread it. I saw one at *Burton* in *Bedfordshire* at one *Francis Woodward's,* who had his barn burnt down, that it kindled again in the carts before they got a furlong from home. And I have heard my Father speak of it often, that there was a Parsonage-barn, with much corn in it, burnt down at *Leighton-Buzzard,* where he was born, and they did not carry it away, but watched it continually; but for eight nights together still about mid-night it broke out again, that they were forced to ring the bells, and to carry all away at last, when they had wearied them with watching.

If any shall doubt of the efficacie of these things, I desire him to consider of these five things.

First, He seeth dayly, that an extinguisher puts out a candle; yea a candle puts out it self by turning the flame downward: then a blanket on a chimney, or any where else, much more.

Secondly, If any doubt the blanket will burn; it may be so, if it have holes in it: but they are easily stopt with throwing on horse-dung, or dirt. And for both these let him try this conclusion: Let him take a woollen rag, and a burning coal either

either of wood, fea-coal, or turf, (which of all other is hard-
eft to be extinguifhed, and therefore we ufe to take a piece
of turf and wet it, and rake it up in the afhes to keep fire, yet)
let him wrap this coal in his cloth, or lay it on the hearth,
and cover it clofe that no air can get in, and your coal quick-
ly dieth.

Thirdly, Ask any fouldier, and he will tell you, that the
beft way to put out his match is to put it into the mouth of
his piece with the coal down-ward.

Fourthly, You may eafily fee the effect of duft, fand, horf-
dung, or fuch like, if ever you faw an hearth of char-coal
burnt, and quenched.

Fifthly, If a mow fhould be covered at the top, and not
at the end, you will fay it will burn underneath like an oven:
I anfwer, put a whole fedge-fheaf into an oven at once, let it
be at full fire, ftop up the oven, and prefently the fire goeth
out.

CHAP. XXXII.

Of keeping a fire light all night with a farthing-charge.

I Have before, in the laft chapter, fhewed you how to put
out fire: now in this I will fhew you how to keep fire a
long while light with a little charge. Suppofe you dwell in
a lone-countrey-houfe, where one is fick, and you have but
one farthing-candle in the houfe, and borrow you cannot,
and you would fain have it laft burning a whole long-winters-
night; then do thus. Cut your candle in two pieces, light one
of them; and heat a great pin, and thruft it into the great end
of the candle long-wife half the pins length, then fill a pail
with water fo deep that the length of the candle, pin and all,
will not reach the bottom, then holding the candle by the
light, let it down gently into the water with your fore-fin-
ger and thumb, till it comes to the flame, there ftaying it a
while till the water be ftill, and then take away your hand; fo
ftill, as the candle burns the flame will raife it: and which an-

N 2   fwers

Tallow is a
small matter
specifically
lighter.

swers the whole busineß, that the fire will go no otherways, save upward to his own element.

CHAP. XXXIII.

Of laying down of ground for pasture.

OF all ground the best to lay for sward is the black-mould, or strong clay. And although the black-mould be excellent both for Wheat, Barley, and Beanes; yet in the low level ground it is infinitely more commodious for pasture in summer; that the three years crop of graß without any charge at all is more worth then your two crops of grain with all your two years seed, your dung, and carriage, and five or six plowings, harrowings, rowlings, and weedings. But you will say, ground is long in graßing, and I am but a Tenant, and have but a short time in my lease; when I have made it fit for another, my Land-lord will turn me out, or make me pay more rent. This, I confeß, is something, and in some cases may serve for an answer: but yet upon this condition thy Land-lord will renew thy lease for one and twenty years, (if he be wise) and then you are well enough: for whereas you say it it long in graßing, that is remedied with one years charge of arable; for if thou first-plow it, and lay it flat, and with as few furrows as may be, about *November*, and then dung it, then plow it again, about the beginning of *March*, still laying it flat, and filling up the furrows; then sow it with hay-dust, or chaff-dust, which every horse-keeper, if they are spoken to about *Michaelmas* before, will (for a trifle) save for you on purpose. If you harrow in this, you shall have a crop of graß at *Mid-summer*, will be worth 30 or 40 shillings an acre, and still be better and better. But by all means plow in your dung. I have laid some in that manner, and some I have dung'd above ground three times, yet this will not be comparable to the other; yet but a furrow of a plow between, and both laid down 40 years ago.

And by no means lay down any ground, that is worn out

of

of heart; for by that means if ever thou get good grafs of it
in 40 years, I'le never be trusted, unlefs thou dung it extraor-
dinarily; and yet it will not do. Rather this do; if it be inclo-
fure, take nothing but the mowing crop for divers years toge-
ther, and fo doing that crop will be more worth then two
whole years crops taken as ordinarily. I fpeak all this of mine
own experience upon my own grounds.

But *I* have often heard of, and in part feen another fort of
fpeedy grafling, which is this. They fow their ground with feed
of claver-grafs, a very fmall quantitie on an acre, and in fome
places they mow it twice in a year, yet never fow it but once.
Whether they plow it or not, *I* cannot juftly tell: *I* think not.
Thus I have feen at *Maddingley* three miles from *Cambridge*,
theyfave their common fallow fields till *Midfummer*; and then
have an exceeding crop of claver, and then fallow. But whe-
ther they fow for each crop, or whether it be of the nature
of Muftard-feed, that need never be fown but once, though
the ground hath lien fward 40 years before, *I* know not.

But you will fay, yours perhaps is common field, if you
fhould lay it fward, you fhould lay it for other folks. And
what of that? If you have more benefit that way, then you had
before, never grudge at it, though others take a part. 2ˡʸ, Thou
fhalt take part with others of it, as they do with thee.
And in moft places one acre of fward hath as good right of
common as three, or in fome places five acres of arable hath.
3ˡʸ, There is no doubt but others feeing thy good and fpeedy
fuccefs will foon fecond thee, and then thou fhalt have as
good benefit of his, as he hath of thine.

Ob. But if every one fhould lay fward that would, how
fhall we do for bread? *I* anfwer, *I* do not fay *I* would have
every one that lift fhould lay down for fward; but this *I* fay,
I would have all ground turn'd to the moft advantage, firft of
the Common-wealth, then of the owner: I would not have
fuch ground, as will bear two or three load of as good hay as
ever beaft eat, turn'd to arable, when the next acre to it be-
ing fown fome years hath fcarce yeelded the feed again. Where

an ordinarie acre of pasture is worth 50 shillings *per annum,* and the best arable not above 8 shillings, for as for an acre of sward, though it be worth but 20 shillings to the owner, yet to the Common-wealth it is worth 30 shillings the after-pasture, where it is reckoned at a third part of the rent; with us at *Cambridge* far more: and that is not lost, it doth not vanish into air; and though the Master get it not, the Common-wealth doth: and how would *Luton* and *Hitching* do for hay, were it not for *Harlington, Pullox*-hill, *Gravenhurst.* Or how would *Cambridge* do, were it not for the Fenns? Yea, I have known that hay hath been carried out of *Bedfordshire* to *London,* thirty five miles. And I am sure, that it is an easier matter to drive fat cattel an hundred miles, then to carry corn fourty by land. Neither would I have *Chiltern*-ground turned to pasture, because there an acre of arable is more worth then an acre of pasture. Yet certainly it plainly appears by this, that generally there is more want of pasture in *England* then of arable; for that we have daily fat cattel brought out of *Ireland* and *Scotland,* but never any go out; but where grain comes in once, it goes out ten times.

CHAP. XXXIV.
Of the choise of a rich ground.

FOr a generall fat soil, and such as is good for all things, or at least most things, both grass and grain, (for indeed no ground is fit for all things, *Non omnis fert omnia tellus*) the black ground of a good deep staple, with a mixture of gravel or sand, is not unworthily commended of the Poet, *Lib.*3. *Georgic.*

> *Pinguis item qua fit tellus hoc denique pacto*
> *Discimus; haud unquam manibus jactata fatiscit,*
> *Sed picis in morem ad digitos lentescit habendo;*
> *Humida majores herbas alit, ipsaque justo*
> *Latior: ah, nimium nè fit mihi fertilis illa,*
> *Neu se praevalidam primis ostentet aristis.*

For

For this we commend *Ailes-bury.*

And some extoll as highly earth that is of a reddish colour; as the ground about *Armagh* in *Ireland,* which (some report) hath had no manner of manuring since the memory of man. I know some such black ground in *Pullox*-hill afore-said, but I know no such red. *Virgil* also saith, That if you dig a deep hole in the ground, and fill it up again, if you cannot tread in the earth again, then it is rich arable ground, 2. *Georgic.*

----altéque jubebis
In solido puteum dimitti: omnémque repones
Rursus humum: & pedibus summas aquabis arenas.
Si deerunt, rarum pecorique, & vitibus almis
Aptius uber erit: sin in sua posse negabunt
Ire loca, & scrobibus superabit terra repletis
Spissus ager: glebas cunctantes, crassáque terga
Expecta, & validis terram proscinde juvencis.

Also a sweet smell after the first rain, or a drought, or after new plowing, is a token of a rich soil. Also where thistles, nettles, or other weeds grow rank. Also where trees grow long and upright. Also where fruit, especially pears, are more pleasant in taft then in other places: for if a young pear-tree bears pleasant pears in a good ground, and you remove it into a bad ground, you will think the fruit not to be of the same kinde, yet all grounds are not alike for all things:

----Non omnis fert omnia tellus.

And for the moftpart, those grounds that are moft barren above, are richeft within, as ftone-pits, fullers-earth, lead, coal, tin, filver and gold-mines.

Some grounds are fitter for wood, then either for corn or grafs. I have feen a ground in *Hartford-shire,* that hath been laid two years, where were grown naturally black and rank fallows all over the ground in tuffocks, fome fix, fome feven foot high, fo that the crop of wood was more worth then the crop of grafs.

CHAP.

CHAP. XXXV.

Of inriching lean ground.

Lean grounds are either inriched with reſt, or with dung-ing. As for paſture, if you neither eat nor mow it two or three years, or onely mow it once a year ; or if you will eat it, by no means eat it too low, and you will greatly thereby both better the ground, and get a ſpeedier increaſe of the crop; for after it once covers the ground, it grows more in a week, then in ſix weeks before, by reaſon it keeps the ground both hot and moiſt, yet not ſo hot as to be ſcorched with the Sun: therefore be ſure to ſpare ſuch barren grounds by *Candle-maſs* at the furtheſt. As for lean arable , though common-field ground, it is a common thing in divers places, where they have a great deal of lean land that lies far from any Town, to let ſome thereof lie lea ſix or ſeven years; and the longer it lies, the more heart it gets.

As for dunging, the benefit of horſ-dung and cow-dung is every where known in part, yet not to all alike; ſome will not lay it on their land till it is rotten, but will carry it out of their yards, and lay it on dung-hills in the field, either at the lands end, or ſome place near to it, though the land be not then ſown: whereby they make a double labour, and loſe a double benefit of their dung, which they may eaſily finde by this, that a great part of the ſtrength of it goes into the ground it lies upon, as appeareth in this, for if they lay it in ſmall heaps on the land where it ſhould be ſpread, if it lieth long unſpread, let them ſpread it as clean as they can, yet thoſe places will be ranker corn then the reſt. A ſecond benefit which they loſe is the ſtiving upward, which in dry weather ſhould be the onely nouriſhment to the corn. If you pleaſe to try two acres of like land lying together, and carry out twenty loads of horſ-dung about *Mid-ſummer*, that is new-made, as ſuch you may have at an Inn, and lay that on a heap in the field by it ſelf till *February* or *March*, and then fetch twenty loads more of the like; lay theſe twenty on one of the acres, and the heap

on

on the other, but let your loads from the Inn be alike, and then tell me which acre is the beſt barley. But though you finde but little difference in the barley-crop, you ſhall finde a vaſt difference in the peaſ-crop. And if you will ſow them three years together, there will be no ſmall odds; for the ſtiving of the dung will be over in two or three years. And this alſo will appear, if you take a load of ſtraw, and lay it in ſome Orchard, where no cattel come, upon planks, boards, or ſtones, and ſpread it ſo that the rain may get into it, and turn it three or four times in a year, and by three years end you will hardly have a quarter of a load of dung left, and that which is left will be turned to earth alſo: yet I deny not but that earth may be better then ordinary.

Alſo ſtreet-earth, eſpecially in Market-towns, where goes *Street-* ſtore of ſinks from ſtables, kitchens, dairy-houſes, but eſpecial-*earth.* ly ciſterns for malting. I have known them that have got up all the piſs they could get in a Market-town, and carried it to their land in a tun, and there ſtrewed with good ſucceſs. But if they, that have ſuch convenience for carriage, would but make triall of the water of the ſink of a Cheeſ-preſs, or of ciſtern-water, I doubt not but in ſhort time there would be little of it loſt.

And we ſee now how much ſoot is ſet by, which within *Soot.* theſe fifty years men would not ſuffer to be thrown upon the dung-hill, but into the midſt of the ſtreet.

And although, by *Moſes* Law, ſome great offenders were *Salt.* to have their land ſown with ſalt; and likewiſe in *Judges* ix. 45. *Abimelech*, when he took *Sichem*, deſtroyed it, and ſowed it with ſalt; the reaſon was, that it ſhould never bear graſs nor grain. And indeed it is an eaſie matter, either with ſoot, ſalt, pigeon-dung, or piſs, to over-dung and ſpoil all. I have known ſome carry out pigeon-dung in ſacks in *May*, and lay a ſack-full on a heap upon the corn; but they could not gather it up ſo clean, but they kill'd all the corn as far as the heap lay.

I have ſown pigeon-dung in an extream hot and dry year *Pigeon-* *upon dung.*

upon barley, on an hot and dry land, when at harvest the barley hath scarce peeked out of the hose, yet it hath been the best in the furlong. Again, I have in a wet year sown pigeon-dung on sand, when my crop hath been more worth then the fee-simple, or value of the ground.

Folding of land.   Land that is folded a little before, or presently after the sowing, doth far better then otherwise. But herein many men wrong themselves in surfeiting their sheep in Summer-time, when their fold goes on single-lands, as on roods or half-acres, in laying them so thick, that they over-heat one another; thinking that if they have as many hurdles as they had before, that then they lie as thin as they did before; but this I have spoken of before in the *first Chapter*; where also I have shewed the disproportion, and therefore to it I refer you. Yet before I leave this, I must add further, that I see no reason why other countreys may not fold in Winter as well, or rather, then Oxford/bire, or *Buckinghamshire:* nay, far rather, either upon sward or arable, especially *Hartford/bire,* or *Middlesex,* if they will do as they do, that is, winde their hurdles on two sides with broom, and remove their hay-rack and cratches with their folds. *Hartford/bire* hath far drier laire, their sheep more hardy and sound, and never rotting, more hedges to shelter them, and dung infinitely dearer. And if they broom their hurdles to keep them warm, then why not to keep them warm by keeping them together? I never knew sheep take hurt by lying warm in Winter. If you will not fold your arable, yet fold your sward; if not your sward remote from the hedges, yet at least your hedg-rows. It is the office of a land-meter, to give the quantity or mensuration; but the office of a Surveyour, to acquaint you with all means of melioration.

Rags and Horn-shavings.   Now we are come to rags and horn-shavings. It is almost incredible the odds of an acre of the best barley in *Hitching-*parish fifty years ago, and twenty years ago, and all by buying rags and horn-shavings at *London,* carrying up malt, and bringing them down all the year long. As for their rags, they carry them to the land, and lay them on heaps like dung-heaps, but

not

not ſo big ; then chop them in pieces on a ſtick with a hand-bill, and then plow them in, and theſe and horn-ſhavings en-dure a long-while, and have ſo mended their ſoil thereby, that whereas about fifty years ago, an acre of their barley was not above three pounds ten, or four pounds the beſt; now about twenty years ago, I was requeſted to meaſure two acres of barley in a field called *Kings-field* in *Hitching*-pariſh that the very crop of them was ſold for nine pounds an acre by the Statute-pole.

Malt-duſt alſo is little inferiour to Pigeon-dung. Alſo lime, five or ſix quarters to an acre. Aſhes of all ſorts. Chalk for all red grounds , both arable and ſward. Scowring of old ditches, good for all white grounds and clay. Alſo marl of ponds, where ſinks of yards run into them; but in a ſpring or running water, though the mud look never ſo black, there is no heart in it, except holpen by land-flouds, becauſe there is no ſalt in it ; for ſalt is the ſtrength of all dung: therefore let it alone, unleſs to lay on a white ground, for mixing of earths; for if you lay an hungry gravel on an hungry clunch, *& con-trà,* they fertilize each other.

Alſo any ſward plowed up, and thrown on the land, or laid on heaps till it be rotten : or making a dung-hill, and laying *ſtratum ſuper ſtratum,* a laying of ſtreet-earth, and a laying of theſe turves, laying upon laying, till they be rotten, makes an excellent compoſt for many years.

The burning of hawm upon the ground, commonly called *Devonſhiring* (becauſe much uſed in *Devonſhire*) is not un-worthily a little extolled of the Poet :   *Georgic. lib.* I.

Sæpe etiam ſteriles incendere profuit agros,
Atque levem ſtipulam crepitantibus urere flammis:
Sive indè occultas vires, & pabula terra
Pinguia concipiunt: ſive illis omne per ignem
Excoquitur vitium, atque exſudat inutilis humor:
Seu plures calor ille vias, & cæca relaxat
Spiramenta, novus veniat quà ſuccus in herbas:
Seu durat magìs, & venas adſtringit hiantes,

O 2   *Nè*

Nè tenues pluviæ, rapidive potentia Solis
Acrior, aut Borea penetrabile frigus adurat.

To this give me leave to add a little of mine own experi-
ence. About the year 160¾, was such a frost, without snow,
that it killed all our wheat : one M^r. *How* of *North-Myms*
had but two bushels growing of thirty acres sown. I sowed
most part of mine again with barley in *March*, onely I had one
head-land that looked most gloriously, covered green all
over, as thick as grass in a meadow. I thought this might do
well enough, I let it alone till mid-*May*, then I began to mis-
trust by the blade, that all were but wild-oats. I digged up a
turf as broad as my hand, wherein I found two wheat-corns,
but 200 wild-oats, grown to that height all of one depth per-
fectly upright, as thick as they could stand one by another,
just as letters are set in a frame to print a book. How they
should come there at all, the Lord knows, much more in that
manner. Well then, I saw there was no hope of a crop of
wheat, and thought it too late to sow barley, neither had I
any left, save a little tary-head-corn, that I took & steep'd it a
day and a night in water of an horf-dunghill. I sowed all that
head-land ; but one quarter of it , which had been troden
with horses turning upon it in wet weather after it was sown.
This barley, when harvest came, was the first I had ripe, clean
without tares, or any other soil, as thick as it could stand, and
every way the best that ever I had growing : but the wheat
not worth the reaping; wherefore I let it stand till harvest was
home; but had I mowed it green, it had been the best horf-
meat of all other , as afterward I found in wild-oats and
beans. When harvest was home, on a fair day, the winde sit-
ting right, I set fire on it: but he that had seen that fire, and
heard the noise, and had not read *Virgil* before, would have
said certainly *Virgil* was at that fire before he made his book,
and that there he learnt it, or else he could never have found
out such an Epithete, as ---*Crepitantibus urere flammis*: for
whether it was by reason of the wild-oats, in every horf-
footing made by turning on in wet weather, or otherwise,
there

there was such a noise as if twenty muskets had gone off at
once, insomuch that an herd of cattel being a quarter of a mile
off, seeing the fire, and hearing the noise, as if they had been
out of their wits, or rather stark mad, set up also such a
running, roaring, bellowing, and howling, that it made me to
run as fast as they, to hear such an hideous noise, and the fire
so violent, the weather being dry, and the whole crop being
still there which was very great, and the winde full in one end,
and whistling, insomuch that all the ground for two or three
and twenty pole long, and a pole and half broad, was all on
fire at once: this past my skill to quench, neither would all the
blankets in the Town have served the turn, if I had had them
there. But that this was soon out, I think neither the *Sicilian*
Ætna, that throweth stones sixty miles nor *Heela* in *Ise-*
land, nor *Vesuvius* in *Campania*, that sends his ashes more
then two hundred miles off; (or, if you will believe *Cassiodorus*,
in the time of *Titus* and *Vespasian*, they flew into *Asia*, *Syria*,
and *Egypt*: and lastly, breaking out again in the year 1632,
Crepitus miliaria centum auditus: & did you not hear this *cre-*
pitus? certainly it was because either you were deaf, or not near
enough) could present a greater terrour. But notwithstanding
all this, my wild-oats were not yet killed; and then I was vexed
with my self, that I had not mowed them green for horf-meat:
for out of every horf-footing, contrary to my hopes, I could
takeup whole yeapsonds, that were never the worse for the fire,
save onely their smell. Then I filled my hand-kerchief and both
my pockets with them, to carry home to my hoggs, hens, pi-
geons; but not a corn any of them would touch. All this was
still worse and worse. About *All-Saints*-day following, there
came a frost and a little snow, upon that there was so many
flesh-crows, that you would have thought that there had been
proclamations set up in all woods, groves, fields, and yards
through the whole land to summon them thither, or whether
that was their beacon when I burnt it, or no, I know not.
These for a fortnight together so covered the ground, that
you could not choose but say, it was far blacker then ink: for

O 3   this

this was of a double die, one of black crows, and another of black ashes. The frost breaking, those that they had not eaten they trod into the ground with their feet, so that by the later end of the moneth, no meadow could be thicker of green grass, then that was of green-oats. I plowed them in, and by *Candle-mass* it was green again; I plowed it again, then it lay till the later end of *April*, and was green again; then I steeped my seed as I did the year before, and sowed it with barley, and had a very good crop, and so killed the wild-oats.

Burning of queach, &c. The burning of queach also, in some ground, is exceeding profitable. And not onely the steeping seed in dung-hill water helpeth greatly, but also in lime and water, by reason that which gives it heart lies close to the root. Some also wash seed-wheat and rie in lime and water in the seed-leap in the field, and then sow it, and so no crows nor pigeons will ever touch it.

CHAP. XXXVI.
Of planting Willows.

IN stead of beetle and stake, or crow of iron, make you an augre like a pump-augre, make it after this manner: Make a plate like a peel of a foot or fourteen inches square, well steeled, and turn it as an augre is turned; let it have a socket like a peel, but four-square, into which put a stake of good tough ash two foot long, and four-square, as the socket is, with a bar or hoop of iron about it at the top, to keep it from cleaving: let it be two inches square at the least upward, in which near to the top bore an hole, or else make a mortes to put in a cross piece to turn it by, and to take it out by, then enter it a little with your spade, as you do a carpenters wimble with a gouch, and then bore your holes; which in strong clay is an exceeding speedy way. Besides that, if the sets be not very great, you will have room enough to ram the moulds down to the bottom.

CHAP.

CHAP. XXXVII.

*Of reducing wood-land to statute-measure, and statute
to wood-land.*

I Have feverall times meafured ground by ftatute, which
fhould have been done by the eighteen-foot pole ; but ne-
ver the contrary. One amongft the reft was a clofe in *Hexton*
in *Hartfordfhire*, where three Copy-holders had each of them
apart expreffed in their feverall copies, how much by meafure,
but not by what meafure: thereupon it was taken for granted,
that it muft be ftatute-meafure. One of the three had held all
in his occupation divers years together, and lying in ftitches, &
no banks between had plowed one amongft another. A and B
would have theirs again. A muft have fo much on the Eaft-
fide, B fo much on the middle, and C the reft; for C would
neither fhew his copie, nor yet make known how much he
fhould have. So I laid out each man his fhare accordingly,
and took a plot of the whole. Still it runs in B his minde, that
his part was not fo good as it had been formerly, miftrufting
that I had done him wrong in laying it forth; fo that he ac-
quainted the Lord of the Mannour with it, who demanded
of him by what meafure he had meafured it: he anfwered by
the ftatute-pole; Then, quoth the Lord, there is the errour, the
cuftome is eighteen foot, and was the meafure taken in *Henry*
the *eight* his time. This being known and reduced, C fhewed
his copie, and there was not a pole difference in the whole
thing: fo I gave them direction to alter it without going to the
ground. To do this there are feverall ways. Firft a ftatute-
pole is fixteen feet and an half, or 33 half foot long; there-
fore 33 half-feet fquare is 1089 fquare half-feet in a ftatute-
pole: but in an eighteen-foot pole, which is 36 half-feet
fquare, are 1296: fo then if you multiply your ftatute-poles
by 1089, and divide the product by 1296, you have the num-
ber of eighteen-foot poles, which divided by 40 gives you the
roods, and *vice verſâ*. And thus fix acres of ftatute, which
                                                            is

is 960 poles, multiply'd by 1089 makes 1045440, and that divided by 1296 gives 806 $\frac{864}{1296}$ or $\frac{2}{3}$ which is five acres six pole $\frac{2}{3}$ of the 18 foot.

Likewise five acres of 18 foot is 800 pole, that multiply'd by 1296 produceth 1036800, which divided by 1089, quotient 952 $\overline{1089}^{12}$ pole, that is 5 acres, 3 rood, 32 pole. And this is the best way. So that the analogy is thus.

As 1089. 1296 :: 800. 18 foot pole to 956. 1089^{12}, *id est*, 5 acres, 3 roods, 32 pole 1089^{12}. And as 1296. 1089 :: 800 statute, to 672 $\frac{2}{9}$, *id est*, 4 acres, 3 roods, 32 poles $\frac{2}{9}$. And this is your best way: and thus may you do with all other poles.

Another way is, if upon your scale you have two scales, one of 11 in the inch and another of 12: if you lay down statute-measure by the scale of 12, and then measure the same plot by the scale of 11, it gives you the wood-land measure, and likewise on the contrary.

CHAP. XXXVIII.

To finde any scale that a plot is made by, the content being known.

SUppose any scale, as 10, and measure it by that; now if by measuring it by the scale of 10, it comes to but 23 acres 82 parts: but it is truely 34 acres, 31 parts; therefore finde a mean proportional between these two; which, because the work is somewhat difficult, I will therefore shew you the manner of it.

First multiply 32. 82. by 34 31. as here it is set down: so you see it produceth 817 | 2642. And because there are four figures in the Fracti-
ons of the two Factours; therfore there

34.	31.
23.	82.
08.	62.

are

are also four in the product; so the whole
number is 817 and 2642, the Fraction,
the square-root is 28 ⌊ 59. which is the
mean proportional desired; then say, As
the lesser of the two numbers, *viz.* 23,
82. is to your mean proportional 28. 59:
so is your supposed scale to 12. the true
scale, as 23, 82; 28. 59 :: 10. 12. See
the work.

$$27. \quad 44. \quad 8.$$
$$102. \quad 93.$$
$$686. \quad 2.$$
$$817 \lfloor 2642$$
$$4 \quad (28 \lfloor 58$$
$$\overline{417}$$
$$48$$
$$\overline{3.84}$$

```
      28 ⌊59                3326
      .10                    565
   28590 (12               2825
   2382                    
    4770                  50142
   2382                    5708
   4764                   45664
      6                    4478
```

But because there is too much difficultie to finde it this
way, and so little by the line of numbers, and so soon done,
and is exact enough; therefore by it divide the distance be-
tween 23, 82, and 34, 31. into two equall parts, and the
compasses will fall at 28, 59. then because 28, 59. is more
then 23, 82. therefore set one foot in 10, and turn the other
upward; it will fall at 12, the scale desired.

CHAP. XXXIX.

Of making an Index *or* Table, *whereby readily to finde out any*
ground, that ever you have measured, and to tell the quan-
tity of them an hundred years after, and draw a plot
of them without going again into the field.

I Shewed before (in *Chap.* 2.) the manner of keeping your
field-book; by help of that, and this, you may readily ob-
tein your desire.

All the field-books, that ever you fill with notes, page

P　　　　　　　　　　　　　them

them all, writing at the top of each page the name of the Pa-
rifhes, or Parifh, wherein the land lieth conteined in that
page: and, at every beginning of a new man, fet down his
name; and likewife at the beginning of every new field, fur-
long, or parcell in a furlong, fet down the name of the clofe,
field, furlong, or parcell. Alfo write on the cover of your
firft book, A; on the fecond, B; on the third, C; &c. Then
referve four and twenty pages at the end of your firft book,
A; which fhall not be paged, or elfe make a little book by it
felf: and on the cover thereof write *I N D E X*, and on
the top of each page, write A, B, C, &c. in *Alphabetical* or-
der. Then under each feverall letter write: firft the Towns
name beginning with that letter; fecondly, The mans name;
for whom you meafured; thirdly, The books name, in which
you wrote it; and fourthly, The pages: either all of them, or,
at leaft, the firft and laft. And whereas you may think this
way will not be fo beneficial to you, as to go meafure it again;
for that you may do as you fee good: you need not finde it,
unlefs you will. Befides that, you deferve pay both for fur-
veying, plotting, and notes; as if you had meafured it. And
if you will meafure it again, thefe notes will do you no hurt.
See an example:

P

Purton. W. Norton. lib. *C.* pag. 31, 32, 33, 34.
Panchurch. Rob. Audley. lib. *B.* pag. 64. *ad* 76.
Putford. Tho. Dennie. lib. *K.* pag. 97. *ad finem.*

Refer

The Faithfull Surveyour.   115

But if you would bring water to your house from a conduit, where you desire to place a cock as high as you can, and that without Instruments : First, begin at the conduit , and dig a trench near a foot deep there ; but as you go farther off, let it be still shallower for five or six pole in length, more or less, according to the fall of the ground; so that the water may but just follow you, and when it begins to run over, there stay it, and begin a new depth as afore : but be sure the fall of it be down-right like a stair, and so go on till you come where you would be: then add the fall at the conduit, and all your stairs together; and so high may you set your cock above the level of your trench.

F I N I S.

P 2   An

¶ An Appendix to my

Faithfull Surveyour.

E have, in the book it self, spoken of measuring such things, as are measured by observing Instruments, as the Pandoron, plain-Table, Quadrant, Quadrat, Theodelete, Circumferentor, &c, *viz.* of measuring of land, taking of Altitudes and Distances, taken by the chain: here we will speak of such *superficies* as are done by a two-foot-rule; as board, glass, pavement, wainscot; and of solid, as stone and timber: forbearing those things, that seldome, or never, come in question; as globes, regular bodies, and the like. First, Because land-measure and those seldome meet together in one man; Secondly, Neither would I have the book to be of two big a price; and Thirdly, Because my little time I have, hath need to be spent to the best advantage for the common good.

CHAP. I.

Of making the Rule.

First, I would have the Rule, (whether it be of box, or of brass; whether joynted in the middle, or streight out.) to be just two-foot-long by some standard of brass, kept by the *Clerk of the Market* and not, as I have seen some; that have been half an inch too long. Let it be an inch and an half broad at the least, and a third part of an inch thick with a square stroke struck round about it just in the middle of the length thereof. Let one edge be befild off: which serves that if you have occasion to draw lines with a pen, if you turn that fide downward, you need not fear blotting: if your rule chance to be blackt with inke, if you rubb it well with sorrel, that will fetch it out. Through the midst of this befill strike a Gage-stroke: an another along the midst of the other edge:

divide

divide the reſt of this ſide, beſide the beſill, into eight equall parts with ſeaven Gage-ſtrokes. In the 4 next columnes ſave one to the beſill, you may place all the under-meaſure of this Table of board-meaſure following, which will not fall in a ſcale upon the rule, *viz.* all inches, halves, and quarters from one inch to ſix, or if you will to ten inches, in ſmall ſpaces the inches of the breadth of the board, in the column next ſave one to the beſill: the feet required to a foot foreward at the breadth in the next: the odd inches in the third: and the *Centeſmes* in the fourth. And adjoyning to this Table toward the middle of the Rule, in the firſt of thoſe four columnes ſet one inch divided into ten equall parts, and each of thoſe into halves, and each of thoſe halves into five; or ſuppoſe them ſo divided: ſo is it divided into 100 parts or *Centeſmes*: from which inch you ſhall take off all your *Centeſmes* with your compaſſes, that are to be ſet in any of your ſcales.

For making the ſcale of board-meaſure.

: Before you can make this ſcale, you muſt have one column, on the otherſide the Rule next the beſill, parted into three ſmall parts with Gage-ſtrokes, and divided in the middle of the length of the rule into two equall parts or feet: whereof divide one of them into ten equall parts, and each of them into ten more, and each of them ſuppoſe at leaſt to be divided into ten other; ſo ſhall that foot be divided into 1000. and this *Gunther* calleth foot-meaſure: which muſt be reckoned both wayes, firſt from the beginning of the rule to the middle, thus, 1, 2, 3, &c. and backward again, and thus, 11, 12, 13, &c. and becauſe the other foot makes ten of theſe inches, and theſe ten make twelve of them, therefore divide the other foot into twelve equall parts or inches, and each inch into eight parts, and number it from the end toward the middle with 1, 2, 3, 4, &c. but from the middle to the end with 13, 14, 15, &c. and this he calleth inch-meaſure. By help of this inch-line and the inch aforeſaid, and by help of your Tables for board and timber-meaſure, are made your ſcales for board and timber-meaſure. And this Table of board-meaſure

P 3. is.

is thus made : Firſt, for all whole inches divide 144 by the inches of the breadth, and you have the inches forward to a foot. If any thing remain after diviſion, it is the Numerator of a common Fraction, whoſe Denominator is the Diviſor; to which remain annex two ciphers on the right hand, and divide again by the ſame Diviſor, and you have the *Centeſme* deſired.   *Example.*

Let a board be ſeven inches broad, I deſire to know how many inches forward makes a foot. Divide 144 by ſeven, it gives twenty inches; or one foot eight inches $\frac{4}{7}$. Now to bring $\frac{4}{7}$ into *centeſmes*, annex two ciphers to the remain four, it makes 400: which divide again by ſeven, it gives $\frac{57}{100}$. But for half-inches reduce the breadth into an improper Fraction, as $6\frac{1}{2}$ is $\frac{13}{2}$; then multiply 144 by the Denominator 2, it gives 288 : ſo that you muſt always divide 288 by the Numerator, or number of half-inches of the breadth of the board, which is 13; ſo have you 22, or one foot, ten inches, 15 *centeſmes*. But if your breadth be an odd quarter, or three quarters : Firſt, reduce it into quarters, and divide 576 by it: ſo $6\frac{3}{4}$ is 27 quarters, therefore divide 576 by 27, it gives 21 inches; or one foot, nine inches, $\frac{2}{27}$, or 33 *centeſmes*. The Table followeth.

A Table ſhewing how many feet, inches, and centeſmes *of inches forward are required to make a foot of board meaſure at all breadths, both whole inches, half-inches, quarters, and three-quarters, from one inch in breadth to 36 inches.*

Quar.

Quar. Board	feet	inch	cent	Quart.	feet	inch	cent	Qu	inch	cent	quar.	inch	cent
1 0	12	0	0	8 0	1	6	0	15	9	60	22	6	55
1	9	7	20	1	1	5	46	1	9	44	1	6	47
2	8	0	0	2	1	4	94	2	9	29	2	6	40
3	6	10	29	3	1	4	46	3	9	14	3	6	33
2 0	6	0	0	9 0	1	4	0	16	9	0	23	6	26
1	5	4	0	1	1	3	56	1	8	87	1	6	19
2	4	9	60	2	1	3	16	2	8	73	2	6	13
3	4	4	36	3	1	2	77	3	8	57	3	6	6
3 0	4	0	0	10 0	1	2	40	17	8	41	24	6	0
1	3	8	31	1	1	2	5	1	8	32	1	5	94
2	3	5	15	2	1	1	76	2	8	22	2	5	88
3	3	2	40	3	1	1	35	3	8	12	3	5	82
4 0	3	0	0	11 0	1	1	9	18	8	0	25	5	76
1	2	9	88	1	1	0	80	1	7	81	1	5	70
2	2	8	0	2	1	0	51	2	7	78	2	5	65
3	2	6	31	3	1	0	25	3	7	68	3	5	59
5 0	2	4	80	12 0	0	0	0	19	7	58	26	5	54
1	2	3	41	1	0	11	76	1	7	48	1	5	48
2	2	2	18	2	0	11	52	2	7	39	2	5	43
3	2	1	4	3	0	11	29	3	7	29	3	5	38
				Qu.		**Inch.**	**Cent.**						
6 0	2	0	0	13 0		11	8	20	7	20	27	5	33
1	1	11	4	1		10	87	1	7	11	1	5	28
2	1	10	15	2		10	67	2	7	2	2	5	24
3	1	9	33	3		10	46	3	6	94	3	5	19
7 0	1	8	57	14		10	29	21	6	86	28	5	14
1	1	7	86	1		10	11	1	6	78	1	5	11
2	1	7	2	2		9	93	2	6	69	2	5	5
3	1	6	58	3		9	76	3	6	62	3	5	1

Q.	I.	C.	Q.	I.	C.	Q.	I.	C.	Q.	I.	C.
29	4	97	31	4	65	33	4	36	35	4	12
1	4	93	1	4	61	1	4	33	1	4	9
2	4	89	2	4	58	2	4	30	2	4	6
3	4	84	3	4	54	3	4	27	3	4	3
30	4	80	32	4	50	34	4	24	36	4	0
1	4	76	1	4	46	1	4	21			
2	4	73	2	4	43	2	4	18			
3	4	69	3	4	39	3	4	15			

Now to place this Table upon the rule, divide the second, third, fourth, and fifth columns next to the befill, at one end into small squares that may hold two figures a piece, in which set over-most the inches of the breadth, in the second the feet required in length, at each inch, half inch, and quartern. In the next the odd inches, and in the next the odd centesmes : and this you must do to six inches, you may do it to ten inches if you will. Then at the end of ten inches, set one inch divided into ten equal parts, and each of them into halves, and suppose each half into five, so will it be supposed to be divided into an hundred parts, as before. Then from six inches to 36 you shall set all in the column next the befill, with small strokes, after this manner : First, I begin with six inches and a quarter, to which I finde in the Table there belongeth one foot, eleven inches, four centesmes, that is eleven inches, four centesmes from the middle cross stroke of the rule. But because my compasses will not reach so far, I onely take 56 centesmes from the former inch, which makes it just two foot from the same end, which I set the under measure at.

Another example let be 9 ¼, for which I finde in the Table one foot, three inches, 56 centesmes. First, I take with my compasses 56 centesmes from my inch of centesmes, and prick it down upon a line upon a paper. Also with my compasses I

take

take three inches in the foot-line of inch-meafure on the other
fide of the Rule: fet that diftance alfo on the paper at the end
of the 56 *Centefme* in the fame line; then take with your com-
paffes the whole length of both, fet one foot in the middle-
crofs-line of the Rule, and in the faid fcale, and the other to-
ward the beginning of the Rule, and it gives the length corre-
fpondent to nine inches and $\frac{1}{4}$, from the ftroke to the end of
the Rule. Thus do with all the reft; marking each whole inch
with its proper number to 24, alfo 30, and 36.

And now, before we proceed to fhew you the making of the
Table of timber-meafure, we will firft fhew the meafure of
boards.

CHAP. II.

Of meafuring of boards with the Rule.

THere are divers ways of meafuring of boards: of which
the fundamental way is this; 12 inches in length, and 12
in breadth, that is twelve times twelve, or twelve inches fquare,
which is 144 inches, make a foot of board: therefore multiply
the inches of the length of the board by the inches of the
breadth, and divide the product by 144, you have the content
in feet. If any thing remain, divide it by twelve, it gives the
odd inches, or twelve parts of a foot: for an inch is the twelfth
part of a foot, let the foot be what it will. *Example.*

Let a board be 13 foot five inches long, that is 162 inches
long, and nine and an half broad, thefe multiplied give 1529
and an half, which divided by 144, give ten foot, & 89 fquare
inches and $\frac{1}{2}$ remains, which divided by 12 is 7 $\frac{1}{2}$ *fere* inches of
board. Secondly, If you multiply the length in feet, 13 feet
5 inches, by the breadth in inches 9 $\frac{1}{2}$: firft, 9 inches by 13
foot, is 9 foot 9 inches; & half of 13 is 6 $\frac{1}{2}$, and 6 fquare inches;
and 9 times 5 inches is 45 fquare inches; and half five inches is
two and an half fquare inches. Firft then, add all your inches
together, 45, 6 and 2 $\frac{1}{2}$ make 53 and $\frac{1}{2}$, which divided by 12,
gives 4 board inches, and 5 $\frac{1}{2}$ fquare inches, or half a board

inch

inch *ferè*. Now add thefe 4 inches to 9 and 6 inches, they make 19 inches, that is, one foot, feven inches, to which add 9 foot, it gives ten foot, feven inches ½ *ferè*, juft as afore: and both thofe ways are performed by any common Rule that Lath no board-meafure on it. Hence then is difcovered this errour, that if a board be nine inches broad, to take 15 inches forward to make a foot, that is fo much more then twelve, as nine is lefs, whereas our Table faith you muft take 16, is a falfe way: for nine times 15 is but 135, which wants nine fquare inches of 144, and is always the fquare number of half the difference of nine and 15 equally diftant from 12, whofe fquare is 9. So likewife 8 and 16 being multiplied make 124, which wants 16 of 144: and becaufe they are equidiftant from 12, and their half difference is 4, therefore their product is lefs by fixteen, the fquare number of four, then the fquare of twelve.

3. A third way of meafuring board is by this rule, Meafure the breadth of the board; if it be lefs then fix inches, your Table of under-meafure will fhew you how much forward you muft take to a foot forward. If it be broader, and under 36 inches, then the ftrokes on your fcale give it.

4. Some meafure all the breadths of the boards with a line, then ftretch the length on a block, and fo meafure the breadths of all the ftock at once, and then meafure the length of a board, then multiply the length in feet and parts, by the breadth in feet and parts: So fuppofe the breadth of all the boards is ten foot, nine inches, and the length 154 inches, inftead of nine inches, I take ½ ¼ of a foot, and inftead of four inches I take ⅓ or ¼ one inch, and the work will be thus, and it makes 164 feet ²⁄₄, 1 inch and an half.

And this is a very good way in cafe a block be hewn eight-fquare, before it be fawn: which if it be fit for boards, it is pitty it fhould be hewn any other way; fo will it be no lofs of timber, the boards will be all ftreight-edged. If it be fold in timber, and meafured as eight-fquare,

$$15. \quad 4. \quad 1.$$
$$10. \quad 2. \quad 4.$$
$$150.$$
$$2. \quad 2.$$
$$248.$$
$$7. \quad 248.$$
$$3. \quad 24.$$
$$164. 2. 4. 1. 2.$$

(as

(as ſhall be ſhewn) there will be no loſs either to buyer
or ſeller.

CHAP. III.

*Of making of a Table of timber-meaſure for ſquare timber, to
make the ſcale of ſquare timber-meaſure by:
as alſo the under-meaſure.*

Firſt know that a foot of timber is twelve inches every way
breadth, length and thickneſs, and therefore conteineth
1728 ſquare inches, for 12 times 12 is 144, that is, a foot of
board or a *ſuperficies,* and twelve foot of board make 1728
inches; therefore to proceed to the Table. Firſt, For whole
inches: ſquare the ſquare of the piece, that is, multiply the
ſquare by it ſelf, and by that product divide 1728. *Example.*
Suppoſe the piece be 8 inches ſquare, the ſquare of 8 is 64, by
which divide 1728, it gives 27 inches, or two foot, three in-
ches. But if you have odd half-inches, then you muſt reduce
as before all your inches into half-inches, or an improper
Fraction, by whoſe Denominator (which will always be 4)
multiply 1728, it gives 6912, which muſt always be divided
by the Numerator of the Fraction. Suppoſe the ſquare given
be 6 ¼, that ſquared is 42 ¼ which reduced is 169 quarters; by
which 169 divide 6912, it gives 46 inches, or 3 foot 4 inches
ninety *Centeſmes.* Again if the ſquare be of odd quarterns or
¾ you muſt work as before, and then your dividert will be 16
times 1728, that is, 27648. *Example.* Let your ſquare be 6
¼, that ſquared is 45 & 9 ſixteenths: which reduced into 16
parts by multiplying 45 by 16 and adding 9, it gives 7 19
ſixteenths. Therefore divide 27648 by 729 it gives 7 inches,
or 3 foot, 1 inch, 92 *Centeſmes.*

Here followeth the Table of timber-meaſure.

Inch

Inch squar.	feet.	inch.	cen.	inch squar.	feet.	inc.	cent.	Inc.	Inc.	C.	Inc.	Inc.	C.
1 0	144	0	0	8 0	2	3	0	15	7	68	22	3	57
1	92	1	92	1	2	1	39	1	7	43	1	3	49
2	64	0	0	2	1	11	91	2	7	19	2	3	41
3	47	0	24	3	1	10	57	3	6	97	3	3	34
2 0	36	0	0	9 0	1	9	33	16	6	76	23	3	27
1	28	5	33	1	1	8	19	1	6	54	1	3	20
2	23	0	48	2	1	7	14	2	6	35	2	3	13
3	19	0	60	3	1	6	25	3	6	16	3	3	6
3 0	16	0	0	10	1	5	28	17	5	98	24	3	0
1	13	7	55	1	1	4	44	1	5	81	1	2	94
2	11	9	6	2	1	3	67	2	5	64	2	2	88
3	10	2	88	3	1	2	95	3	5	48	3	2	82
4 0	9	0	0	11	1	2	28	18	5	33	25	2	76
1	7	11	67	1	1	1	65	1	5	19	1	2	71
2	7	1	33	2	1	1	6	2	5		2	2	66
3	6	4	75	3	1	0	51	3	4	91	3	2	61
				Inch.		Inc.	C.	In.	In.	C.	In.	In.	C.
5 0	5	9	12	12		12	0	19	4	78	26	2	56
1	5	2	69	1		11	51	1	4	66	1	2	53
2	4	9	12	2		11	6	2	4	55	2	2	46
3	4	4	26	3		10	63	3	4	43	3	2	41
6 0	4	0	0	13		10	29	20	4	32	27	2	37
1	3	8	23	1		9	82	1	4	21	1	2	33
2	3	4	89	2		9	48	2	4	11	2	2	29
3	3	1	92	3		9	14	3	4	1	3	2	25
7 0	2	11	27	14		8	82	21	3	92	28	2	21
1	2	8	88	1		8	52	1	3	83	1	2	17
2	2	6	72	2		8	22	2	3	74	2	2	13
3	2	4	77	3		7	90	3	3	66	3	2	9

In.	In.	C.	In.	In.	C.	In.	In.	C.	In.	In.	C.
29	2	6	31	1	80	33	1	59	35	1	41
1	2	2	1	1	77	1	1	56	1	1	39
2	1	99	2	1	75	2	1	54	2	1	37
3	1	95	3	1	72	3	1	52	3	1	35
30	1	92	32	1	69	34	1	49	36	1	33
1	1	89	1	1	66	1	1	47			
2	1	86	2	1	64	2	1	45			
3	1	83	3	1	61	3	1	43			

To place this Table on the Rule.

Begin at the other end of the Rule taking thofe 4 columns next the thick edge fave one, and divide them into little fpaces, as you did for board-meafure, fetting on them all the under meafure to 8 inches and an half fquare, yet you may do it to 12 inches, if you will; fetting the fquare inches of the block in that column next fave one to the edge: then the feet requi-red to make a foot forward in the next: then the odd inches in the next to that, and the *Centefmes* in the laft of the 4. Then from 8 and ½ to 36 you may take off your inches from your line of inch-meafure, and your *Centefmes* from your inch of *Centefmes*, as you did in board-meafure, and place it back-ward or forward, according as it fhall be more or lefs then a foot.

CHAP. IIII.

Of meafuring folids, as ftone, timber, &c. and firft of fquare timber.

FOr meafuring all kind of folids the fundamental or gene-ral way is to multiply the inches of the breadth by the inches of the depth, and that product by the inches of the length, and divide the laft product by 1728. This is fo plain, it needs no example: and this is the beft way for ftone of all other.

Q 3   2. A

2. A second way of meafuring fquare timber is by this Ruler. Having the fquare of the piece given look on the Rule, and fee how often you finde the length required at that fquare between that and the end of the Rule in the length of the block, fo many foot of timber is in that block.

To finde the true fquare of a piece broader one way
then another.

But to finde the true fquare of the piece, multiply the breadth by the depth, and from the product extract the fquare-root.

As let the breadth be eight, and the depth 14, thefe multi-plyed make 112, whofe fquare root is 10 $\frac{12}{21}$, according to which fquare you muft meafure the piece. Which difproveth a common errour; which is this, To add both fides together, and to take $\frac{1}{2}$ thereof for the fquare: for fo 8 and 14 make 22, the half thereof is 11. And although there feemes but fmall difference, *viz.* lefs then $\frac{1}{2}$ an inch between their num-bers or roots 10 $\frac{12}{21}$ and 11: yet between their fquares there is no lefs then 9 inches difference, for 11 times 11 is 131, but 8 times 14 is but 112.

3. Now therefore becaufe every Carpenter cannot extract the fquare-root, and to them that can do it, it is but a flow way: and thirdly we never fet any fcales of timber-meafure upon Rules, but for inches, halves and quarters: take this for the beft way of all other, where there is fuch difference of the fides meafure it firft that falfe way, then take out of it always a fquare piece of $\frac{1}{2}$ the difference of the fides. quite through the block; fo in our example 8 and 14, their difference is 6, the $\frac{1}{2}$ thereof is 3: therefore take a piece of 3 inches fquare through the length of the block, for that 3 fquared gives 9, which is the difference between the fquare of it and the rectangle of 8 times 14.

CHAP.

CHAP. V.

Of round timber.

BEcaufe to every circle there belongeth 3 fquares, firft the fquare without the circle, or the fquare of the diameter; fecondly, the fquare equal to the circle, not in Peripherie, but in the *area*; for if the *area* of a circle of a mile round, and a mile about in a fquare be compared, we fhall finde the fquare to contain juft 40 acres, whereas the circle of the fame Peripherie containeth 50 acres, 3 roods, 25 poles $\frac{2}{11}$; and thirdly the fide of the fquare within the circle: therefore we will firft fhew the manner of making thefe 4 fcales, and then the meafuring of round timber: yet before we fhew the making of them our beft way is to take *Virgil's* advice, and to do as he doth with his Bees.

Principio fedes apibus ftatióque petenda.

So before we fhew the making of them we will firft finde out a feat for each of them, and then the making of them one after each other. Firft, in the beginning of the firft chapter we fhewed that we would have one of the edges on one fide befild off : and the reft of that fide divided length-wife into eight equal columns with 7 Gage-ftrokes upon the befill, $\frac{1}{2}$ the length of the Rule, you may fet a fcale of 20 in the inch dividing each inch into halves and quarters. Numbring each half-inch with 10, 20, 30, &c. fave that half-inch next the beginning, which muft not be accounted for any of the tens: but that muft be divided into ten equall parts by it felf, to take the odd inches above even ones, that any round block or circle is about.

Befides this, you have three other fcales that are for round meafure, that fhew the three fquares belonging to the circle: and any of thefe four being known, all the reft are known onely by taking the number thereof upon its proper fcale with your compaffes, and apply that diftance to the fcale proper to the thing defired: and thefe three fcales for thefe fquares are

one

one for the Diameter, or fide of a fquare without the circle, and that each fide thereof toucheth the circle. Another is the fide of a fquare within the circle, or of the chords of 90 degr. and the other is a fide of a fquare, whofe content is equal to the content of a circle. For *Example.* Let a block be girded about with a nealed wyer, and then that wyer laid along upon the block, being found to be 88 inches, I fet one foot of the compaffes in 80 of the faid circle fcale, and the other foot in 8 of thofe 10 odd parts next the beginning of the Rule, reckoned from ten upward, being the contrary way to the other 80. If then you defire to know the Diameter of the circle, or fide of the fquare including the circle, you fhall finde it juft 28 inches, by fetting one foot of the compaffes in 25 of the Diameter fcale, and the other will fall in three odd parts, which added make 28 : for all thefe three laft fcales muft be divided into fives, and numbred with 5, 10, 15, &c. and five odd ones above, at the beginning. Likewife if you apply the fame widenefs of the compaffes to the fcale of the fquare within the circle, that is, to the fquare, that a block being round will be, being hewed juft to the four edges; then fet one foot of the compaffes in one of thofe great divifions by fives, fo that the other may fall amongft the odd fmall divifions, and it gives you 19 $\frac{1}{4}$ *ferè*.

And laftly, if you apply the fame widenefs of the compaffes to the fcale for the fquare equal, fetting one foot in the great divifions, fo that the other may fall in the five odd fmall ones, it gives 24 and about $\frac{2}{3}$.

And in like manner if any of the other three fcales be given, as if the Diameter 14 be given ; if you take 14 upon the Diameter, and carry that to the circle; it gives 44; if to the fquare equal, it gives about 12 $\frac{1}{3}$, and fo of the reft.

C H A P.

CHAP. VI.

Of the proof of these scales by Arithmetical calculation.

FIrst, for the circle-scale, that needs no proof, so that it be truly divided : for that is the basis, on which the other are built, or scale, by which they are made. ·

Secondly, For the Diameter *Archimedes* gives this rule, Multiply the Circumference by seven, and the product divide by 22, so have you the Diameter: so on the contrary. Thus our circle 88, multiplied by seven, gives 616, which divide by 22, quoteth just 28, as afore.

Thirdly, For the square within the circle this is the rule. The square without the circle is double in content to the square within. Or thus, The content of the square within the circle is to the content of the circle as 7 to 11 : First, therefore by the content of the square without, we found the Diameter, or side of the square to be 28, that squared or multiplied by it self is 784, the content thereof. Therefore the content of the square within is but $\frac{1}{2}$ 784, that is, 392. whose square-root is 19 $\frac{11}{39}$, as afore. Secondly, by the content of the circle: for which *Archimedes* saith, half the Diameter multiplied by half the Circumference gives the content, so 44, the half of the Circumference, multiplied by half the Diameter 14, gives 616, the content of the circle. This therefore multiplied by seven, makes 4312, which divided by eleven gives 392, just as afore.

Fourthly, For the square equal to the circle, having by this last rule found the content of the circle to be 616, we need but extract the square-root thereof, which is 24 $\frac{40}{49}$, which doth discover a most monstrous, and a most gross errour in measuring round timber, of which hereafter.

R   C H A P.

C H A P. VII.
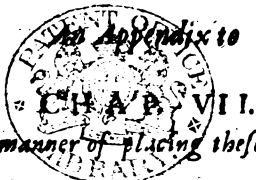
Shewing the manner of placing these upon the Rule.

Irst, To set out the Diameter, you may take the nether part of the third column of the besil'd side, to set it on from the middle square stroke of the Rule. Then *Gunther* (in his *Use of the line of numbers in broad-measure, Prop.* 11.) hath this proportion. Having the Circumference of a circle, to finde the Diameter: As 3143 to 1000, so is the Circumference, suppose it 47 ⌊13 to the Diameter 15 : so that if you take 47 ⌊13 in your circle-scale, and set in that column from the middle square downward, so shall you set out 15 in that distance, run that distance as oft as you can to the bottom of the Rule, which will be 4 times more, divide each of them into 3 equal parts, and the uppermost third into 5 equal, and number all the other great parts, save that with 5, 10, 15, &c. or if you will you may double 47 ⌊13, that is 94, 26, and take it from the circle-scale, set it there they will be 30, then half it, and they will be 15, then third it into fives.

2. To finde how to proportion the square within the circle by the Diameter. Let the Diameter be the *Radius* 1000, then will the chord of 90 degrees, which is the side of the square included, be the natural sine of half 90. *viz.* 45 degrees, the sine whereof is 707, therefore then because I would divide my scale into even sines, if therefore I take 7 times 5, that is 35, the proportion will be 707. 1000 :: 35. 49 ⌊50. or 49 ½: therefore if you take 49 ½ on the Diameter, and set it on the scale of chords, and divide it into 7 equal parts, and that part next the end into 5 small parts, numbring all but that with 5, 10, 15, &c. you have your scale of chords or square within the circle. Or (if you think it troublesome to divide it into 7 equal parts) you may take 6 times 5, that is 30. and say. 707. 1000 :: 38, 42 ⌊43, so then you may take 42 ⌊43 of the Diameter, and set on your scale of chords, and then divide each of them into halves, and each half in to 3 parts.

Other-

Otherwise thus, The content of this circle according to *Archimedes* is just ½ the content of the square of the Diameter. Suppose the Diameter 24, the square thereof is 576, the half whereof is 208, the root whereof is 17. *fere*, then say; If 17 in chords require 24 Diameter, what shall 40 in chords, or any other even number of fives? *Answer*, 56 ½: therefore take 56 ½ of the Diameter, and set it in the scale of chords, which because it gives 8 times 5, first divide it into halves, then into quarters, then into eight.

3. It may also be made by this Rule of his, The *area* of the square within the circle is to the content of the circle as 11 to 7, so that the circle begin known, the content is thus found: ½ the Diameter multiplied in ½ the Circumference gives the content of the circle, which if you multiply by 7, and divide the product by 33, it gives the content of the square within: whereof take the square-root, and you have the side desired; therefore 19 | 8.88 :: 20. 88 | 9, or as M^r. *Wingate* hath it (in *Problem* 33. of his *Appendix* to his *Rule of Proportion*) 225. 1000 :: 20. 88 | 9. So that take 88 | 9 from the Circumference and set it on this scale, and divide it into four fives, and this scale may be set on the lower half of the besil'd edge.

4. Having the content of the Circumference, to find the side of the square equal. Take the square-root thereof: so we found before that the Circumference being 88, the content is 616; whose square root is 24 | 4⁰⁄₄₉, that is more then 24 ¾. or more easily, because, as *Gunther* hath it, the Circumference is to the side of a square equal as 1000 the *Radius* to 282, therefore say, 282. 1000 :: 20. 70 | 9. Therefore take 70 | 9 of the Circumference, and set it in the scale of the square equal, it gives 20 of that scale; with which distance set out all the twenties the side will bear, dividing each 20 into four fives, and the last into five little ones, and numbring them by five as afore : and this scale may be set in the over part of the third column next the square edg e.

Errour in round timber to take a quarter of the circumference for the square.

5. And here I muft acquaint you with that monftrous errour in meafuring round timber which I fpake of before, which is this, to gird the piece about, and to take the fourth part for the fquare thereof: as fuppofe the piece be 80 inches about, then by this account the fquare fhould be but 22 inches: whereas in the laft fection we found it to be above 24 ¼, whereby the full fifth part of the timber is loft to the feller; which notwithftanding the moft of them know to be extream falfe, by reafon that when they have hewed it, they make a great deal more of it, then they did before it was hewed. But what is their excufe? Even this they fay, That will fcarce pay for the hewing, and it is but fap and bark. I anfwer, The goodnefs or badnefs of any thing is confidered in the price; but neither in the meafure nor the manner of meafuring. I have feen a fack of fine feed, white wheat, fold for ten fhillings a bufhel, another of grey wheat at feven, fold the fame day all to one man: yet he had no more meafure of the coarfe grey, then of the fine wheat. Secondly, In that they fay, They had need have that for hewing: I fay, They never hew what they rend to laths, pales, rails, plow-timber, cart-timber, wheel-timber, boles, trenchers, difhes, fpoons, and infinite other, which they rend, and fell fap and all. Thirdly, When they do hew any timber, they leave it fo wany, that (in *Cambridge-fhire* efpecially) they leave it nearer round then fquare; and yet allow nothing for the wanes: fo that in all other things, whether fold by weight or meafure, the buyer is to have the draught, though it be but in an ounce of pepper, in this he muft want of his meafure, and that no fmall matter; for they feldome hew nigher to fquare in this Countrey, then that the four wanes are as broad as the four flats, all which are equal to a fquare piece of the breadth of one of thofe wanes; & although thofe wanes be lefs in fome places then in other, yet will they be of no fervice fo deep as the deepeft wane goes. And what fenfe or equity is there, that in buying they
fhould

should defire fo much over-meafure , and yet in felling it hew-
ed fell fo much fhort, as in buying ? Hath not he that buyeth
wane-timber, that the wanes run not ftreight, as much need,
and as much reafon,to have allowance for the wanes, and to
have the knots and bark left on them for hewing, as you to
have the fifth part and more, and yet never hew a great deal
of it at all? Befides , you have a trick , when you buy
round-timber with the bark on it, be it thick or thin, you will
cut a notch round about the piece in the middle of the block,
fometimes deeper then the bark, faying, That is but a boid:
now you buying by meafure, what right have you to the bark,
which you meafure not? yet when it is hewed, they that buy
it muft be content with air inftead of timber. And yet fur-
ther, I have known a Wheel-wright, that ufed to buy all his
timber by the foot of fourteen inches every way to the foot,
and to girdle it, and to take the fourth part for the fquare;thus
did he over-reach the fellers , who thought it to be but a
feventh part more then ordinary, and that he gave a penny or
twopence more in a foot then others gave,they thought them-
felves well enough; whereas (poor fimple fools!) they fold
above two foot for one.

6. If you buy round timber that is ordinarily taper, little
or much, then you will be fure to gird it in the middle, or
nearer the little end, whereby you gain no fmall matter.

Laftly, How common a thing is it with Wood-mongers, to
have one Rule to buy by,& another to fell by: one a quarter of
an inch too long, another as much too fhort ? And great pity
it is, that confidering there are fo many abufes in meafuring
land and timber, it is not a whit looked into, whereas in all
other things fold by weight or meafure the abufes are punifhed
by the *Clerk of the market.*

Now for correction of this falfe meafure in round timber,
committed by this way of taking the fourth part for the
fquare, if it be a perfect Cilinder, and not taper, you may help
your felf by this Table, taken out of Mr *Stirrup's Plain-fcale,*
or *Carpenters new Rule, page* 60, which you may draw into a

<div align="center">R 3　　　　fcale</div>

ſcale, as you do for ſquare timber or board-meaſure; all but the
firſt ſeven inches, which are under-meaſure, and ſet thoſe 7 in
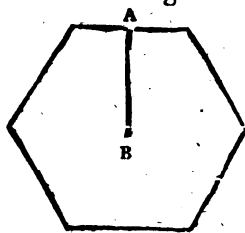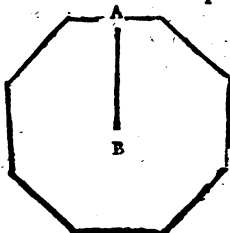four columns, between the two Tables of board and timber
under-meaſure.

Squar. Inch.	Feet.	Inch.	Cent.	Squa. Inch.	Inc.	Cen.	Squa. Inch.	Inc.	Cen.
1	113	1	71	11	11	22	21	3	11
2	28	3	42	12	9	42	22	2	80
3	12	6	85	13	8	3	23	2	56
4	7	0	85	14	6	92	24	2	35
5	4	6	30	15	6	3	25	2	17
6	3	1	71	16	5	30	26	2	0
7	2	3	70	17	4	69	27	1	86
8	1	9	23	18	4	19	28	1	75
9	1	4	76	19	3	76	29	1	61
10	1	1	57	20	3	39	30	1	51

The uſe of this Table is thus.

Girt the piece about, and take the fourth part for the
ſquare, as if it were the true ſquare, and therewith enter this
Table; and it gives the feet, inches, and *Centeſmes* required
forward to make a foot forward at that falſe ſquare. So 44
inches circle gives 11 inches for the fourth part, which in the
Table gives 11 inches, 22 *Centeſmes*, forward to a foot-ſquare
of timber. Or elſe having taken the Circumference with a nea-
led wier, and there made a twiſt, and meaſured the number of
inches about, take off ſo many with your compaſſes, and ap-
ply that wideneſs to the ſcale of the ſquare-equal, and you
have the ſquare you muſt meaſure it at. And becauſe as I
ſaid before, that to hew a log for boards, the beſt way is to
hew it eight-ſquare, both for ſaving timber, and to have all the
boards ſtreight-edged; ſo neither ſhall the ſawyers be paid for
more then they ſaw, nor he that buieth the boards, or the block
it ſelf, want, or have too much : we will now therefore give
you

you one rule whereby to meafure all equal-fided timber, fo that it be not taper, how many fides foever it hath. Firft, finde the centre of your piece, and meafure the femi-diameter thereof to the middle of one of the equal fides; then add all the fides together, multiply half thereof by the femi-diameter: fo have you the content of the bafe, and that multiplied in the length gives the content of the piece. So in the figure the 8 fides are ten a piece, that is, 80; the half whereof is 40; the femi-diameter or perpendicular A B is 12, that multiplyed by 12 makes 480, which is the content of the bafe, that is, one inch fawed off of the end of the piece. Then if either you multiply 480 by the inches of the length of the piece, and divide the product by 1728, you have the content of the piece. Or elfe you may extract the fquare-root of 480, which is 22 *ferè*, and then meafure it, as if it were 22 inches fquare. And thus may you meafure all manner of timber, not taper, by meafuring one inch at the end, as if it were land : then extract the root, and meafure is as if it were fo much fquare.

C H A P. VIII.

Of taper-timber, whether Conical or Pyramidal.

FOr fuch kinde of timber of either fort, meafure it as if it were a whole Cilinder or Prifme, that is, Firft, finde the *area* of the bafe, and multiply it by the whole length, thus; Let a Prifme be four-fquare, the fide 12, the *area* of the bafe is 144, and fuppofe the length 100, thefe multiplied make 14400. But by the Corollary of the 7th *Prop.* 12. *lib. Euclid.* every Pyramis is the third part of a Prifme, having the fame bafe and altitude : therefore divide 14400 by 3, it giveth

4800

4800 the content of the Pyramis. But suppose it be an imper-
fect Pyramis, that runs not to a point, but hath his top cut off,
you shall then continue out the sides to a perfect Pyramis, by
plotting it in paper, or else finde how much it wants by the
Rule of three. *Example.*

The side of the base being twelve, the length of the piece
fiftie, and the side there is six, so that there is six lost in fiftie;
but the whole side of the base is but twelve, whence take six,
six resteth. Then say 6. 50:: 6. 50. and 50 and 50 make
an hundred, as before. Now then for this little Pyramid, the
side or Diameter of the base thereof being six, whose square is
36, the third part whereof is twelve, that multiplied by 50,
gives 600, the content of the lesser Pyramid. Subtract this
perfect Pyramid out of the great perfect Pyramid 4800, rests
4200, the imperfect Pyramis. And the reason, that holds be-
tween the Prisme and Pyramis, holdeth also between the Cilin-
der and Cone, *Prop.* 10. 12. *Euclid.* Every Cone is the third
part of a Cilinder, having the same base and altitude.

Of the Cone.

Let us now suppose a Cone also divided in length into 50
and 50, the greater Diameter at the base to be twelve, and six
in the middle. First, to finde the Circumference to 12, the Di-
ameter: 12 multiplied by 22 is 264, that divided by 7 is $37\frac{5}{7}$,
the Circumference. Then multiply half $37\frac{5}{7}$ (that is) $18\frac{6}{7}$ by
half the Diameter, (that is) six, it gives $115\frac{5}{7}$, the greater
area, which multiplied by 100 the length, it gives $11514\frac{2}{7}$ the
Cilinder, the third part whereof is $3838\frac{2}{21}$ the greater Cone,
Now for the lesser, the Diameter is six, multiply it by 22, it is
132, that divided by seven, is $18\frac{6}{7}$ the base, which multiply by
the length 50 is 942, the third part thereof is $314\frac{2}{7}$ the
lesser Cone.

Now take $314\frac{2}{7}$ out of $3838\frac{2}{21}$, resteth the imperfect
Cone 3520, which is almost twelve times as big as the lesser.
Or, if you rather desire 12 and 6, the bases of the Pyramis, to
be the sides of the square within the circle, as there they are,
and then to see their dimensions: then first, if twelve be a side
of

of a square within the circle, since the content, or square there-of, is but half the content of the square of the Diameter: therefore double the square thereof, and out of the double extract the square root, and you have the Diameter : so 12 squared is 144, that doubled is 288; whose square-root is 17 *fere*, the Diameter.

Now to finde the Circumference, multiply 17 the Diameter by 22, *facit* 374. that divide by seven, it quoteth 53 ¼ the Circumference: then multiply half the Circumference 26 ⁵⁄₇ by half the Diameter 8 ½, it gives the *area* of this base 2₂7 ₁₄ⁱ, which multiplied by 100, the length, gives 22707 ¼ the Cilinder, which divided by 3 gives the great Cone 75695 ½. Like-wise for the lesser square within, which is six, the square is 36, that doubled is 72, the square-root whereof is 8 ½ *fere*, the Diameter. Multiply 8 ½ by 22, it gives 187; which divided by 7 gives 26 ⁵⁄₇ the Circumference, then multiply half 26 ⁵⁄₇ (that is) 13 ⁵⁄₁₄, by half 8 & an half (that is) 4 ¼, and you have 56 ¹⁷⁷⁄₈₇₉ or ⌊72 *fere*, the content of that *area*; which multiply by 50 the length gives 2835: the third part thereof is 945, the lesser Cone. Take this lesser 945 out of the greater 7569, resteth 6624, the imperfect Cone: So that the imperfect Cone is more then seven times as big as the little one.

The discovery of severall errours in measuring the Pyramid and Cone : and first of the Pyramid.

Some hold that to be true, To add the *areas* at both ends together, and multiply the 1 half thereof by the length of the piece, as in our example the *area* of the great end is 144, and the little end nothing therefore half 144 (*i.e.*) 72 multiplyed by 100 is 7200; but it should be but 4800: it is too much by 2400.

A second errour is to take the *area* at the third part from the great end, as in this figure, at C and C, but there the square or side is 8, and the square number or *area* thereof is 64, which multiplied by 100 is 6400, too much by 1600.

A third errour is to take the square in the midst of the piece,

as at B and B, where the fide is 6, the *area* 36: that multiplied by 100 the length gives 36,0, which is too little, for take 3600 out of 4800, the difference is 1200, a juft quartern loft of the timber to the feller; fo that it falleth near the middle between B and C, where it is 7 inches, for that gives 5900, yet there it is too much by an hundred.

Secondly in the Cone.

The common practife is to gird it in the middle, and to take the fourth part for the fquare. In meafuring the cilinder, there was more then the fift part loft to the feller: but here that it is taper alfo, is a more intolerable lofs. For if in the fquare Pyramid was loft a full quartern onely by reafon of tapering: what will here be loft where two fuch errours combine in one to wrong a man? The Circumference in the midft of the piece is 26 ½, the fourth part thereof is 6 ½, which fquared is 45 ½ and that multiplied by 100 makes 4556 ¼, which taken out of 7569, there is loft to the feller 3013, which is almoft one half thereof. Yet this goeth fo for currant in all places, that he that contradicts it is fcorned as a fool, and accounted as a knave.
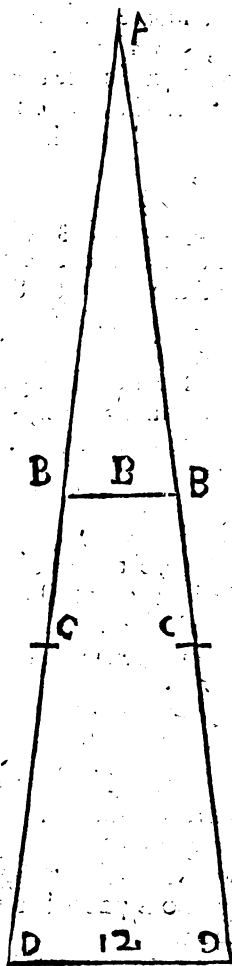
CHAP. IX.

Of the making of four other lines on the flat-sides, whereof three
are Mr. Gunthers *lines, of numbers, sines, and tangents; and*
instead of the Meridian line, which is onely usefull for Navi-
gation, whereof Carpenters *make little or no use, we have*
added a sextant of chords.

ALthough *Mr.* Wingate (in his book called *The Rule of*
Proportion,) hath set down the making of them: yet for
that he hath done them after another manner then here is
shown, neither will an ordinary Rule bear all those lines, we
will therefore content our selves with *Mr.* Gunther's, & the
line of chords onely. You shall divide the rest of the Rule be-
side the columns of feet & inch-measure before spoken of, into
four other great columns, and divide each of them into two
equal, and one of them into two also; so the great shall be
for figures, the other 2 for strokes.   These two of Mr. *Gun-*
thers you may set in the three middle columns, and the line
of chords on the other outside.

    First , for making the line of numbers.

   I told you before that I would have you strike a stroke
round about cross the Rule, I would also have another at
each end of the Rule so close as possibly you can, onely
to set one point of the compasses on.   Then first set
out your great division in each foot ; *viz.* the thousands,
if your number consist of four figures, or howsoever they
are to be the left hand figures of any number , as 3 in 3
32. 346. 3654. 37046, &c. and must be marked with the 9
digits in either foot, and the first last and middle-most with
one, so that you may understand as many ciphers with it as
shall be requisite, so that it may signifie 1. 10. 100. 1000.
and then if one signifie 10 the next two will naturally signifie
20, but not always. Now to take and set the number 2 in his
right place, take a Table of Logarithmes of absolute num-
bers, and look either the Logarithme of 2. 20. or 200. and
          S 2   take

take the three next figures to the Characteristick, which are
301: then with your compasses take 301. *viz.* three inches,
no tenth part of an inch, and ‚¹⁄₁‚ of a tenth part or *Centesmes*
of an inch, and set one foot in the nether-most cross stroke,
where you set the first one, and turn the other upward in the
same column, and there set your 2 likewise with the same
numbers, set one foot in the middle cross stroke where you
set the middle one, and turn the other upward toward the up-
permost one, and there set your 2 also: likewise, do with
3 whose Logarithme is 477 (*id est*) 4 inches, 7 tenths; 7 *Cen-
tesmes*: also with 4. And these figures for the making of this
line we will call hundreds, the next subdivision tens, and the
least *Centesmes*. But now because we will suppose your com-
passes will not well reach beyond the figure 4, whose Loga-
rithme is 602, that is above 6 of those inches: therefore first,
let us set on the tens so far on both feet, and then the rest of
each foot afterward. Next set out each fifth tenth so far: be-
cause you must mark them with longer strokes, then each sin-
gle ten: so then you must not account the next of those fifths
to 1 as 5. (for then you will account the one for nothing) but
you must account it for 15. or 150. and so take the Loga-
rithme thereof, which is 176. Likewise 25, or 250, is 398, which
you must take with your compasses, and set in their places in
in both feet, and in like sort shall you do with all your single
tens; accounting that next 1 not for 1, nor 2, but for 11.
Or instead of taking them off with your compasses, strike out
all the first foot with a fine small striking squire of brass, lay-
ing it upo n the Log. in the line of foot-measure, and then set
out the other foot with your compasses by this.

New for the rest of each foot, look out the Logar. of your
numbers, and take the distance between it and the middle cross-
stroke, and with that wideness set one foot in the upper 1, and
where the other falls, there is the place of that number. *Ex-
ample.* I would set out 70, the Log. is 845; I take the distance
between it and the middle-stroke of the Rule, or the Arith-
metical complement of it, 154, and set it both from the upper
stroke

ſtroke and middle-ſtroke downward, and you ſet out ſeventy.
But your over-foot may bear unites to 20, and from thence to
40, divide each tenth into five, and from thence to the end
into two.

To make the line of ſines.

First, you muſt know that neither the line of ſines, nor tan-
gents, enter the Rule till 35 minutes: where you ſee the two
next figures to the characteriſtick 8, are both ciphers; there
alſo the characteriſtick changeth from 7 to 8: for your chara-
cteriſtick ſhews what foot you are in: therefore ſince we rec-
kon the minutes onely by tens, our firſt number or diviſion up-
on the Rule will be at 40 minutes of the firſt foot. ſhewn by
the characteriſtick 8: for 9 is the laſt, and therefore belongs to
the laſt foot; ſo that whereas you ſee that the Log. of one mi-
nute hath 6 the characteriſtick, & 4 63 the three next figures:
therefore one minute would be above a foot and half before
the entrance on the Rule, and likewiſe would the firſt minute
of the tangents be. Now the Logar. of 40 minutes hath beſide
the characteriſtick 8 the three firſt figures 066 *ferè:* therefore
take off 0 inch, 6 tenths, and 6 *centeſmes*, or 5 *centeſmes*, and
7 *milleſmes,* if you can ghueſs ſo near, and ſet them from the
nethermoſt croſs-ſtroke at the beginning of the line of ſines
forward. And thus do for all under two degrees, be it ſine or
tangent: but from thence to ſine 5 degr. 45 min. or tangent
5 degr. 43 min. (As ſuppoſe the ſine of 4 degr. whoſe Logar.
beſide the characteriſtick is 843:) you ſhall take the diſtance
between 8 inches, 4 tenths, 3 *cent.* and ten inches, and apply
that diſtance from the middle-ſtroke down-ward: and ſo of
the reſt of the quarter. But for all both ſines and tangents
in this firſt foot: you may by their Logarithmes ſtrike them
with a ſquare, as you did the line of numbers.

Now for the upper-part ſhewed by the characteriſtick for
all ſines and tangents to 20 degr. as ſuppoſe the tangent of 20
degr. the Logarithmes of 20 degr. tangent is 56: ſet it from
the middle-ſtroke forward, but from thence to the ſine of 90,
and tangent of 45 degr. as the ſine of 40, whoſe Logar. is

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808; take the diſtance between it and the middle-croſs-line, and apply it in the line of ſines from the upper croſs-ſtroke down-ward: then number all the whole degrees to ten, with 1, 2, 3, and after that in the ſines with 20, 30, 40, &c. to 90, and the tangents with 10, 20, to 45, and back with 50, 60, to 80 degrees.

Laſtly, for making the ſextant of chords.

Set a pair of beam-compaſſes, with a beam of willow, deal, or ſallow, near half an inch thick, and ¼ broad; make a little nut of good tough wood, with a mortes in it, that the beam may ſlide in it to and fro, indifferently ſtiff, and in all places a-like, with a ſhort prick, or little piece of an aule-blade in one end, and another longer in one edge of the beam hard by the end, ſo long from the beam as the other point is. If it goeth not ſtiff enough to ſtand and tran with at any place, make the mortes a little the deeper one way to put in a wedge, or elſe help your ſelf with a ſcrew-pin, then go to ſome ſmooth loft boards, opening your compaſſes to 23 ½ inches, and with that wideneſs tran an arch, that may be two foot long at the leaſt, and with each foot of the compaſſes make a prick in the ſaid arch, and ſet it likewiſe upon the Rule; then divide that ſpace in the arch into two equal parts, which will be 30 degr. a piece, and each of them into three apiece, which will be 10 degr. apiece, and each of them into two, which will be five apiece, and each of them into five ſimple ones. Then take them off from the floor, and ſet them on the Rule, one after another, and number them with 10, 20, 30, 40, 50, 60, and this will be wonderfull beneficial in Dialling, and alſo in many other things, as to divide a circle into any number of equal parts, or to make an angle of any number of degrees, or to finde the quantity of any angle, and ſo by the line of foot-meaſure you may alſo divide a ſtreight line into as many parts as you will.

Now as I have ſhewed the uſe of all the lines on the other ſide of the Rule, and alſo of both the out-ſide lines on this ſide; ſo for the other three I muſt content my ſelf to ſhew

you

you the ufe in general : for if I fhould defcend to particulars, all the paper in *Cambridge* would be too little to hold them. Firft therefore, you fee already, that as by the line of foot-meafure, and Table of Logarithms thefe lines are made; fo may you by thefe lines finde the Logarithme of any abfolute number, tangent or fine, as if it were by the Table of Logarithms.

Secondly, By thefe two lines of numbers and foot-meafure may be refolved all queftions whatfoever, that common Arithmetick can refolve. And more ; for hereby may be refolved all queftions of Intereft, Purchafes, Annuities, &c.

Thirdly, By thefe three lines of numbers, fines, and tangents is refolved the whole doctrine of Triangles, and whatfoever may be performed by them, either in Meafuring, Dialling, Geography, Geometry, Arithmetick, Navigation, Cofmography, Aftronomy, &c.

But, becaufe (gentle Reader) I would have thee learn now to go alone ; I will commit thefe to thine own confideration, knowing that that chicken that will peck up never a corn, but what the hen puts in the mouth, will never be a fat chicken.

Now if the Rule of three is accounted of all men worthy for its excellency of the name of the *Golden-Rule* (which is but the leaft part of the ufe of one of the lines of this Ruler) then juftly may this Ruler be called the *Golden-Ruler*.

FINIS.

DEPARTMENT OF PRINTED BOOKS

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