



R. d. Freynolds
his Book
1730.

John Dalton

1777

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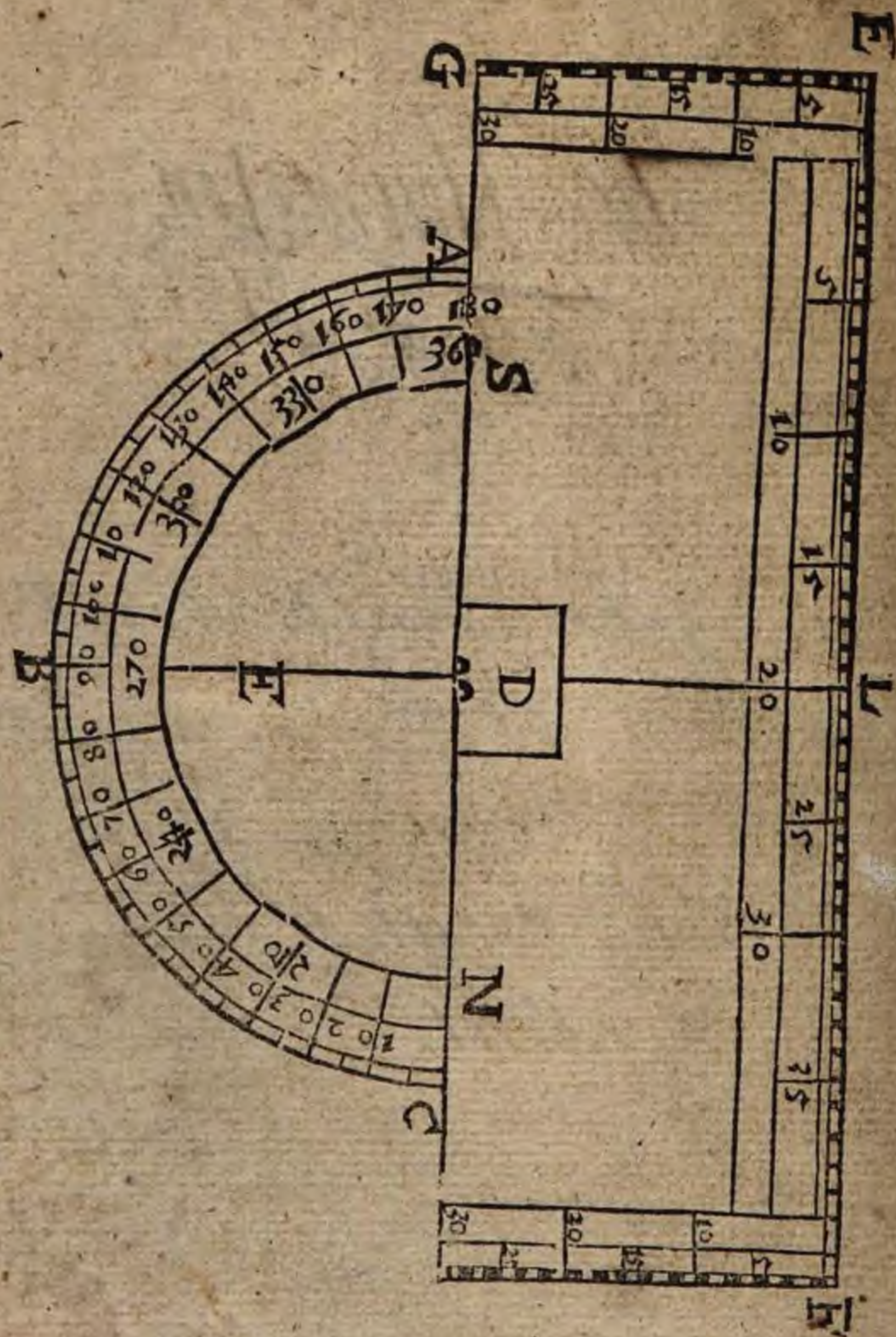
Jos Newnham of Badby in Conder
Carpenter gives All his Money & Jewels
for money to Richard Wells of Badby of our
Lab^r power of attorney *Wells* & *Wells*
Wells Sole Exec^r.

~~Bought this Book
at Mr. Clay's Coventry. 1777~~

Bought this Book
of Mr. Clay A.D. 1777

8532 *aaa* ✓





J.W. Lambton 3. pp. 2. ed.

THE EXACT SURVEYOR: OR, The whole ART of SURVEYING OF LAND.

Shewing how to Plot all manner of Grounds, whether small Inclosures, Champain plaine, Wood-lands, or Mountains, by the *Plain Table*, *Theodolite*, and *Circumferentor*; And how exactly to prove the truth thereof.

And also how to finde the Area, or Content of any Land; To Protract, Reduce, and Divide the same, as required: To take the Plot of a whole Mannor, and to make a perfect Map or Chart thereof, and how to Advance and beautifie the same.

Usefull for all that either Sell or Purchase.

BY J: EYRE,
Practitioner in the Mathematicks.

LONDON,
Printed for *Nath: Brook*, at the Angel
in *Corne-Hill*, 1654.



To
The *READER*.

THe utility of the *Art of Surveying*,
viz. Measuring, Plotting, and Di-
viding of Land, is so well known, that
it needeth not my commendation, And there-
fore to speak any thing thereto, were but to light
a *Candle before the Sun*.

It may be objected, that there are *Bookes*,
already extant sufficient for this purpose, to
which I answer; most *Bookes* of this subject, are
out of *Presse*, and not easie to be had; And
there is also, more variety of *Bookes* of other
Sciences that are lesse conducing to the publique
good; And lastly, thou wilt finde in this, some
things not to be found in others.

In the following *Treatise* is contained,
first, the *Description* of all the most usuall
Surveying Instruments, *viz. the Theodo-*



THE EXACT
SURVEYOR
OR
THE WHOLE ART OF
SURVEYING
OF
LANDS

Showing how to Plot all manner
of Townes, Villages, Hamlets,
Churches, Parishes, Woodlands, or Meads,
and how to divide any Land into
any number of Parts, as is required:
And how to measure any Land
by a single Survey, and to make
a true Map or Plan thereof, and how
to lay out any Land into
any number of Parts, as is required:
And how to measure any Land
by a single Survey, and to make
a true Map or Plan thereof, and how
to lay out any Land into
any number of Parts, as is required:

BY
WILLIAM
BLUNDELL
OF
OXFORD
ESQ;
Printed for J. Sturges, at the Angel
in St. Dunstons Church-yard, 1675.

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To the Reader.

lite, Circumferentor, Plain Table, and Protractor; The Decimall Chaine and Field-Booke.

2. Certaine Geometricall Principalls, fit to be knowne by the Surveyour before he enter upon his Work.

3. An Artificiall Table of Sines, to every 5. Min. of the Quadrant, and a Table of Logarithmes unto 1000. With their use in taking of Angles, Heights, Depths, and Distances, &c.

4. How to plot all manner of Grounds severall wayes; And how to prove the truth of your Worke most exactly, by a Decimall Table never before Printed.

5. How to cast up, or finde the Area, or Content of any Piece of Land.

6. How to Divide any Land, according to any Proportions, or Parts, required, with Lines passing by any assigned points in the same.

7. How to deduce Irish Measure into English Statute Measure, and the contrary; And how to reduce English customary Measure, into English Statute Measure, and the contrary, by new Tables, for that purpose.

8. How to take the Plot of a whole Mannor

To the Reader, &c.

together, consisting of divers severalls, with the manner how to keepe account in your Field-book.

9. How to reduce your Plot into a lesser proportion, or the contrary; And how to adorne and beautifie the same.

10. How to know whether water may be conveyed from a Fountaine unto an appoynted place.

11. How to measure the solid Content of Stone or Timber. And how to reduce a Wine or Beere Vessell into a Cylinder, and to finde the content thereof in Wine, or Beere Gallons.

In all which is used much brevity, yet every thing so plaine, that the meanest apprehensions may understand the same.

It was written by the Author at his Recreative houres, for his private use, and now at the request of Friends is made publique. Thy favourable censure, and kind acception hereof, may animate him to present thee with something of more consequence hereafter,

J. Eyre.

Whosoever hath or Shall have Ocasion
for all or any of these Instruments
Mentioned in this Booke or any Other
for the Mathematicall Practice Either in
Silver Brass or Wood may Be Exactly
furnished by Walter Hayes At the
Crosse Daggers in Moore fields Neere
Bethlem Gate London



CHAP. I.

Of the most necessary Instruments
appertaining to Surveying
of LAND.



Among the many Instruments that
have from time to time beene
invented for the practice of *Survey*,
these three have been in most
esteeme. 1. The *Theodolite*, 2. The
Circumferentor, and 3. The *Plaine*
Table; And for asmuch as these three
are grounded upon one and the same
Principle, they have been all united
and made as one instrument, viz.
The *Plaine Table*.

Now for as much as in the practi-
call part of *Survey*, we intend onely
to make use of the *Plaine Table* (as
it is now framed) being the most
generall Instrument of any other: I
shall therefore first in generall
termes, deliver the severall parts
of which the other two are framed,
And then particularly describe the
severall Materialls, of which a
Plaine Table is composed, that so
the Surveyour

may take his choise; And being well exercised in the use of one Instrument, hee cannot be ignorant of the application of that to any of the other, for in many cases one Instrument may make a quicker dispatch, and be altogether as exact as another, and in laying downe of a spacious businesse, I would advise him to use the *Circumferentor*, or *Theodolite*, and for Townships, and small inclosures the *Plaine Table*, which (as I said before) containes both the other, and therefore may very well supply the want of both or either of them, as in my description of them severally, I shall make appeare.

CHAP. II.

A description of the Theodolite, and its severall parts.

THIS Instrument consisteth of foure parts. First, The *Planisphere*, or *Circle*, whose limbe is divided into 360 equall parts, called *degrees*, without which it were fitting to have drawne six concentrick Circles (not equidistant, Master *Norwood* having sufficiently detected that error in pag. 81. of his *Architecture Military*) with *Diagonalls*, by which the parts of a degree are distinguished.

The second part of this Instrument is the *Geometricall Square*, described upon the former *Planisphere*, within the *Circle*, whose use with the helpe of the *Index*, is chiefly to find *Length*, *Bredths*, and *Distances*.

The third part of this Instrument is a *Semicircle* or *Quadrant*, perpendicularly erected, and artificially

tially contrived upon the *Index*; whose Limbe is divided (if a *Semicircle*) into 180. *degrees*, but if a *Quadrant* into 90.

The fourth and last part of this Instrument is a scale divided into a certaine number of equall parts, whose use is chiefly to finde *Altitudes*, and *Profunditudes*: The description and use of this Instrument is largely treated on by Mr. *Leonard Diggs*, in his *Pantometria*, and therefore I am emboldned to pass it over with the more brevity.

CHAP. III.

A Description of the Circumferentor, and the parts thereof.

FOR portability, this Instrument exceedeth any other, and is usually made of wood, containing in length about eight Inches, and in bredth about foure Inches, and in thicknesse three quarters of an Inch, the left side whereof is divided into divers equall parts, most fitly of twelve in an Inch, to be used as the scale of a protractor, the Instrument of it selfe being fitting to protract the plot on paper by helpe of the *Needle*, and the degrees of Angles, and length of Lines taken in the Field. About the middle of the upper side of this Instrument is turned a round hole, three Inches and a halfe diameter, and about halfe an Inch deepe; in which is placed a Card divided commonly into 120 equall parts, and each part againe into three, which makes 360. answerable to the degrees of the *Theodolite*; In which Card is also a *Diall* drawne

to finde the houre and Azimuth of the Sun; over this Card, and within the Box, is hanged a Needle touched with a Load-stone, and covered with a cleere Glasse, to preserve it from winde and weather.

On the upper part of this Instrument is also described a Table of sines divided answerable to the Card specified before, that is to say, If the Card be divided but into 120. parts, the sines must be so also; but if into 360. the sines must be the absolute degrees of the *Quadrant*: but in regard we intend onely to make use of the *Plaine Table*, we will reject that Table of sines seeing we have hereafter added a table of Artificiall sines to supply that defect more commodiously.

There is also belonging unto this Instrument two sights, the one double in length to the other, the longest containing about seven Inches, being placed and divided in all respects, as those hereafter mentioned in the description of the *Plaine Table*. On the edge of the shorter sight, toward the upper part thereof, is placed a small wyer representing the Center of a supposed Circle, the *Semidiameter* whereof is the distance from the wyer to the edge of the Instrument underneath the same, which part is imaginarily divided into sixty equall parts, and according to those divisions is the right line of divisions on the edge of the Instrument, divided and numbred by 5. 10. 15. from the perpendicular point to the end thereof: And also from the same point on the upper edge of the Instrument is perfected the degrees of the quadrant, supplying the residue of those which could not be expressed on the long sight, from 28. to 90. by tens. There

There are also belonging unto these divisions, a little ruler at the one end, whereby is a little hole to put it upon the wyer on the edge of the shorter sight; at the other end of this ruler is placed a small sight, directly over the fiduciall edge thereof; which edge is likewise divided according to those divisions on the edge of the Instrument: to this short side is added a plummet to seat the Instrument horizontall.

Note that this short ruler and divisions serve for taking of *Altitudes* and *profundities*, and for the reducing of *hypothensall*, to *horizontall* lines.

CHAP. IV.

Of the Plaine Table, and the severall parts of which it is composed, how it may be made generall, and supply the wants of the other two Instruments before mentioned.

OF what generall use this *Plaine Table* is of, I shall make appeare when I come to the use and application thereof, to our present purpose. In the interim give me leave to describe the severall parts thereof, as I would advise (where I may) the *Surveyour* to have it framed.

The Instrument consisteth of severall parts, As first, The *Table* it selfe being a *Parallelogram*, containing in length about fourteene Inches, and an halfe and in bredth eleven Inches. This Table is in three severall boards, which may be easily taken asunder, for ease and convenience in carriage. The second part of which this Instrument is composed, is a joynted frame, so contrived that

it may be taken off, and put on the Table at pleasure, and is to fasten a sheete of paper upon the Table; When you are to describe the plot of any Field, or other inclosure by the *Table*. This frame may have upon it neere the inward edge, scales of equall parts, on both sides, for the exact and speedy drawing of parallel lines upon the paper: The third part of this Instrument is a *Ruler* or *Index* containing in length about sixteene Inches or more, it being full as long as from Angle to Angle of your *Table*, it ought to be about two inches in bredth, and one third part of an inch in thickeffe: unto this *Ruler* or *Index* belong two sights, the one whereof is double in length to the other, the longer containing in length about twelve Inches, the other halfe as much: On the top of this shorter sight, is placed a brasse pin, and also a third and plummet to place your Instrument horizontall, through the longer sight must be made a slit, almost the whole length thereof. These two sights thus prepared, are to be perpendicularly erected upon the *Ruler* (by two Mortesses made for that purpose) in such sort, that the wyer on the top of the shorter sight, stand precisely over the fiduciall edge of the *Ruler*. The space or distance of these two sights one from the other, is to be equall to the divided part of the longer sight (which hereafter I may call the length thereof.) Upon the longer sight is to be placed a vane of brasse, to be moved up and downe at pleasure, through which a small hole is to be made, answerable to the slit in the same sight, and the edge of the Vane. By these sights thus placed on the *Ruler* there is projected the Geometri-

call

call *square*, whose side is the divided part of the long sight (or the distance between the two sights) In the middle of the long sight (through the whole bredth thereof) there is drawn a Line called the Line of Levell, dividing the side of the projected square into two equall parts: Also the same side is on this sight divided into a hundred equall parts, which are numbred upwards and downwards, from the Line of Levell, by fives and tens to fifty, on either side, which divisions are called the scale.

There is also on the same sight another sort of division representing the *Hypothensall* Lines of the same square, as they are increased by units, and are likewise numbred upwards and downwards, from the Lines of Levell, from one to twelve, by 1. 2. 3. &c. Sometimes signifying, 101. 102. 103. &c. these divisions shew how much any *Hypothensall* or *slope line* drawn over the same square, (that is from the pins head to any such division) exceedeth the direct *Horizontall Line*, being the side of the same square.

On this sight there is a third sort of divisions, representing the degrees of a *Quadrant* (or as many as the same sight is capable to receive, which are about 25.) numbred from the Line of Levell upward and downward by fives and tens to 25. which divisions are called the *quadrant*.

On the upper part of this *Ruler* may be placed the *Table* of sines, before mentioned in the Description of the *Circumferentor*.

Unto this Instrument also belong other necessary parts, as the *Socket*, the *Staffe*, the *Box*, and *Needle*.

According to this Description, have *Plaine Tables* usually beene made, but (as I said before) that it may become an universall and absolute Instrument, I would advise the Surveyour to have these additionall parts following.

1. Upon the frame (towards the outward edge thereof) I would have projected the 180. degrees of a *Semicircle*, from a *Center* noted in the surface of the *Table*, and numbred from the left hand towards the right (when the *Center* is next to you) by fives and tens to 180. and back againe the same way to 360. these degrees thus inserted is of excellent use in wet and stormy weather, when you cannot keepe a sheet of paper upon your *Table*; either in respect of Raine or winde. And also it maketh the surface, or upper part of your *Plaine Table*, to be capable of all the uses that the *Plani-sphere* of the *Theodolite*, or the *Card* of the *Circumferentor* can performe.

2. Upon the *Index* or *Ruler* before spoken of, I would have (instead of the sight there described) two sights with sliding Loops, both of one length, and double sighted; the one having a slit below, and a thred above, and the other a slit above, and a thred below, serving to looke backward and forward at pleasure without turning about the Instrument, when the *Needle* is at quiet. How much expedition the back sights will make, I shall leave to the Surveyour to finde by experience, for using these he shall need (in going about an inclosure) to plant his Instrument but at every second Angle,
and

and may looke backward and forward at pleasure, without moving of the *Index*.

3. Instead of the divisions of the sights before described in the description of the *Plaine Table*, I would advise the Surveyour to have upon the *Index* of this *Plaine Table* a *Quadrant*, whose Limbe must be divided into 90. degrees, or equall parts: whereby all manner of *Altitudes*, and *Profundities*, are most exactly computed onely by *Addition*, and *Subtraction*, without other *Arithmeticall calculation*, or *Geometrical Projection*.

Moreover, for the exact accomplishment of this most absolute Instrument there belongeth some other materiall parts, as a *Box* to containe a *Card*, and *Needle*, (such as is formerly described in the projection of the *Circumferentor*) covered over with a cleere *Glasse*, and close stopped with *Wax*, to preserve it from wind and weather.

This *Box* may be so contrived, that it may have two *Mortesses* made therein, to place the *sines* of the *Plaine Table*, and may have also the *Table of sines* thereon, which is inserted in the description of the *Circumferentor*, and so will the *Plaine Table* be as capable of all the uses of the Instrument as of the *Theodolite*.

Also you must have a socket of *brasse* to be screwed on the back-side of the *Table*, to put in the head of your three-legg'd staffe; This staffe ought to be joynted in the Middle, so that it may be more portable.

This staffe may be so fitted, as to be fastened to the *Box*, and *Needle*, when it is used as a *Circumferentor*.

Note that this Instrument (when made as here is directed) is the most absolute Instrument for a Surveyour to use.

CHAP. V.

The making and Division of a Decimall Chain.

FOR the better avoyding many inconveniences, I would advise the Surveyour to have his Chain made of a good round wyre, not to containe above two statute Poles, or Perches, or three at the most, (which we will hereafter call an unite) containeth in length 16. feete and a halfe, which is 198 Inches, this quantity is first to be divided into ten equall parts (called Primes) every of which containe in length 19. Inches, and foure fifth parts of an Inch, and againe every of those Primes to be subdivided into ten more equall parts, which wee will call Seconds, and so every of these seconds shall containe in length one inch and forty nine of fifty parts of an inch, and so is the whole Perch, Unite, or commencement, divided into 100. equall parts, or Links, called seconds.

The Chain being thus divided, at the end of every fifth pin, or fiftieth second, or Link, which is the end of every halfe Pole, Let a large Curtaine-ring be fastned, so shall you have in a whole Chain (if but two Perch-long) three of these rings, the middle-most being the divisions of the two Poles of which the whole Chain consisteth, then at the end of every Prime, that is, at every tenth second or Link,

Link, let a small Curtaine-ring be placed, by these distinctions, the Chain is divided into these 3. terms: Unites, Primes and Seconds, whose Characters are these, 0. 1. 2. So that if you would expresse 26. Units, foure Primes, and five Seconds, they are thus to be written; 26.45. by which you may perceive that these figures which have no prick over them, are Units, or Integers, and the first point, Primes, and the next, Seconds: and according to this Rule three Units, seven Primes, and two Seconds will stand thus, 372. Besides these divisions Mr. Rathborne for his own use sowed at the end of every two Primes and a halfe (which is a quarter of a Pole) a small red cloath, and at every seven Primes and a halfe (being the three quarters of a Pole) the like of yellow, or other discernable colour, which if any Surveyour likewise doe, he shall most speedily reckon the quantity of every ring, remembering that if it be the next ring short of the red, it is two Primes; If the next over, three; if the next short of the yellow, seven Primes; if the next over, eight; if the next short of a great halfe-ring it is foure, the next over, Six, And lastly, if the next short of the middle great ring, it is nine, and if the next over one.

But here is to be noted, that if you use this distinction by colours, you must worke with one end of the Chain from you alwayes.

This Chain thus divided, and marked, you have every whole Pole equall to ten Primes, or 100. Seconds, every three quarters of a Pole, equall to seven Primes and a halfe, or 75. Seconds, every halfe Pole equall to five Primes, or fifty Seconds: and

and Lastly, every quarter of a Pole, equall to two Primes and a halfe, or 25. Seconds.

Here is to be noted, that in the ordinary use of this *Chain*, for measuring and plotting, you may take onely notice of Units and Primes, which is more exact, than in ordinary use: but in case of separation or division of Lands, or for the dimension of common Fields, into severall parts, you may make use of Seconds.

Some observations in the use of your Chain, and the manner to account upon the same.

It is to be observed that when you are to measure any distance with your *Chain*, (Especially if it be not by a hedge side, but in the middle of a Field) which most commonly happeneth, when you worke by a *Plaine Table*, and take your station in the midst of the Field, you must measure directly in a streight Line, (Otherwise great error may ensue) which that you may doe with most convenience, you must provide certaine little sticks, (as arrowes or the like) that at the end of every *Chain* you may stick one of them in the ground, and so you may at every *Chains* end see whether they and your Instrument be in a streight Line or not, and if they be, you may be assured you have measured exactly, otherwise you may in time recall your selfe and mend your error.

These small sticks will stand you in excellent good steed for keeping of your account, for in measuring of a large distance you may easily mistake a *Chain* or two (if you be not very carefull) but

but the number of your sticks, being taken up as you goe back from the place measured to your Instrument, will be a good remembrance. The Convenience of these will be best seene in Practice.

CHAP. VI.

A Description of the Protractor, and the Scale thereof.

A Protractor consisteth of two principall parts, viz. the *Scale*, and the *Semicircle*: it must be made of Brasse, to containe in length from *G.* to *H.* five Inches and a quarter, and in bredth from *L.* to *B.* somewhat more than three quarters and a halfe, which place must be divided in the middle both wayes, by the Lines *G. H.* and *L. B.* cutting each other at right Angles in the point *D.* then upon the point *D.* as upon a Center, describe the *Semicircle A. B. C.* then divide the Limb of this *Semicircle* into 180 equall parts, or degrees, numbring them by fives and tens to 180. and back againe to 360. as in the figure; the first number serving for the East-side, and the latter for the West-side of the whole *Circle*. Then let the edges of the *Scale* as *E G.* *E F.* and *E H.* be made very straight and smooth, and exactly parallel to the edges of the place, of which the Protractor is made: then divide the parallel degrees at either end of the *Scale*, between *E G.* and *T H.* and let the *Scale* of 12. be placed on the edge *E F.* and the

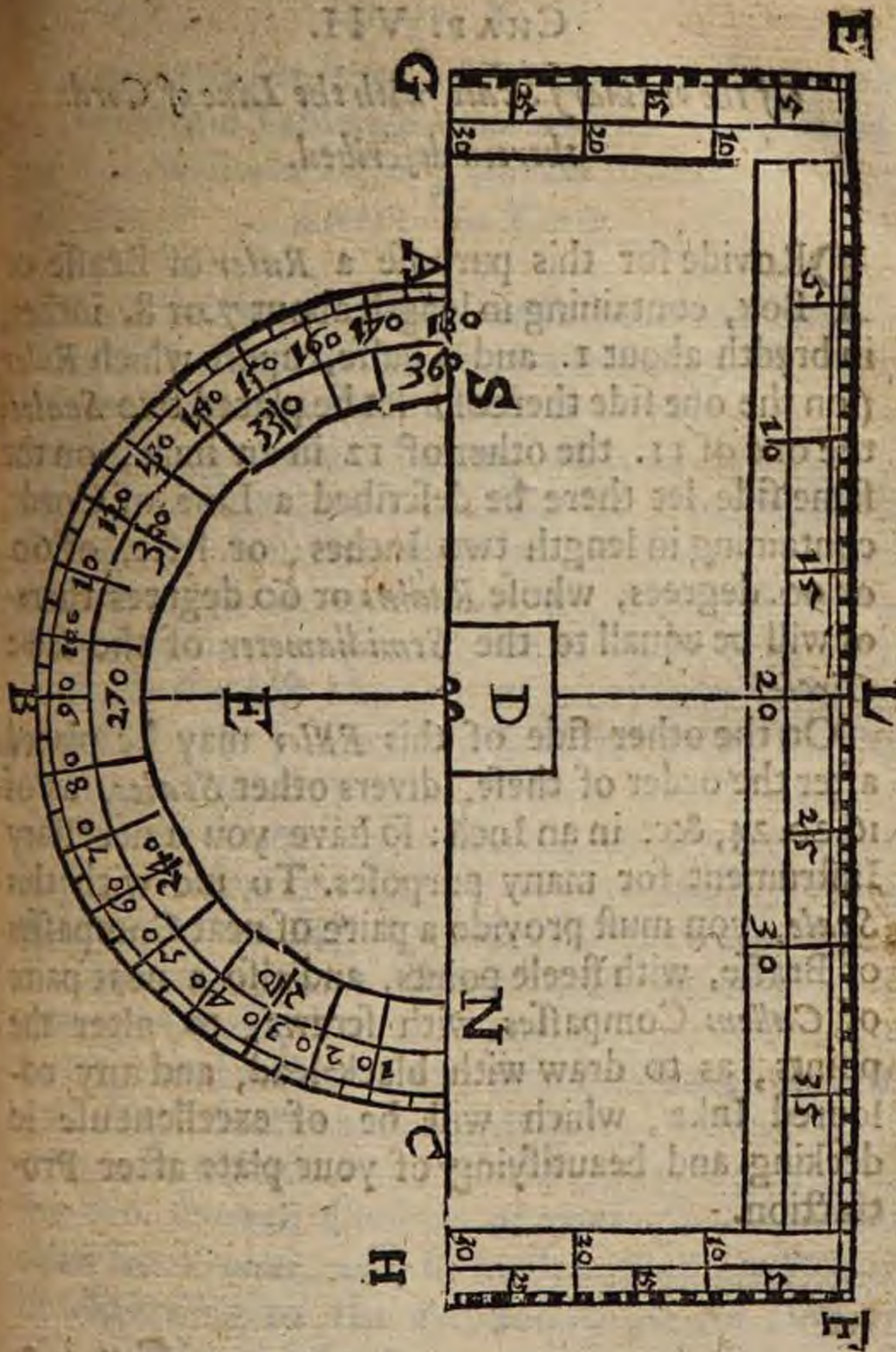
Scale

Scale of 11. on the edge of the back side, which are more meete, and necessary for use than any other.

Lastly, let the Square about the Center D. be cut quite out, that the point (in protraction) may be found, on which the protractor is to be laid, and here have speciall regard, that the points G D. and H. be in a direct Line, being the Meridian Line, and so the guide of the rest.

For the use of this Protractor in protracting, you must provide a fine Needle put into a piece of box or Ivory, neatly turned, to finde your Center, note your degrees, and make small markes in drawing your plots, which we will call a protracting Pin.

E.



CHAP. VII.

*Of the ordinary Scale with the Line of Cords
thereon described.*

PROVIDE for this purpose a *Ruler* of *Brasse* or *Box*, containing in length about 7. or 8. inches, in bredth about 1. and a halfe, upon which *Ruler* (on the one side thereof) let be placed two *Scales*, the one of 11. the other of 12 in an inch, on the same side let there be described a *Line of Cords*, containing in length two Inches, or lesse, of 60. or 90. degrees, whose *Radius* or 60 degrees thereof will be equall to the *Semidiameter* of the same *Circle*.

On the other side of this *Ruler* may be placed after the order of these, divers other *Scales*, as of 16. 20. 24, &c. in an Inch: so have you a necessary Instrument for many purposes. To use with this *Scale*, you must provide a paire of neat *Compasses* of *Brasse*, with steele points, and also a neat paire of *Callem* *Compasses* with screws, to alter the points, as to draw with black-lead, and any coloured Inke, which will be of excellent use in decking and beautifying of your plats after *Protraction*.

CHAP.

CHAP. VIII.

The manner of ordering a Field booke, to be used with the Plaine Table, when you work by the degrees on the frame thereof, without drawing of Lines on the Table.

IT having beene our businesse hitherto to provide us of necessaries for the present purpose, let us not be destitute of this which is so necessary, for the making of which booke, observe this direction; Let it containe a quantity of paper more or lesse (suppose halfe a quire or thereabout,) bound in a long *Octavo*, or a *Semi-folio*, like an Alphabeticall debt booke, (which is best :) let it be ruled towards the left Margine of every page with five Lines, so that you describe foure columns, the first serving for the degrees of observation cut by the *Index* on the frame of your *Table*, and the second for parts of a degree: for you are here to observe, that every part or degree on the frame of your *Table* is supposed to be subdivided into 60. other parts called *Minutes*, but it may be, if your Instrument be large and well divided, you may have every degree divided into three equall parts, so shall every part containe 20. *Minutes*: the other two columns for the severall divisions of your *Chain*, as the third for *Unites*, and the forth and last for *Primes*, or according to the accustomed use for *Degrees*, *Poles*, and parts of a *Pole*.

C

CHAP.

CHAP. IX.

Containing certaine Practicalls of Geometry, fit to be known before you enter upon Surveying.

1. **D**efinition. A Line or point is that which hath no part. 2. A Line is length without breadth or thickenesse.

This is the first quantity in (*Geometry*) and may be divided into parts, in respect of his length, but admitteth no other division, and hath for his Termes and Limits that *Geometricall* point formerly spoken of, and of these Lines are two sorts, namely right as the Line *A*. and crooked as the Line *B*.



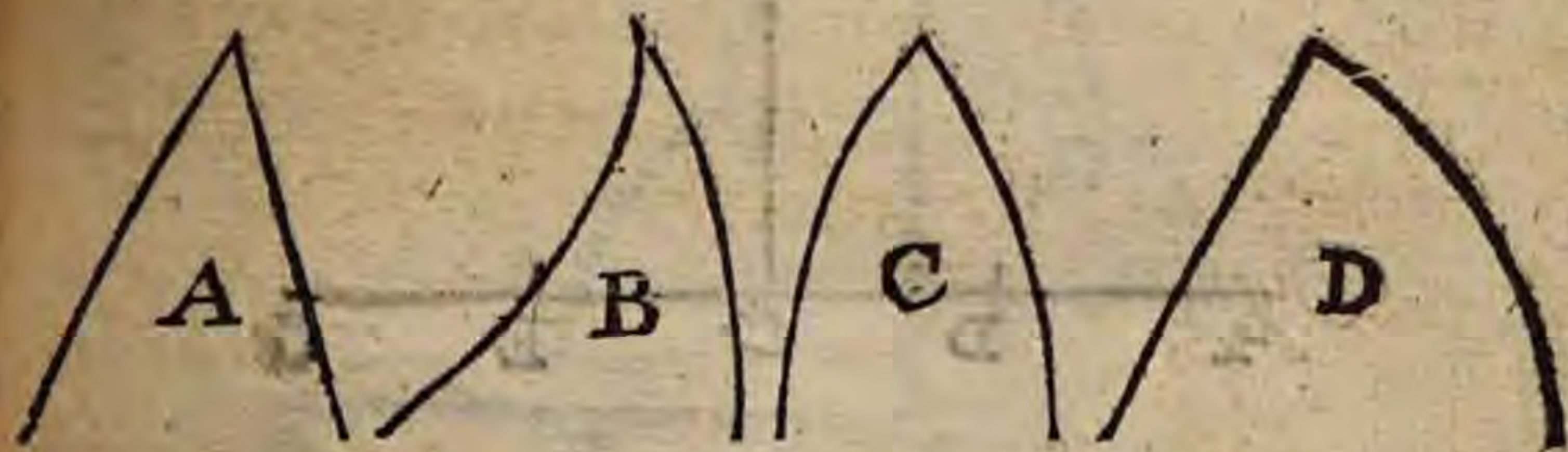
3. A Superficies is that which hath onely length and breadth.

This is the second quantity in (*Geometrey*) having two severall demensions, namely, length, and breadth, without depth or thickenesse, being the third quantity in *Geometrey*, whereunto is attributed all three dimensions of length, breadth, and thickenesse, and as a Line is limited with points, so is a superficies with Lines, and a solid body with superficies, as the figure *A* being a superficies, hath for his length *B. C. or D. E.* and for his breadth *B. D or C E.* which foure Lines are the bands, limits, and termes of the same superficies.

B



3. An Angle is the congression, or meeting of two Lines in any sort, so as both make not one Line.



Generally of Angles, in respect of their Lines. There are three sorts, namely right Lines, spheri- ciall, and mixed, as the Angle *A* is called a right lined Angle, being composed of two right Lines, the Angle *B* and *C* are spheri- ciall, or crooked Angles, and the Angle *D* a mixed Angle being com- posed of both.

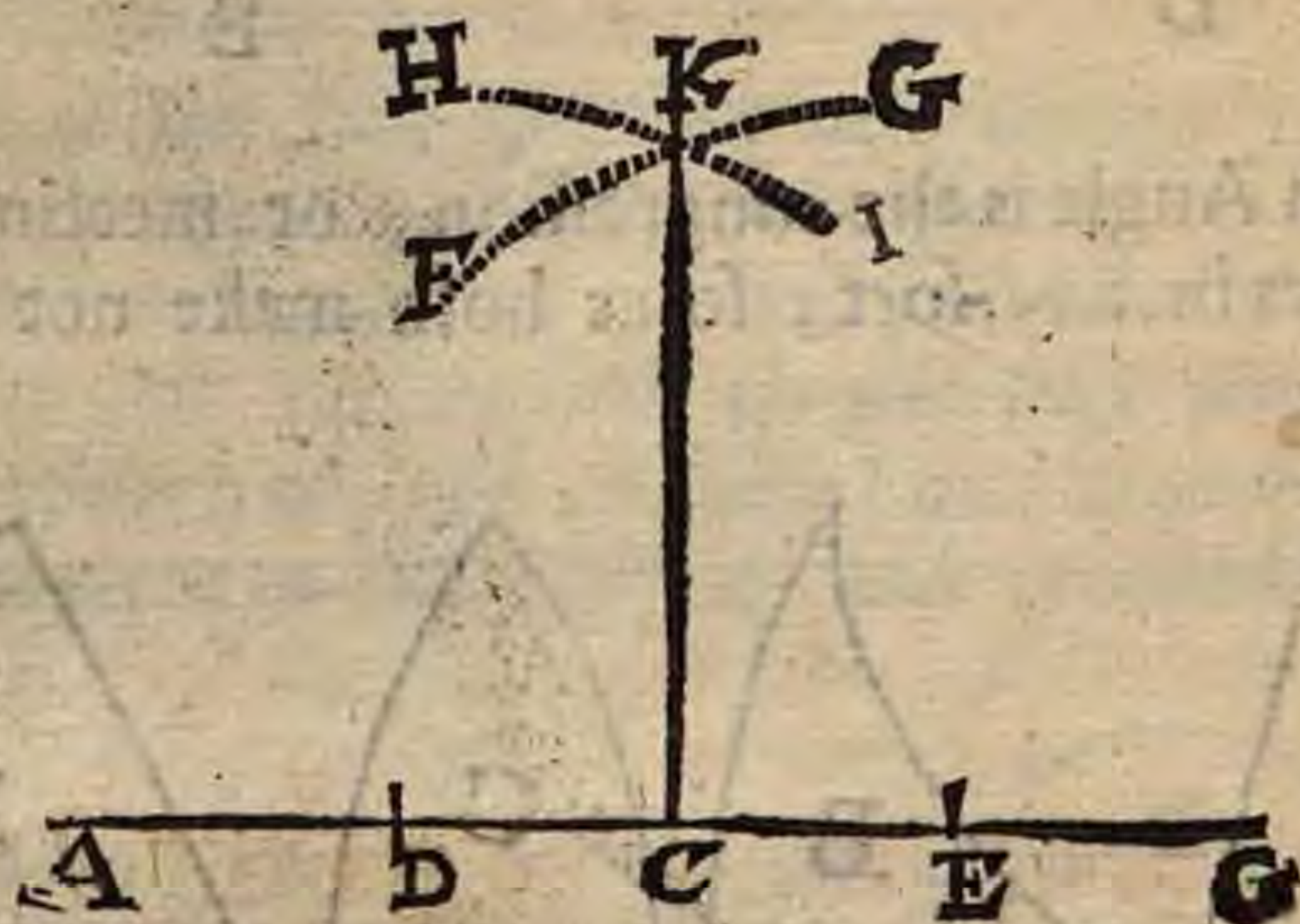
Before wee enter the Fields to survey, I thinke it not amisse to instruct the Surveyour in the Pra- ctice of some principles of Geometry, lest he should be ignorant thereof when need requires them, and make that seeme hard and difficult, when in it self is facile.

C 2

Pro^s

Propo. 1. how to erect a perpendicular upon any point in a Line assigned.

Let AG be a Line given, and from the point C it is required to draw a Line perpendicular to the Line AB . first open the Compasses to any small distance.



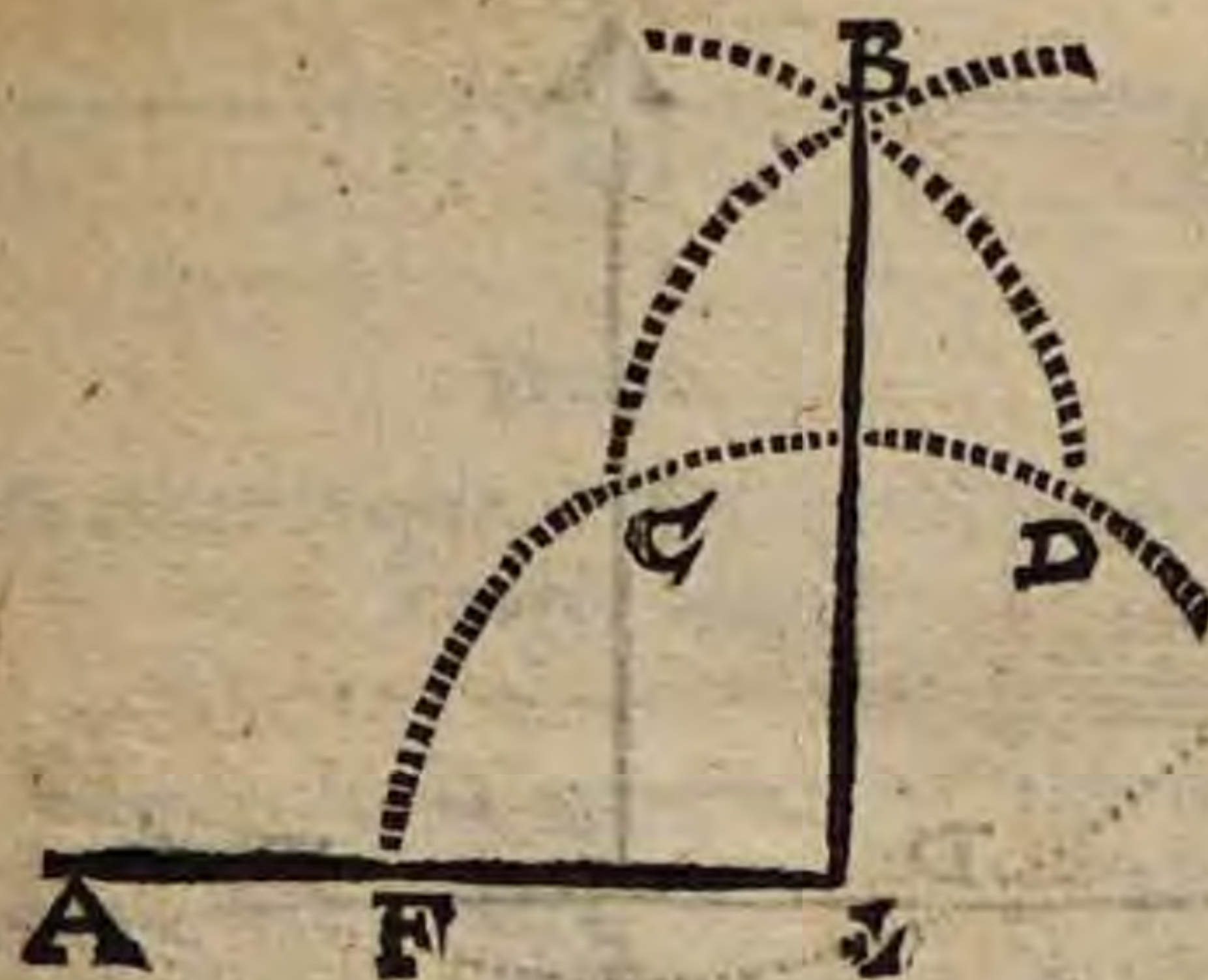
And placing one foot in C . make two marks in the Line, D and E . then opening the Compasses to a greater distance. place one foot in E . and with the other foot draw the arch FG . then (the compasses keeping the same distance) place one foot in D . and with the other draw the Arch HI . and from the point K . where these two lines intersect, draw a Line to C . which Line shall be perpendicular to the Line AB . neither leaning on one side or other, but directly streight or perpendicular.

Propo-

Propo. 2.

To erect a perpendicular on the end of a Line.

Let AE be a Line given, and from the point E let it be required to erect the perpendicular EB .



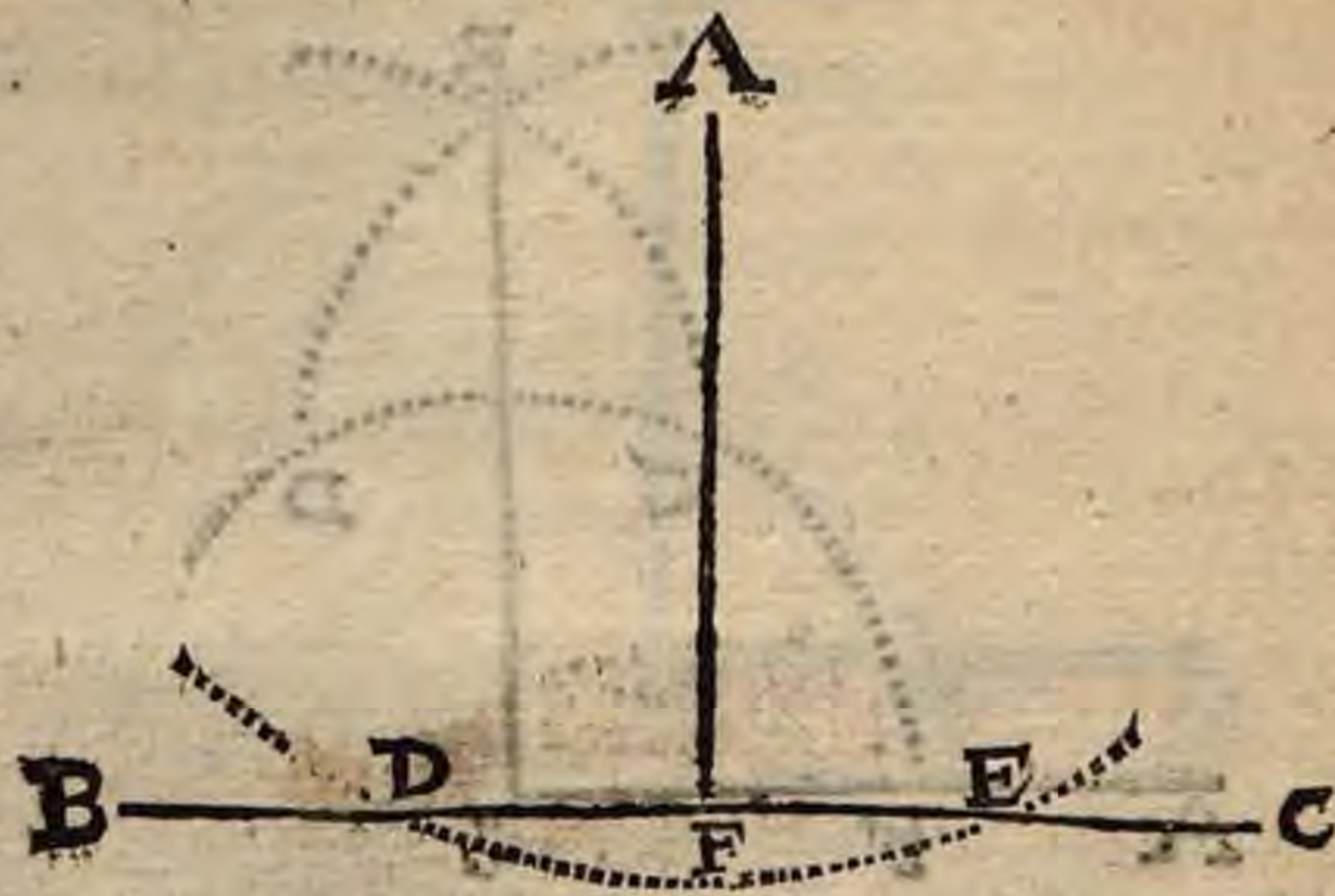
First, open your Compasses to any distance, as to EF . then place one foot in E . and with the other describe the Arch, BCD , then place one foot in F , and with the other make the small Arch C , and removing the Compasses to C draw the Arch BD . then remove the Compasses to D and draw the Arch CB . then draw the Line EB which is the perpendicular required.

Propo. 3.

To let a perpendicular fall upon a Line from a point Assigned.

Suppose A be a point from whence it be required

to draw a Line *perpendicular* to the ground Line BC . First open your Compasses to any distance, so it be greater than AF , and place one foote in A . and with the other draw the Arch DE , then divide the distance DE , into two equall parts at F , so shall the Line AF be *perpendicular* to the Line BC .

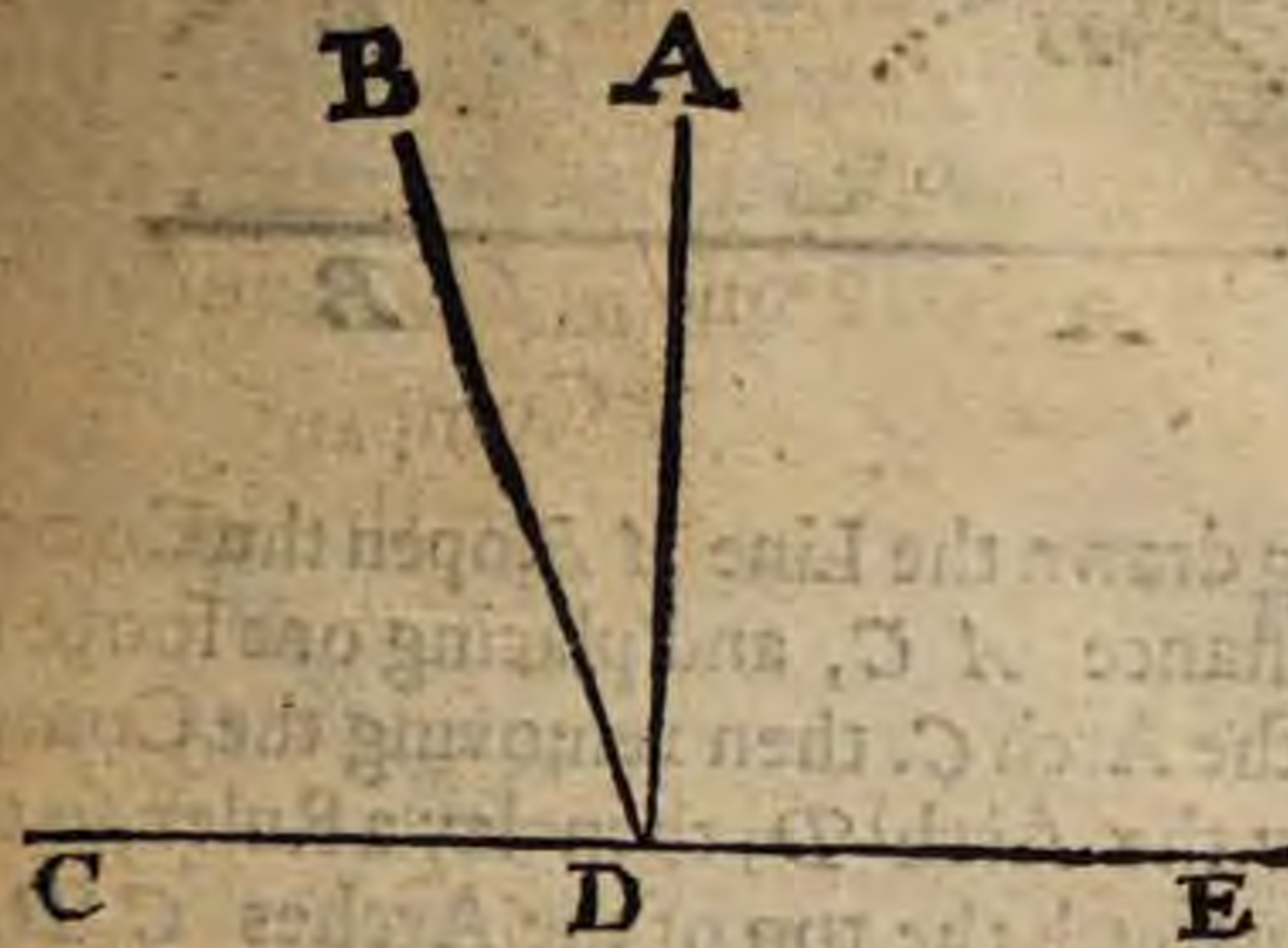


Propo. 4.

An Angle which is greater than a right Angle, is an obtuse Angle.

Every *Angle* in generall (not being a right *Angle*) whether greater or lesser, is called an *Oblique Angle*, but particularly if greater than a right *Angle*, it is called an *Obtuse Angle*, if lesser, an *acute Angle*, as the *Angle* BDC . (being greater than the right *Angle* ADC) is an *obtuse Angle*, for it containeth it, and also the *Angle* ABC .

Propo.



Propo. 5.

An acute Angle is that which is lesser than a right Angle.

This *Proposition* is manifest by the former *diagram*, wherein the *Angle* ADB , is an *acute Angle*, being lesse than the right *Angle* ADE . for the same right *Angle* containeth it, and also the *Angle* BDE , being likewise an *acute Angle*.

Prop. 6.

How to draw Parallel Lines.

Parallel Lines are such, which being infinitely extended would never meete. Wherefore let AB be a Line given, unto which, it is required to draw the Line CD *Parallel*, at the distance AC .

C 4

D



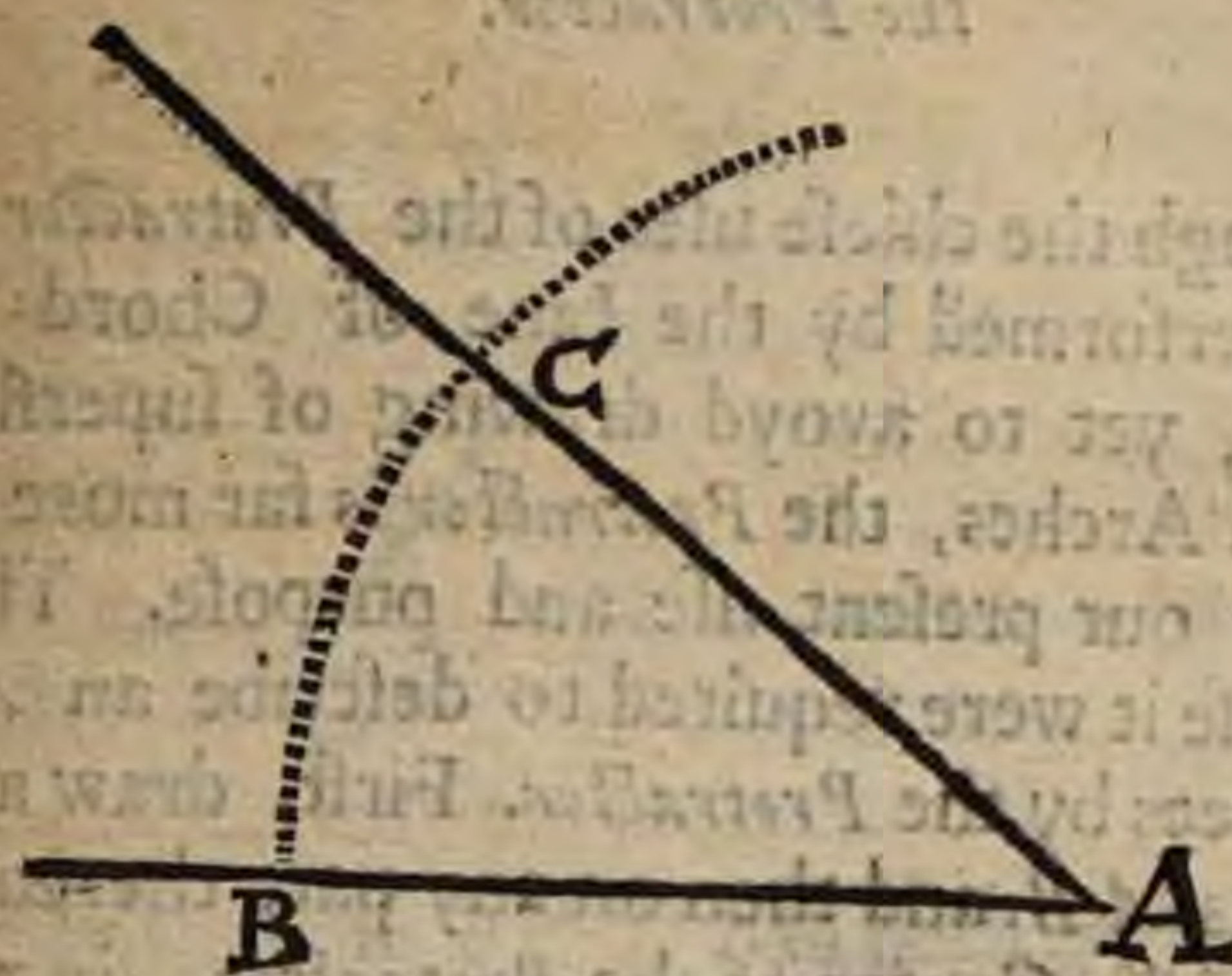
Having drawn the Line AB , open the Compasses to the distance AC , and placing one foot in A , describe the Arch C . then removing the Compasses to B . draw the Arch D , then lay a Ruler, so that it may justly touch the top of the Arches CD , and the Line so drawne shall be exactly *Parallel* to AB .

CHAP. X.

Of the use of the Line of Chords placed on the ordinary Scale before described, and how to lay down an Angle of any quantity required, or to finde the quantity of an Angle given.

Draw a Line at pleasure as AB , and from the point A let it be required to draw an *Angle* of 40. degrees, extend your Compasses upon the Line of *Chords* from the beginning thereof to 60. degrees, (which as I said before in the description thereof, was equall to the *Semidiameter* of the *Circle* from whence that Chord was projected) with which distance set one foot upon the point A , and with the other draw the pricked Arch BC , then with your Compasses take 40. degrees, (which was the quantity of the required *Angle*,) out of the

the Line of the *Chords*, and set one foot thereof upon B . And extend the other to C . Lastly, draw the Line AC , and so the *Angle* CAB . shall containe 40 degrees.



But suppose CAB were an *Angle* given, and it were required to finde the quantity thereof, then as before, open your Compasses to 60 degrees of your *Chord*, and placing one foot in A . describe the Arch CB . and measuring that extent upon your Line of *Chords* from the beginning thereof, you will finde it to containe 40 degrees.

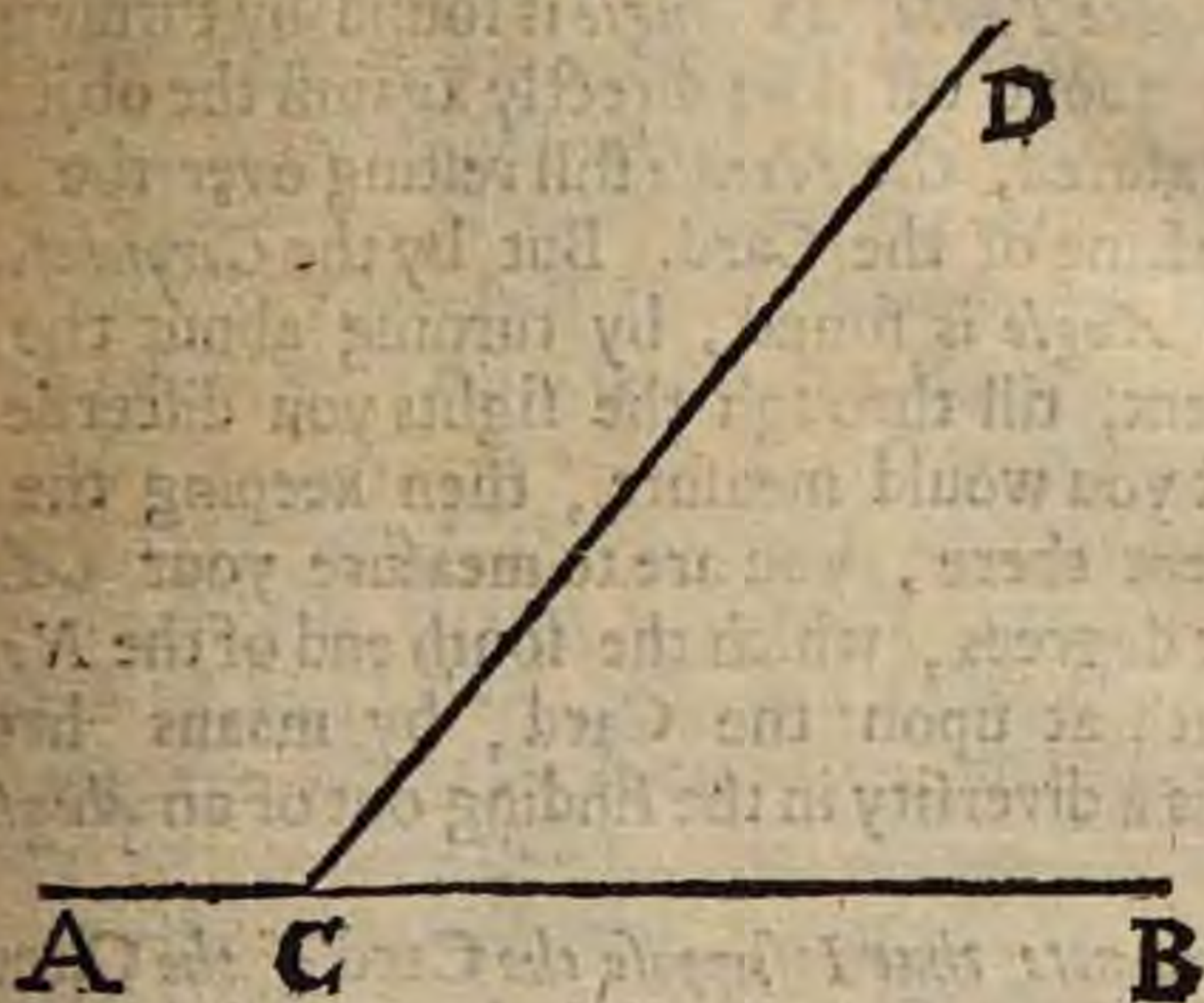
If any *Angle* given or required shall containe above 90 degrees, or the fourth part of a *Circle*, you must then performe it at twice, by taking first the whole Line, and then the remainder.

CHAP. XI.

To lay down an *Angle* of any quantity, or to finde the quantity of an *Angle* given by the *Protractor*.

Although the chiefe uses of the *Protractor* may be performed by the *Line of Chords* last spoken of, yet to avoyd drawing of superfluous *Lines*, and *Arches*, the *Protractor* is far more convenient for our present use and purpose. Therefore suppose it were required to describe an *Angle* of 50 degrees by the *Protractor*. First, draw a *Line* at length as *AB*. and then on any part thereof, as on *C*. place the Center of the *Protractor*, in which point set your protracting pin, and turn the *Protractor* about, till the *Meridian Line* of the *Protractor*, (noted in the description thereof with *GH*) lie directly on this *Line AB*. the *Semicircle* of the *Protractor* lying upwards, then by the *Semicircle*, at the division of 50 degrees, marke the point *D*, and draw the *Line CD*, so shall the *Angle BCD*. containe 50 degrees.

Again



Again suppose *BCD*. had been an *Angle* given, and that it had been required to finde the quantity thereof by the *Protractor*; first you must apply the Center of the *Protractor* to the point *C*, and the *Meridian Line* thereof directly on the *Line AC* as before, then shall you finde the point *D* to lie directly against 50 degrees in the *Protractor*, and such is the quantity of the *Angle* required.

CHAP. XII.

Of the congruity in use between the degrees described on the frame of the *Plaine Table*, and the *Circumferentor*, and the manner how to find the quantity of an *Angle* by either of them.

THese two Instruments in use differ little, save only in this, that by the degrees described on th

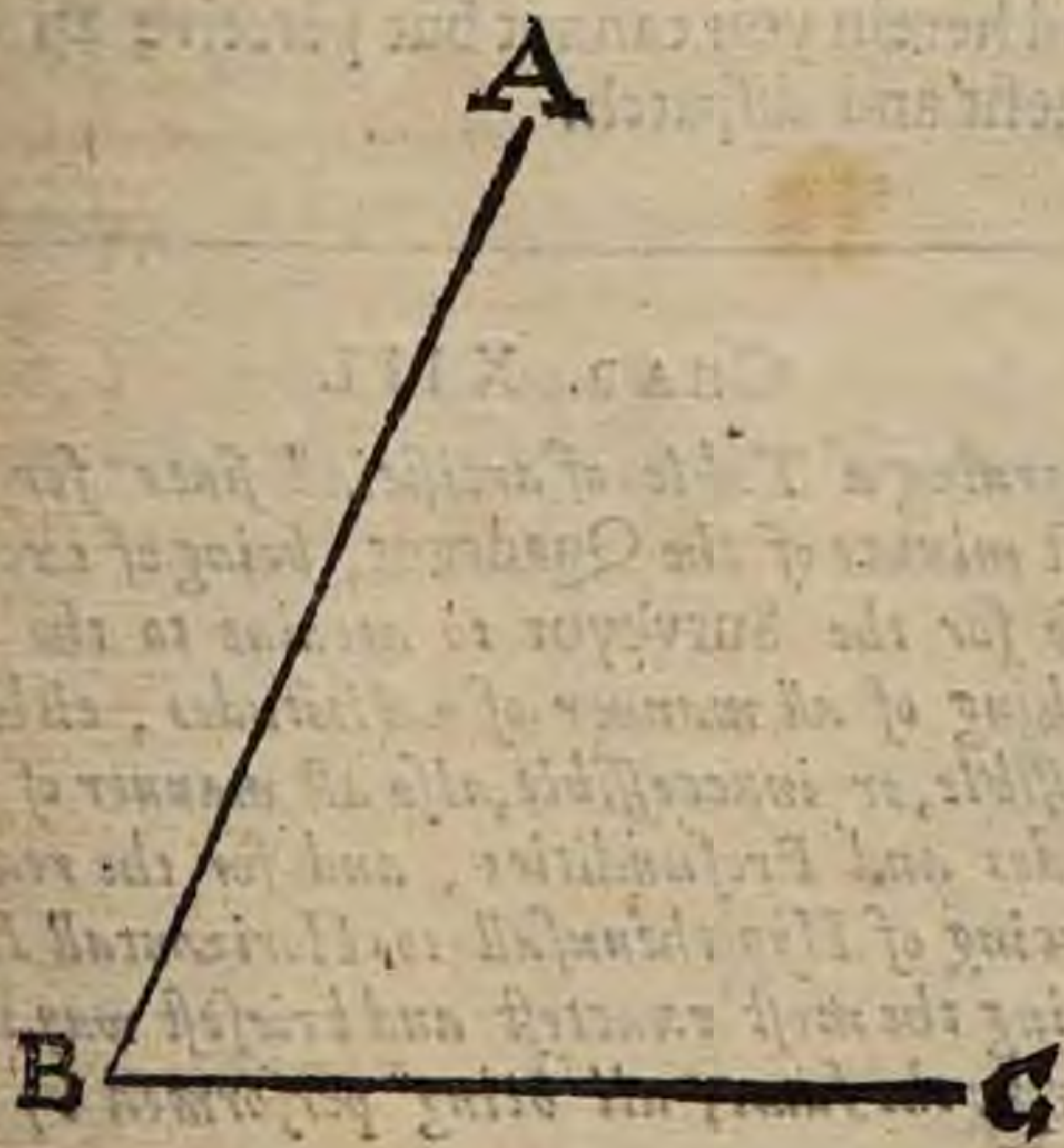
the *Plaine Table*, an *Angle* is found by turning the *Index* about till it lie directly against the object to be measured, the *Needle* still resting over the *Meridian* Line of the Card. But by the *Circumferentor* an *Angle* is found, by turning about the Instrument, till through the sights you discern the object you would measure, then keeping the Instrument there, you are to measure your *Angle* by the degrees, which the south end of the *Needle* pointeth at upon the Card, by means hereof there is a diversity in the finding out of an *Angle*.

Here note that I suppose the Card of the *Circumferentor*, to be divided into 360 degrees, answerable to those on the frame of the *Plaine Table*, and not into 120. which is a third part thereof, (though for the *Circumferentor*, I approve of 120. for the better division in so small an Instrument) but in regard we intend to use onely the *Plaine Table*, I will not (at this time) alter my Method for the benefit of this one conclusion, but onely shew the congruity of these two Instruments; And though I shall in generall shew the use but of one of them, yet I would not have the Surveyor Ignorant of the use of any of them.

Wherefore:

1. To finde an *Angle* by the *Circumferentor*. Suppose *A B C* be an *Angle* in the Fields to be measured, and let *A B* and *B C* be two hedges or other Lines, which are the containing sides of the *Angle*, and let it be required to finde the quantity

quantity thereof by the *Circumferentor*: first place your Instrument in the *Angle* at *B*, then turning about the whole Instrument, that through the sights you can see directly along the Line *A B*, where observe what degree the South end of the *Needle* cutteth, when it standeth still, which let be 120 degrees, then direct your sights towards *C*, and there making like observation, observe the degrees cut by the *Needle* (when it againe resteth which let be 54) now you must subtract 54 the lesser terme, from 120 the greater, and there will remaine 66. the true quantity of the *Angle* required: but had this remainder exceeded 180 degrees (which is a *Semicircle*, or two right Angles) then must you have deducted that remainder from 360. the degrees in the whole Circle, and the remainder of that last deduction had been the quantity required.



2. To performe the same by the degrees on the
Plaine Table.

IN the former *Diagram*, place your Instrument at *B*, the *Index* standing on the *Diameter* (which is a right Line drawn quite along the Table from the beginning of the degrees through the Center, and so to the end of the degrees) then turne about the Instrument on the *staffe*, (the *Index* still resting on the *Diameter*) towards *A*, till your sight be parallel to the Line *B A*, and there your Instrument being fixed, remove the *Index* (upon the Center of the *Table*) directing your sight towards *C*. to be likewise parallel to *B C*. where observe what degree the edge of the *Index* cutteth, which will bee 22. and that is the *Angle* required without any subtraction, offering it selfe at the first view, and herein you cannot but perceive an excellent benefit and dispatch.

CHAP. XIII.

Concerning a *Table* of artificiall sines for every fift minute of the *Quadrant*, being of excellent use for the *Surveyor* to attaine to the exact taking of all manner of *Altitudes*, either accessible, or inaccessible, also all manner of *Latitudes* and *Profundities*, and for the ready reducing of *Hypothensall* to *Horizontall Lines*: being the most exactest and briefest way to performe the same, all being performed by Addition,

tion, and Substraction without either *Multipli-*
cation or *Division*.

IN the following *Table* of Sines, the degrees are placed on the head of each *Column*; and the Sines under the same, as in the first page you finde 0 Degrees, 1 Degree, &c. And the Minutes in the little *Column* on the left-hand, proceeding by fives, as 0, 5, 10, 15, &c. Serving to all the Degrees on the whole page: This *Table* of sines although too briefe for any exquisite Calculation in *Astronomy*, or *Geometry*; yet it is sufficient for our present purpose, and larger than hath beene formerly applied unto *Surveying*. They that desire larger, may make use of Mr. *Briggs*, or Mr. *Wingate*, and others.

The

The Table of Sines.

M.	0 Deg.	1 Deg.	2 Deg.	3 Deg.
0	00000	8,2419	85428	87188
5	7,1627	8,2766	85605	87307
10	7,4637	8,3088	85776	87423
15	7,6398	8,3388	85939	87535
20	7,7648	8,3667	86097	87645
25	7,8617	8,3931	86250	87752
30	7,9408	8,4179	86397	87857
35	8,0078	8,4414	86539	87959
40	8,0658	8,4637	86677	88059
45	8,1169	8,4848	86810	88156
50	8,1627	8,5050	86940	88251
55	8,2041	8,5243	87066	88345

M.	4 Deg.	5 Deg.	6 Deg.	7 Deg.
0	88436	89403	90192	90859
5	88525	89475	90252	90910
10	88613	89545	90311	90961
15	88699	89614	90369	91011
20	88783	89682	90426	91060
25	88865	89750	90483	91109
30	88946	89816	90539	91157
35	89026	89881	90594	91205
40	89104	89945	90648	91252
45	89181	90008	90702	91299
50	89256	90070	90755	91345
55	89330	90132	90807	91390

M.

The Table of Sines.

M.	8 Deg.	9 Deg.	10 Deg.	11 Deg.
0	91436	91943	92397	92806
5	91480	91983	92433	92838
10	91526	92022	92468	92870
15	91568	92061	92503	92902
20	91612	92100	92538	92934
25	91655	92138	92572	92965
30	91697	92176	92606	92997
35	91739	92214	92640	93027
40	91781	92251	92674	93058
45	91822	92289	92707	93089
50	91863	92324	92740	93119
55	91903	92361	92773	93149

M.	12 Deg.	13 Deg.	14 Deg.	15 Deg.
0	93179	93521	93837	94130
5	93208	93548	93862	94153
10	93238	93575	93887	94177
15	93267	93602	93912	94200
20	93296	93629	93937	94223
25	93324	93655	93961	94246
30	93353	93682	93986	94269
35	93382	93708	94010	94292
40	93410	93734	94035	94314
45	93438	93760	94059	94337
50	93466	93786	94083	94359
55	93493	93811	94106	94381

D

M.

The Table of Sines.

M.	16 Deg.	17 Deg.	18 Deg.	19 Deg.
0	94403	94659	94900	95126
5	94425	94680	94919	95145
10	94447	94700	94939	95163
15	94469	94721	94958	95181
20	94491	94741	94977	95199
25	94512	94761	94996	95217
30	94533	94781	95015	65234
35	94555	94801	95034	95253
40	94576	94821	95052	95270
45	94597	94841	95071	95288
50	94618	94861	95090	95306
55	94639	94880	95108	95323

M.	20 Deg.	21 Deg.	22 Deg.	23 Deg.
0	95340	95543	95736	95919
5	95358	95560	95751	95934
10	95375	95576	95767	95948
15	95392	95592	95782	95963
20	95409	95609	95798	95978
25	95426	95625	95813	95992
30	95443	95641	95828	96007
35	95460	95657	95844	96021
40	95477	95673	95859	96036
45	95494	95689	95874	96050
50	95510	95704	95889	96065
55	95527	95720	95903	96082

M.

The Table of Sines.

M.	24 Deg.	25 Deg.	26 Deg.	27 Deg.
0	96093	96259	96418	96570
5	96107	96273	96431	96583
10	96121	96286	96444	96595
15	96135	96300	96457	96607
20	96149	96313	96470	96620
25	96163	96327	96483	96632
30	69177	96340	96495	96644
35	96194	96353	96508	96656
40	96205	96366	96521	96668
45	96219	96379	96533	96680
50	96232	96392	96546	96692
55	96246	96405	96558	96704

M.	28 Deg.	29 Deg.	30 Deg.	31 Deg.
0	96716	96856	96990	97118
5	96728	96867	97001	97129
10	96740	96878	97012	97139
15	96752	96890	97022	97150
20	96763	96901	97033	97160
25	96775	96912	97044	67170
30	96786	96923	97055	97180
35	96798	96935	97065	97190
40	96810	96946	97076	97201
45	96821	96957	97087	97212
50	96833	96968	97097	97222
55	96847	96979	97108	97232

D 2

M.

52

23

The Table of Sines.

M. | 32 Deg. | 33 Deg. | 34 Deg. | 35 Deg.

0	97242	97361	97476	97586
5	97252	97371	97485	97595
10	97262	97380	97494	97604
15	97272	97390	97504	97613
20	97282	97400	97513	97622
25	97292	97409	97522	97631
30	97302	97419	97531	97640
35	97312	97428	97540	97648
40	97322	97438	97550	97657
45	97332	97447	97559	97666
50	97342	97457	97568	97675
55	97351	97466	97577	97683

M. | 36 Deg. | 37 Deg. | 38 Deg. | 39 Deg.

0	97692	97795	97893	97989
5	97701	97803	97901	97997
10	97710	97811	97910	98004
15	97718	97820	97918	98012
20	97727	97829	97926	98020
25	97735	97836	97934	98027
30	97744	97844	97941	98035
35	97752	97853	97949	98043
40	97761	97861	97957	98050
45	97769	97869	97965	98058
50	97778	97877	97973	98066
55	97786	97885	97981	98073

M.

The Table of Sines.

M. | 40 Deg. | 41 Deg. | 42 Deg. | 43 Deg.

0	98081	98169	98255	98338
5	98088	98177	98262	98345
10	98096	98184	98269	98351
15	98103	98191	98276	98358
20	98111	98198	98283	98365
25	98118	98206	98290	98371
30	98125	98213	98297	98378
35	98133	98220	98304	98385
40	98140	98227	98311	98391
45	98148	98234	98317	98398
50	98155	98240	98324	98405
55	98162	98248	98331	98411

M. | 44 Deg. | 45 Deg. | 46 Deg. | 47 Deg.

0	98418	98495	98569	98641
5	98424	98501	98575	98647
10	98431	98507	98581	98653
15	98437	98514	98588	98659
20	98444	98520	98594	98665
25	98450	98526	98600	98671
30	98457	98532	98606	98676
35	98463	98539	98612	98682
40	98469	98545	98618	98689
45	98476	98551	98624	98694
50	98482	98557	98629	98699
55	98489	98563	98635	98705

D 3

M.

The Table of Sines.

M.	48 Deg.	49 Deg.	50 Deg.	51 Deg.
0	98711	98778	98843	98905
5	98716	98783	98848	98910
10	98722	98789	98853	98915
15	98728	98794	98858	98920
20	98733	68800	98864	98925
25	98739	98805	98869	98930
30	98745	98810	98874	98935
35	98750	98816	98879	98940
40	98756	98821	98884	98945
45	98761	98827	68890	98950
50	98767	98832	98895	98955
55	98772	98837	98900	98960

M. | 52 Deg. | 53 Deg. | 54 Deg. | 55 Deg.

0	98965	99023	99080	99134
5	98970	99028	99084	99138
10	98975	99033	99089	99142
15	98980	99038	99093	99147
20	98985	99042	99098	99151
25	98990	99047	99102	99156
30	98995	99052	99107	99160
35	99000	99056	99111	99164
40	99004	99061	99116	99169
45	99009	99066	99120	99173
50	99013	99070	99125	99177
55	99019	99075	99129	99181

M.

The Table of Sines.

M.	56 Deg.	57 Deg.	58 Deg.	59 Deg.
0	99186	99236	99284	99331
5	99190	99240	99288	99334
10	99194	99244	99292	99338
15	99198	99248	99296	99342
20	99203	99252	99300	99346
25	99207	99256	99304	99349
30	99211	99260	99308	99353
35	99215	99264	99312	99357
40	99219	99268	99315	99361
45	99224	99272	99319	99364
50	99228	99276	99323	99368
55	99232	99280	99327	99372

M. | 60 Deg. | 61 Deg. | 62 Deg. | 63 Deg.

0	99375	99418	99459	99499
5	99379	99422	99463	99502
10	99383	99425	99466	99505
15	99386	99429	99469	99508
20	99390	99432	99473	99512
25	99393	99436	99476	99515
30	99397	99439	99479	99518
35	99400	99442	99483	99521
40	99403	99446	99486	99524
45	99408	99449	99489	99527
50	99411	99453	99492	99530
55	99415	99456	99496	99534

D 4

M.

The Table of Sines.

M.	64 Deg.	65 Deg.	66 Deg.	67 Deg.
0	99537	99573	99607	99640
5	99540	99576	99610	99643
10	99543	99579	99613	99646
15	99546	99582	99616	99648
20	99549	99584	99618	99651
25	99552	99587	99621	99654
30	99555	99590	99624	99656
35	99558	99593	99627	99659
40	99561	99596	99629	99661
45	99564	99599	99632	99664
50	99567	99602	99635	99667
55	99570	99604	99638	99670
M.	68 Deg.	69 Deg.	70 Deg.	71 Deg.
0	99672	99703	99730	99757
5	99674	99704	99732	99759
10	99677	99706	99734	99761
15	99680	99709	99737	99763
20	99682	99711	99739	99765
25	99684	99713	99741	99767
30	99687	99716	99743	99770
35	99689	99718	99746	99772
40	99692	99721	99748	99774
45	99694	99723	99750	99776
50	99697	99725	99752	99778
55	99700	99728	99755	99780

M.

The Table of Sines.

M.	72 Deg.	73 Deg.	74 Deg.	75 Deg.
0	99782	99806	99828	99849
5	99784	99808	99830	99851
10	99786	99810	99832	99853
15	99788	99812	99834	99854
20	99790	99814	99836	99856
25	99792	99816	99837	99858
30	99794	99817	99839	99859
35	99796	99819	99841	99861
40	99798	99821	99843	99863
45	99800	99823	99844	99864
50	99802	99825	99846	99866
55	99804	99827	99848	99867
M. 76	Deg.	77 Deg.	78 Deg.	79 Deg.
0	99869	99887	99904	99919
5	99870	99889	99905	99920
10	99872	99890	99907	99922
15	99874	99892	99908	99923
20	99875	99893	99909	99924
25	99877	99894	99911	99925
30	99878	99895	99912	99927
35	99880	99897	99913	99928
40	99881	99899	99914	99929
45	99883	99900	99916	99930
50	99884	99901	99917	99931
55	99886	99903	99918	99932

M.

The Table of Sines.

M.	80 Deg.	81 Deg.	82 Deg.	83 Deg.	84 Deg.
0	99934	99946	99958	99968	99976
5	99935	99947	99958	99968	99977
10	99936	99948	99959	99969	99977
15	99937	99949	99960	99970	99978
20	99938	99950	99961	99971	99979
25	99939	99951	99962	99971	99979
30	99940	99952	99963	99972	99980
35	99941	99953	99964	99973	99981
40	99942	99954	99964	99973	99981
45	99943	99955	99965	99974	99982
50	99944	99956	99966	99975	99982
55	99945	99957	99967	99975	99983

M.	85 Deg.	86 Deg.	87 Deg.	88 Deg.	89 Deg.
0	99983	99989	99994	99997	99999
5	99984	99990	99994	99998	99999
10	99985	99990	99995	99998	99999
15	99985	99991	99995	99998	99999
20	99986	99991	99995	99998	99999
25	99986	99991	99996	99998	99999
30	99987	99992	99996	99998	99999
35	99987	99992	99996	99999	99999
40	99988	99993	99996	99999	99999
45	99988	99993	99997	99999	99999
50	99989	99993	99997	99999	99999
55	99989	99994	99997	99999	99999

M.

Propos. I.

Any degree, and minute of the Quadrant being given,
to finde the Sine thereof.

You must first finde the degree in the head of the *Table*, and the minute in the little *Columnne* towards the left hand; and then at the *Angle* of meeting, you shall have the *Sine* answering thereunto.

Example.

Let it be required to find the *Sine* of 12 degrees: First, you must seeke 12 degrees in the head of the *Table*, and 0 Minutes in the side, and at the *Angle* of meeting, you shall finde 93176, which is the *Sine* of 12 degrees.

In like manner, the *Sine* of 25 degrees will be found to be 96259; The *Sine* of 82 degrees, and 20 Minutes, will be found to be 99961; and the *Sine* of 59 degrees, and 45 Minutes, will be found--- 99364.

Proposition II.

Any Sine being given, to finde the Arch (or degree and min. of the Quadrant) answering thereunto.

Example.

Let this number 92397 be given, and let it be required to finde the *Arch* of the *Quadrant*, answering thereunto. First, I seeke for 92397 in the *Table*, and on the head of the same *Columnne*, I finde 10 degrees; and over against it in the left hand 0 Minutes, which 10 degrees 0 Minutes, is the *Arch* answering thereunto.

I

In like manner, let it be required to find the *Arch* answering to this *Sine* 98213. having found 98213 in the *Table*, you shall finde on the head of that *Column*, wherein you finde it, 41 degrees, and over against it you shall finde 30. Minutes, in the little *Column* for Min. And that is the *Arch* or *Degree*, and *Minute* answering thereunto.

But in case you have a number given which you cannot finde in the *Table*. You must then instead thereof take the neereft in the *Table*, as if your number given were 93500. if you looke for this number in the *Table* it cannot be found, but the neereft thereunto is 93521. which you must take instead thereof.

Thus much concerning the generall use of this *Table* of *Sines*.

CHAP. XIV.

The explanation of the Table of Logarithmes.

Logarithmes are numbers, so fitted to proportionall numbers, that themselves retaine equall differences. This *Table* of *Logarithmes*, containes certaine numbers increasing by a Unite in a continuall proportion from 1. to 1000. so that any number under 1000. being given, you may finde the *Logarithme* thereof, or any *Logarithme* (whose absolute number exceedeth not 1000.) may be found

found by this *Table*, by the following propositions.

CHAP. XV.

Of the use of the Table of Logarithmes.

Propo. 1.

A number under 1000. being given to finde the Logarithme thereof.

Suppose the number given be 18. you must finde 18 in the first *Column* of the *Table* (under the little Num. and against it in the second, you shall finde 12553. which is the *Logarithme* thereof.

Also let it be required to finde the *Logarithme* of 75. seeke 75 in the first *Column*, and against it in the second, you shall finde 18751, which is the *Logarithme* thereof.

The

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
1	00000	28	14472	55	17404
2	03010	29	14624	56	17482
3	04771	30	14771	57	17559
4	06021	31	14914	58	17634
5	06990	32	15052	59	17709
6	07782	33	15185	60	17782
7	08451	34	15315	61	17853
8	09031	35	15441	62	17924
9	09542	36	15563	63	17993
10	10000	37	15682	64	18062
11	10414	38	15798	65	18129
12	10792	39	15911	66	18195
13	11139	40	16021	67	18261
14	11461	41	16128	68	18325
15	11761	42	16232	69	18388
16	12041	43	16335	70	18451
17	12304	44	16435	71	18513
18	12553	45	16532	72	18573
19	12788	46	16628	73	18633
20	13010	47	16721	74	18692
21	13222	48	16812	75	18751
22	13424	49	16902	76	18808
23	13617	50	16990	77	18865
24	13802	51	17076	78	18921
25	13979	52	17160	79	18976
26	14150	53	17243	80	19031
27	14314	54	17324	81	19085

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
82	19138	109	20374	136	21336
83	19191	110	20414	137	21367
84	19243	111	20453	138	21399
85	19294	112	20492	139	21430
86	19345	113	20531	140	21461
87	19395	114	20569	141	21492
88	19445	115	20607	142	21523
89	19494	116	20645	143	21553
90	19542	117	20682	144	21584
91	19590	118	20719	145	21614
92	19638	119	20755	146	21644
93	19685	120	20792	147	21673
94	19731	121	20828	148	21703
95	19777	122	20864	149	21732
96	19823	123	20899	150	21761
97	19868	124	20934	251	21790
98	19912	125	20969	252	21818
99	19956	126	21004	253	21847
100	20000	127	21038	254	21875
101	20043	128	21072	155	21903
102	20086	129	21106	156	21931
103	20128	130	21139	157	21959
104	20170	131	21173	158	21987
105	20212	132	21206	159	22014
106	20253	133	21239	160	22041
107	20294	134	21271	161	22068
108	20334	135	21303	162	22095

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
163	22122	190	22788	217	23365
164	22148	191	22810	218	23385
165	22175	192	22833	219	23404
166	22201	193	22856	220	23424
167	22227	194	22878	221	23444
168	22253	195	22900	222	23464
169	22277	196	22923	223	23483
170	22304	197	22945	224	23502
171	22330	198	22967	225	23522
172	22355	199	22988	226	23541
173	22380	200	23010	227	23560
174	22405	201	23032	228	23579
175	22430	202	23054	229	23598
176	22455	203	23075	230	23617
177	22480	204	23096	231	23636
178	22504	205	23118	232	23655
179	22529	206	23139	233	23674
180	22553	207	23160	234	23692
181	22577	208	23181	235	23711
182	22601	209	23201	236	23729
183	22625	210	23222	237	23747
184	22648	211	23243	238	23766
185	22672	212	23263	239	23784
186	22695	213	23284	240	23802
187	22718	214	23304	241	23820
188	22742	215	23324	242	23838
189	22765	216	23345	243	23856

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
244	23874	270	24314	297	24728
245	23892	271	24330	298	24742
246	23909	272	24346	299	24757
247	23927	273	24362	300	24771
248	23945	274	24378	301	24786
249	23962	275	24393	302	24800
250	23979	276	24409	303	24814
251	23997	277	24425	304	24829
252	24014	278	24440	305	24843
253	24031	279	24456	306	24857
254	24048	280	24472	307	24871
255	24065	281	24487	308	24886
256	24082	282	24502	309	24900
257	24099	283	24518	310	24914
258	24116	284	24533	311	24928
259	24133	285	24548	312	24942
260	24149	286	24564	313	24955
261	24166	287	24579	314	24969
262	24183	288	24594	315	24983
263	24200	289	24609	316	24997
264	24216	290	24624	317	25011
265	24232	291	24639	318	25024
266	24249	292	24654	319	25038
267	24265	293	24669	320	25051
268	24281	294	24683	321	25065
269	24298	295	24698	322	25079
		296	24713	323	25092

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
324	25105	350	25441	376	25752
325	25119	351	25453	377	25763
326	25132	352	25465	378	25775
327	25145	353	25478	379	25786
328	25159	354	25490	380	25798
329	25172	355	25502	381	25809
330	25185	356	25515	382	25821
331	25198	357	25527	383	25832
332	25211	358	25539	384	25843
333	25224	359	25551	385	25855
334	25237	360	25563	386	25866
335	25250	361	25575	387	25877
336	25263	362	25587	388	25888
337	25276	363	25599	389	25899
338	25289	364	25611	390	25911
339	25302	365	25622	391	25922
340	25315	366	25635	392	25933
341	25328	367	25647	393	25944
342	25340	368	25658	394	25955
343	25353	369	25670	395	25966
344	25366	370	25682	396	25977
345	25378	371	25694	397	25988
346	25391	372	25705	398	25999
347	25403	373	25717	399	26010
348	25416	374	25729	400	26021
349	25428	375	25740	401	26031

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
402	26042	428	26314	454	26571
403	26053	429	26325	455	26580
404	26064	430	26335	456	26590
405	26075	431	26345	457	26599
406	26085	432	26355	458	26609
407	26096	433	26365	459	26618
408	26107	434	26375	460	26628
409	26117	435	26385	461	26637
410	26128	436	26395	462	26646
411	26138	437	26405	463	26656
412	26149	438	26415	464	26665
413	26160	439	26425	465	26675
414	26170	440	26435	466	26684
415	26180	441	26444	467	26693
416	26191	442	26454	468	26702
417	26201	443	26464	469	26712
418	26212	444	26474	470	26721
419	26222	445	26484	471	26730
420	26232	446	26493	472	26739
421	26243	447	26503	473	26749
422	26253	448	26513	474	26758
423	26263	449	26522	475	26767
424	26274	450	26532	476	26776
425	26284	451	26542	477	26785
426	26294	452	26551	478	26794
427	26304	453	26561	479	26803

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
480	26812	506	27042	532	27259
481	26821	507	27050	533	27267
482	26830	508	27059	534	27275
483	26839	509	27067	535	27283
484	26848	510	27076	536	27292
485	26857	511	27084	537	27300
486	26866	512	27093	538	27308
487	26875	513	27101	539	27316
488	26884	514	27110	540	27324
489	26893	515	27118	541	27332
490	26902	516	27126	542	27340
491	26911	517	27135	543	27348
492	26920	518	27143	544	27356
493	26928	519	27152	545	27364
494	26937	520	27160	546	27372
495	26946	521	27168	547	27380
496	26955	522	27177	548	27388
497	26964	523	27185	549	27396
498	26972	524	27193	550	27404
499	26981	525	27202	551	27412
500	26990	526	27210	552	27419
501	26998	527	27218	553	27427
502	27007	528	27226	554	27435
503	27016	529	27235	555	27443
504	27024	530	27243	556	27451
505	27033	531	27251	557	27459

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The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
558	27466	584	27664	610	27853
559	27474	585	27672	611	27860
560	27482	586	27679	612	27868
561	27490	587	27686	613	27875
562	27497	588	27694	614	27882
563	27505	589	27701	615	27889
564	27513	590	27708	616	27896
565	27520	591	27716	617	27903
566	27528	592	27723	618	27910
567	27536	593	27731	619	27918
568	27543	594	27738	620	27924
569	27551	595	27744	621	27931
570	27559	596	27752	622	27938
571	27566	597	27760	623	27945
572	27574	598	27767	624	27952
573	27582	599	27774	625	27959
574	27589	600	27782	626	27966
575	27597	601	27789	627	27973
576	27604	602	27796	628	27980
577	27612	603	27803	629	27987
578	27619	604	27810	630	27993
579	27627	605	27818	631	28000
580	27634	606	27825	632	28007
581	27642	607	27832	633	28014
582	27649	608	27839	634	28021
583	27657	609	27846	635	28028

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636

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
636	28035	662	28209	688	28376
637	28041	663	28215	689	28382
638	28048	664	28222	690	28388
639	28055	665	28228	691	28395
640	28062	666	28235	692	28401
641	28068	667	28241	693	28407
642	28075	668	28248	694	28414
643	28082	669	28254	695	28420
644	28089	670	28261	696	28426
645	28096	671	28267	697	28432
646	28102	672	28274	698	28439
647	28109	673	28280	699	28445
648	28116	674	28287	700	28451
649	28122	675	28293	701	28457
650	28129	676	28299	702	28463
651	28136	677	28306	703	28470
652	28142	678	28312	704	28476
653	28149	679	28319	705	28482
654	28156	680	28325	706	28488
655	28162	681	28331	707	28494
656	28169	682	28338	708	28500
657	28176	683	28344	709	28506
658	28182	684	28351	710	28513
659	28189	685	28357	711	28519
660	28195	686	28363	712	28525
661	28202	687	28370	713	28531

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
714	28537	740	28692	766	28842
715	28543	741	28698	767	28848
716	28549	742	28704	768	28854
717	28555	743	28710	769	28859
718	28561	744	28716	770	28865
719	28567	745	28722	771	28871
720	28573	746	28727	772	28876
721	28579	747	28733	773	28882
722	28585	748	28739	774	28887
723	28591	749	28745	775	28893
724	28597	750	28751	776	28899
725	28603	751	28756	777	28904
726	28609	752	28762	778	28910
727	28615	753	28768	779	28915
728	28621	754	28774	780	28921
729	28627	755	28779	781	28927
730	28633	756	28785	782	28932
731	28639	757	28791	783	28938
732	28645	758	28797	784	28943
733	28651	759	28802	785	28949
734	28657	760	28808	786	28954
735	28663	761	28814	787	28960
736	28669	762	28820	788	28965
737	28675	763	28825	789	28971
738	28681	764	28831	790	28976
739	28686	765	28837	791	28982

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
792	28987	818	29128	844	29263
793	28993	819	29133	845	29269
794	28998	820	29138	846	29274
795	29004	821	29143	847	29279
796	29009	822	29149	848	29284
797	29015	823	29154	849	29289
798	29020	824	29159	850	29294
799	29025	825	29165	851	29299
800	29031	826	29170	852	29304
801	29036	827	29175	853	29309
802	29042	828	29180	854	29315
803	29047	829	29186	855	29320
804	29053	830	29191	856	29325
805	29058	831	29196	857	29330
806	29063	832	29201	858	29335
807	29069	833	29206	859	29340
808	29074	834	29212	860	29345
809	29079	835	29217	861	29350
810	29085	836	29222	862	29355
811	29090	837	29227	863	29360
812	29096	838	29232	864	29365
813	29101	839	29238	865	29370
814	29106	840	29243	866	29375
815	29112	841	29248	867	29380
816	29117	842	29253	868	29385
817	29122	843	29258	869	29390

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
870	29395	896	29523	922	29647
871	29400	897	29528	923	29652
872	29405	898	29533	924	29657
873	29410	899	29538	925	29661
874	29415	900	29542	926	29666
875	29420	901	29547	927	29671
876	29425	902	29552	928	29675
877	29430	903	29557	929	29680
878	29435	904	29561	930	29685
879	29440	905	29566	931	29689
880	29445	906	29571	932	29694
881	29450	907	29576	933	29699
882	29455	908	29581	934	29703
883	29460	909	29586	935	29708
884	29465	910	29590	936	29713
885	29469	911	29595	937	29717
886	29474	912	29600	938	29722
887	29479	913	29605	939	29727
888	29484	914	29609	940	29731
889	29489	915	29614	941	29736
890	29494	916	29619	942	29741
891	29499	917	29624	943	29745
892	29504	918	29628	944	29750
893	29509	919	29633	945	29754
894	29513	920	29638	946	29759
895	29518	921	29643	947	29763

The Table of Logarithmes.

N.	Logar.	N.	Logar.	N.	Logar.
948	29768	966	29850	984	29930
949	29773	967	29854	985	29934
950	29777	968	29859	986	29939
951	29784	969	29863	987	29943
952	29786	970	29868	988	29948
953	29790	971	29872	989	29952
954	29795	972	29877	990	29956
955	29800	973	29881	991	29961
956	29805	974	29886	992	29965
957	29809	975	29890	993	29969
958	29814	976	29894	994	29974
959	29818	977	29899	995	29978
960	29823	978	29903	996	29983
961	29827	979	29908	997	29987
962	29832	980	29912	998	29991
963	29836	981	29917	999	29996
964	29841	982	29921	1000	30000
965	29845	983	29926		

Prop.

Propo. 2.

A Logarithme being given to finde the absolute number thereof.

Let the *Logarithme* given be 11461. if you seek this number in the second Columnne of the Table, (under the title *Logarithme*) you shall finde against it, (in the first Columnne) 14. which is the absolute of that *Logarithme*.

But, (as in the *Sines*) if you finde not the absolute *Logarithme* you looke for in the Table, you must take the nearest thereunto, as if you seeke the *Logarithme* 24908. you must take the *Logarithme* 24914 which is the nearest thereunto.

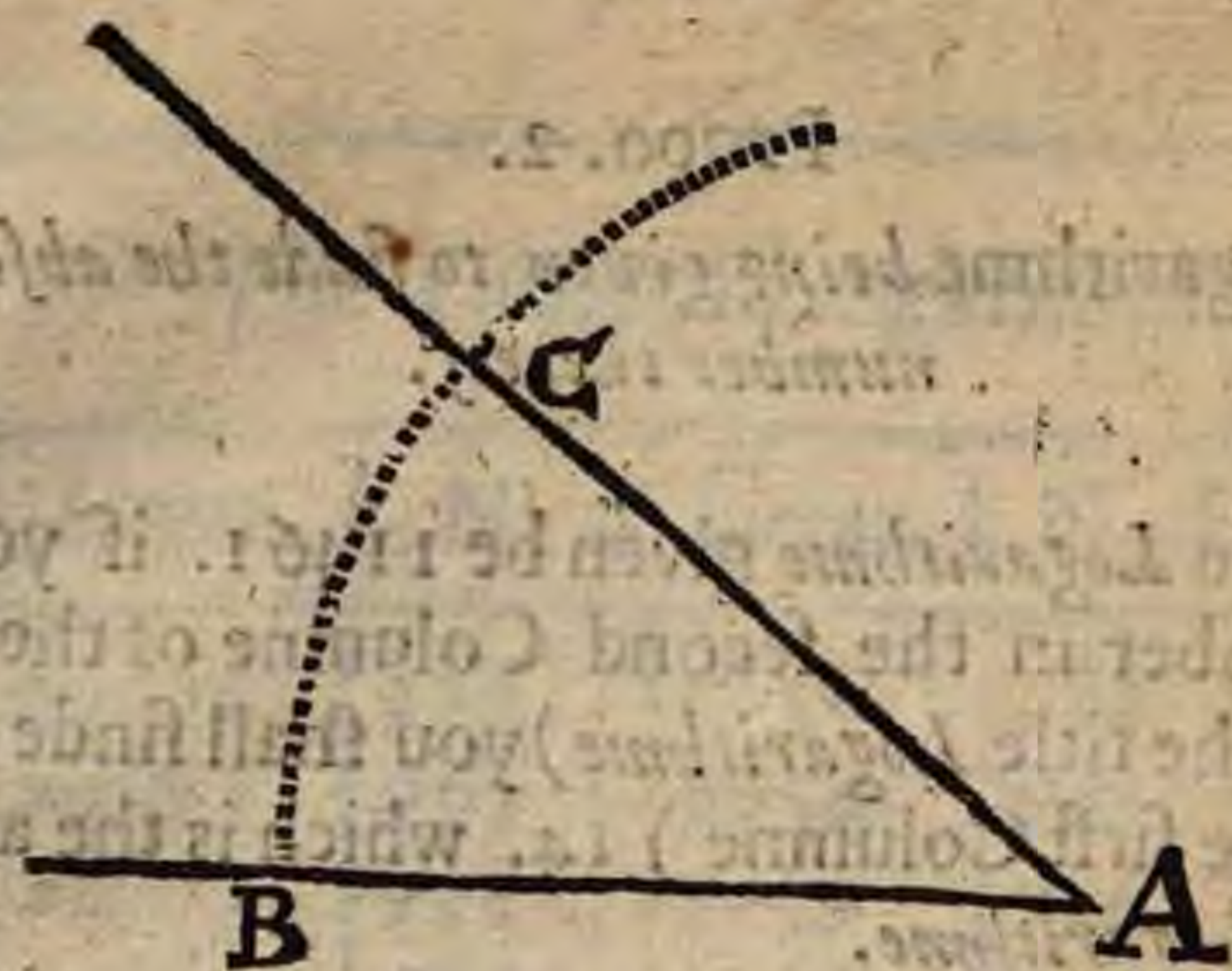
CHAP. XVI.

Of the joynt use of the Tables of the Sines and Logarithmes, in the mensuration of the sides and Angles of right lined Triangles.

FOrasmuch as the taking of Altitudes, and Distances depends wholly upon the mensuration of right lined Triangles, I will first instruct the *Surveyor* in that doctrine; and first he must consider that.

1. A *Triangle* is a figure comprehended of three sides and three *Angles*, as is the figure *A B C*.

C



2. Every two sides of a *Triangle* are called the sides of the *Angle* comprehended by them, as the sides *AB*, and *AC*, are the sides of the *Angle CAB*, for you must note that every *Angle* is noted with three letters, the middlemost whereof is the *Angular* point.

3. The measure of an *Angle* is the Arch of a Circle described on the *Angular* point, as in the following *Triangle*, the Arch *CB*, is the measure of the *Angle CAB*.

4. A degree is the three hundred and sixtieth part of a Circle.

5. A *Semi-circle* is the halfe of a whole Circle, containing 180 degrees.

6. A *Quadrant* is the fourth part of a Circle, containing 90 degrees.

7. The complement of an *Angle* is so much as the *Angle* wanteth of 90 degrees, as suppose the *Angle CAB*, should containe 40 degrees, the Complement thereof would be 50 degrees, for if you take 40 from 90 there will remaine 50.

8. The Complement of an *Angle* to a *Semi-circle*

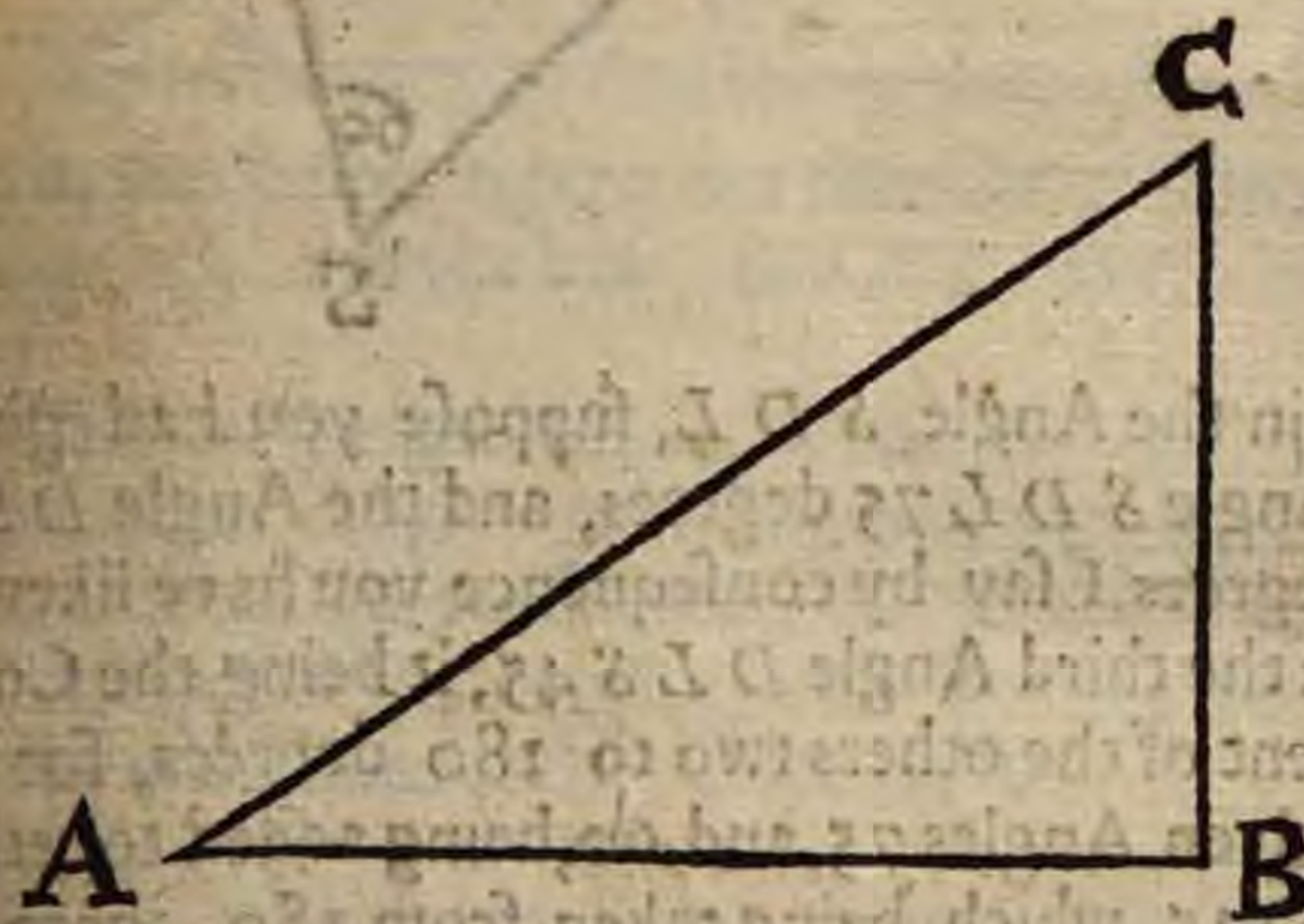
is so much as the said *Angle* wanteth of 180. degrees.

9. An *Angle* is either right, acute, or obtuse.

10. A right *Angle* is that whose measure is a *Quadrant*, as is the *Angle CBA*.

11. An acute *Angle* is lesse than a right *angle*.

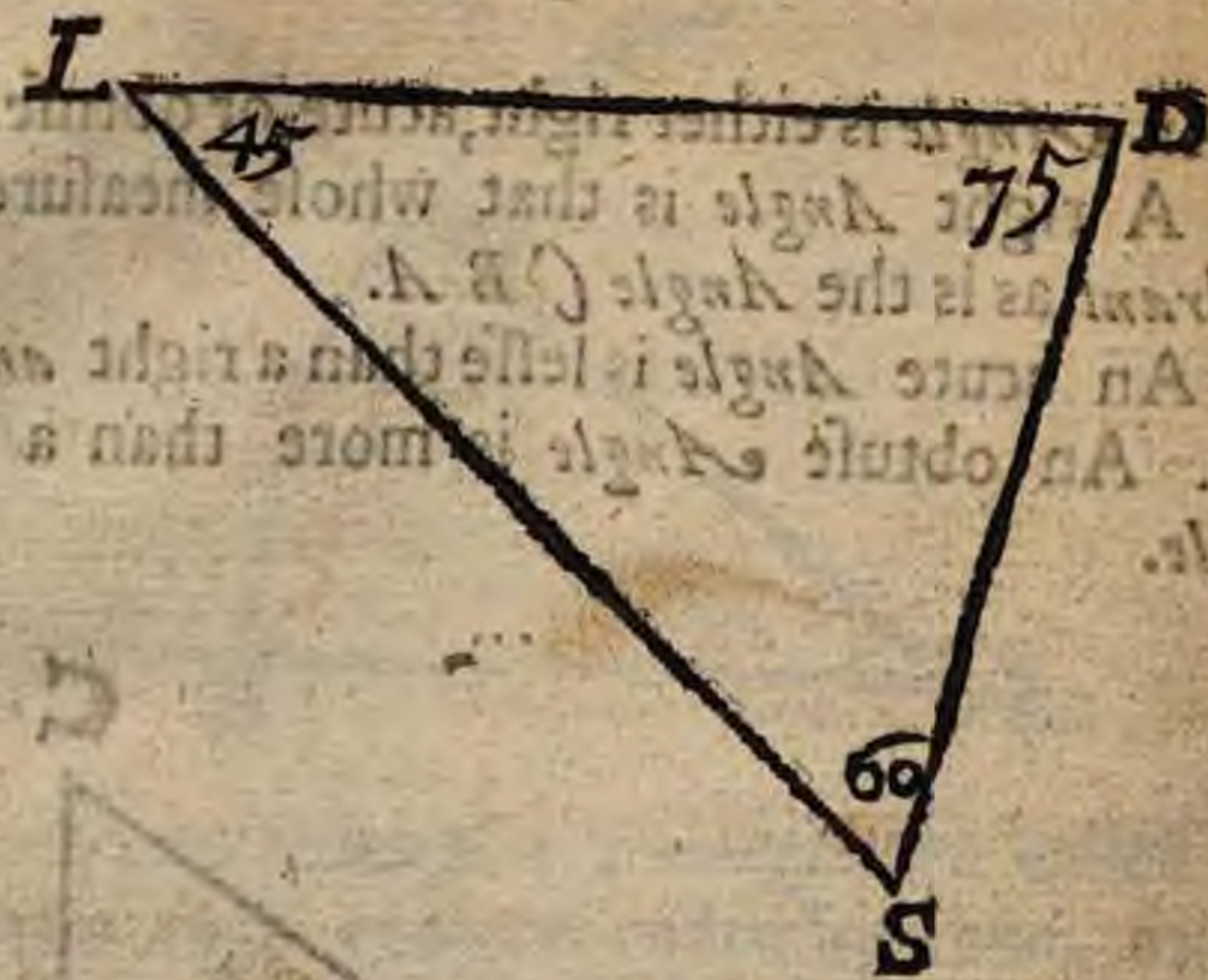
12. An obtuse *Angle* is more than a right *Angle*.



13. A *Triangle* is either right angled, or oblique angled.

14. A right angled *Triangle* is that which hath one right angle, as the *Triangle ABC*. is right angled at *B*.

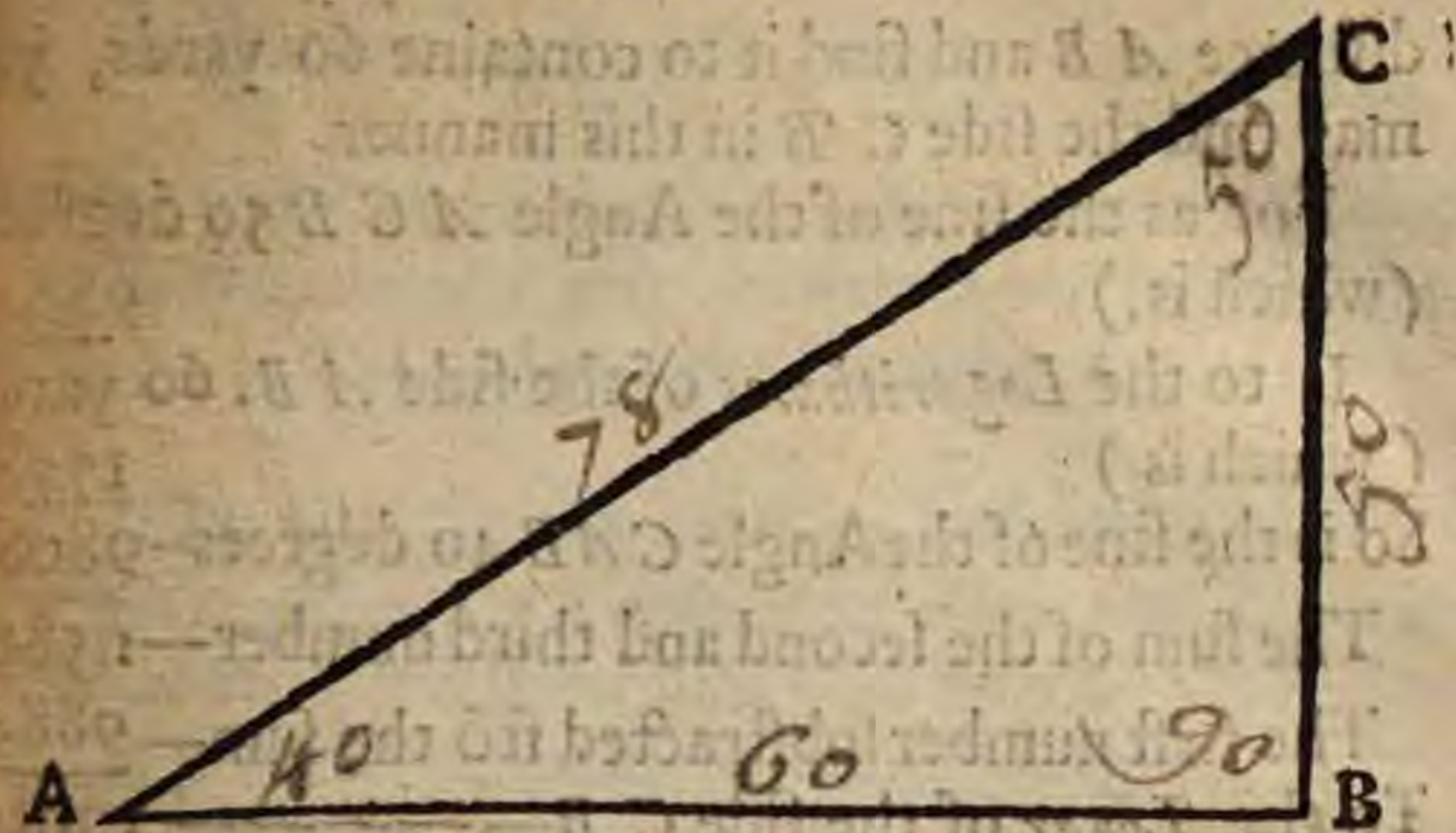
15. The three angles of every right lined triangle, whether acute, or obtuse, are equal to two right Angles, or containe 180 degrees, so that in any right lined *Triangle*, if you have any two of the Angles given, you have also the third given, it being the Complement thereof to 180 degrees.



As in the Angle $S D L$, suppose you had given the Angle $S D L$ 75 degrees, and the Angle $D S L$ 60 degrees, I say by consequence you have likewise given the third Angle $D L S$ 45, it being the Complement of the others two to 180 degrees, for the two given Angles 75, and 60, being added together make 135, which being taken from 180, there remains 45, the quantity of the third Angle.

16. In every right Angled Triangle the side which lieth opposite to the right Angle is called the *Hypothensall*, and of the other two, the one is called the perpendicular, and the other the base, at pleasure, but most commonly the shortest is called the Perpendicular, and the longest the base.

Angles, or containe 180 degrees, to that in any right lined Triangle, if you have any two of the Angles given, you have also the third given, it being the Complement thereof to 180 degrees.



As in the former figure the side $A C$ is the *Hypothensall*, $A B$ the base, and $C B$, the *Perpendicular*.

17. In every right Angled Triangle, having one of the acute Angles given, it being the Complement thereof to 90 degrees, As in the Triangle $A C B$, suppose the Angle $C A B$ were 40 degrees, then by consequence the Angle $A C B$ must be 50 degrees.

18. In all plaine Triangles the sides are in proportion the one to the other, as the Sines of the Angles opposite to those sides, As in the Triangle $A B C$, the sine of the Angle $A C B$, is in proportion to the side $A B$, as the sine of the Angle $C A B$ is to the side $C B$, & *contra*.

Again in the Triangle A B C.

Suppose $C B$ were a Tree, Steeple, or Tower, and that standing at A with your, *Quadrant* you finde the Angle $C A B$, to containe 40 degrees, (as is hereafter taught) then by consequence the Angle $A C B$, is 50 degrees, and that you measure the distance

distance AB and find it to containe 60 yards, you may find the side CB in this manner.

For as the sine of the Angle ACB 50 degrees,
(which is,) 98843

Is to the *Logarithmes* of the side AB . 60 yards.
(which is) 17782

So is the sine of the Angle CAB 40. degrees-- 98081

The sum of the second and third number-- 115863

The first number subtracted fró the sum-- 98843

To the *Logar.* of the side CB ----- 17020 .

Whose number answering to that *Logarithme* is 50, and that is the height of the side CB in yards.

Another Example.

Suppose (in the same Triangle) it were required to find the *Hypothensall* AC , having the same given as before, the proportion will be thus.

As the sine of the Angle ACB 50 degrees,
(which is) 98843

Is to the *Logarithme* of the side AB 60 yards
(which is) 17782

So is the sine of the Angle ABC 90 degrees-- 100000

The sum of the second & third number-- 117782

The first number subtracted fró the sum-- 98843

To the *Logar.* of the side AC ----- 18939 .

Whose number answering to that *Logarithme* is 78 and that is the length of the side AC . in yards.

CHAP.

CHAP. XVII.

How to take an inaccessible distance at two stations by the Plaine Table; and the Tables of Sines and Logar. before mentioned.

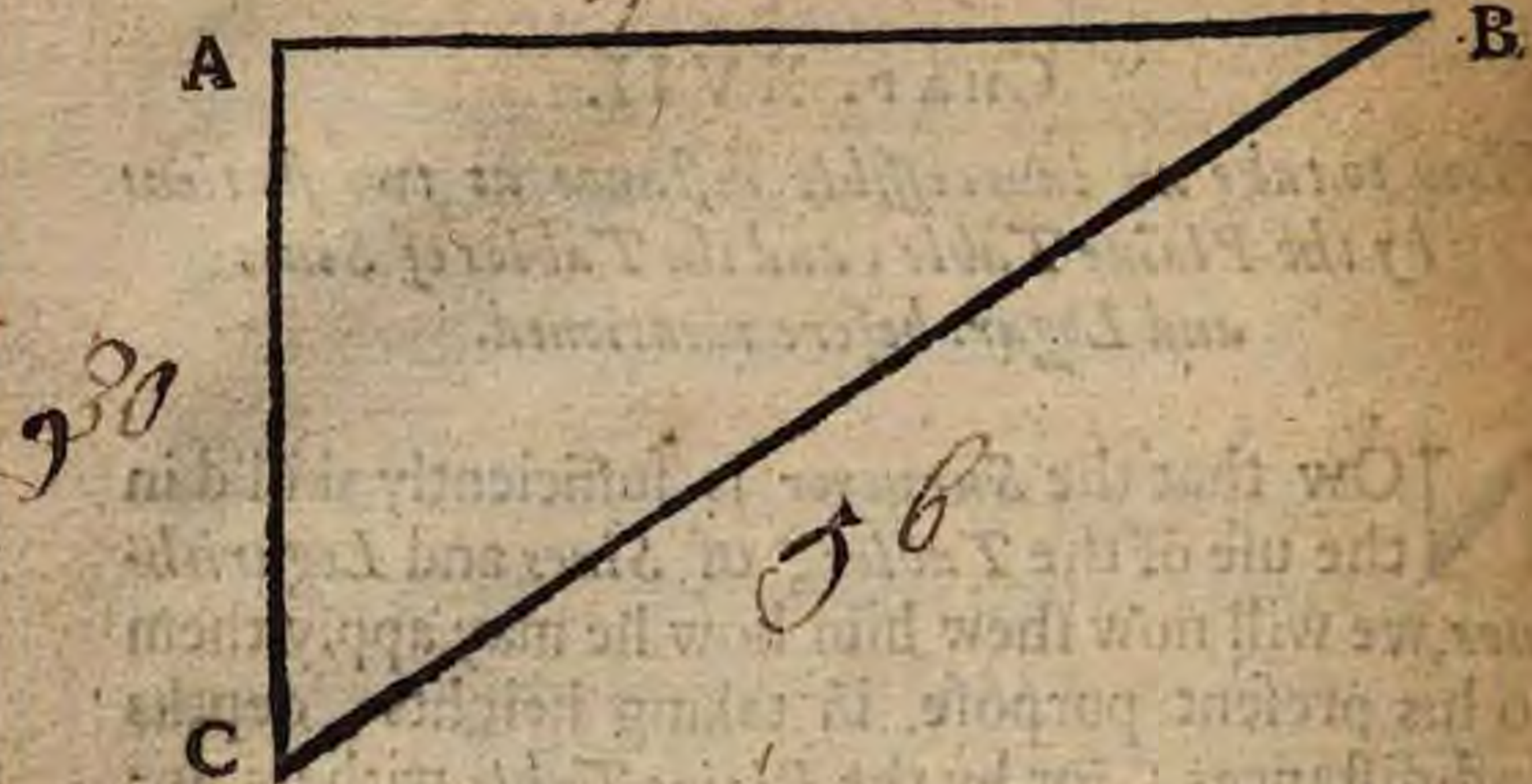
NOW that the *Surveyor* is sufficiently skill'd in the use of the *Tables*, of *Sines* and *Logarithmes*, we will now shew him how he may apply them to his present purpose, in taking heights, depths and distances; for by the *Plaine Table*, with its appurtenances, and the *Tables of Sines*, and *Logar.* he may with celerity and exactnesse measure the distance of any place or places far remote. Also the Altitude of any Mountaine, Hill, Tower, Steeple, or Sconce, whether accessible or inaccessible: and first how to take an inaccessible distance at two stations.

Suppose you were standing at A , and that B were some notable mark, (as a Tree, or the like) whose distance you would know from A your place of standing, but by reason of some opposition, as water or the like, you cannot come neer it.

First, place your Instrument at A , then laying the *Index* with the sights upon the *Diameter* thereof, turne the whole Instrument about, till through the sights you see the marke at B , then fasten the Instrument there, and turne the *Index* about, till it lie upon 90 degrees (which is a right Angle.)

F

A



Then looking through the sights againe, let one set up some marke at C, whose distance AC, let be 30 yards, (or any other number of equall parts,) then removing your Instrument to C, laying the *Index* on the *Diameter* thereof; and turning the Instrument about, till through the sights you espy your first place of standing at A, which found, fasten the Instrument there, and move the *Index* about, till you espy your marke at B, observing what degrees the *Index* cutteth on the frame of the *Table*, which knowne, you may compute the distance; AB in this manner; for by your two stations AC, and your mark B, you have made the right angled Triangle ABC, in which you have given the side AC (which is the distance of your two stations, 30 yards;) 2. You have given the Angle ACB (observed by your Instrument at C) 50 degrees, and 3. You have given the angle ABC (being the Complement to the former Angle ACB) 40 degrees, and you are to finde the side AB which is the distance required.

To

To performe which: you must resolve the Triangle ABC, as is taught before in Chapter 16 for.

As the Sine of the Angle ABC, is to the distance AC, So is the Sine of the Angle ACB, to the distance AB.

So that if you adde the sine of the Angle ACB, to the *Logarithme* of the side AC, and from the sum of them, subtract the sine of the Angle ABC; The remainder shall be the *Logarithme* of the distance AB; in example.

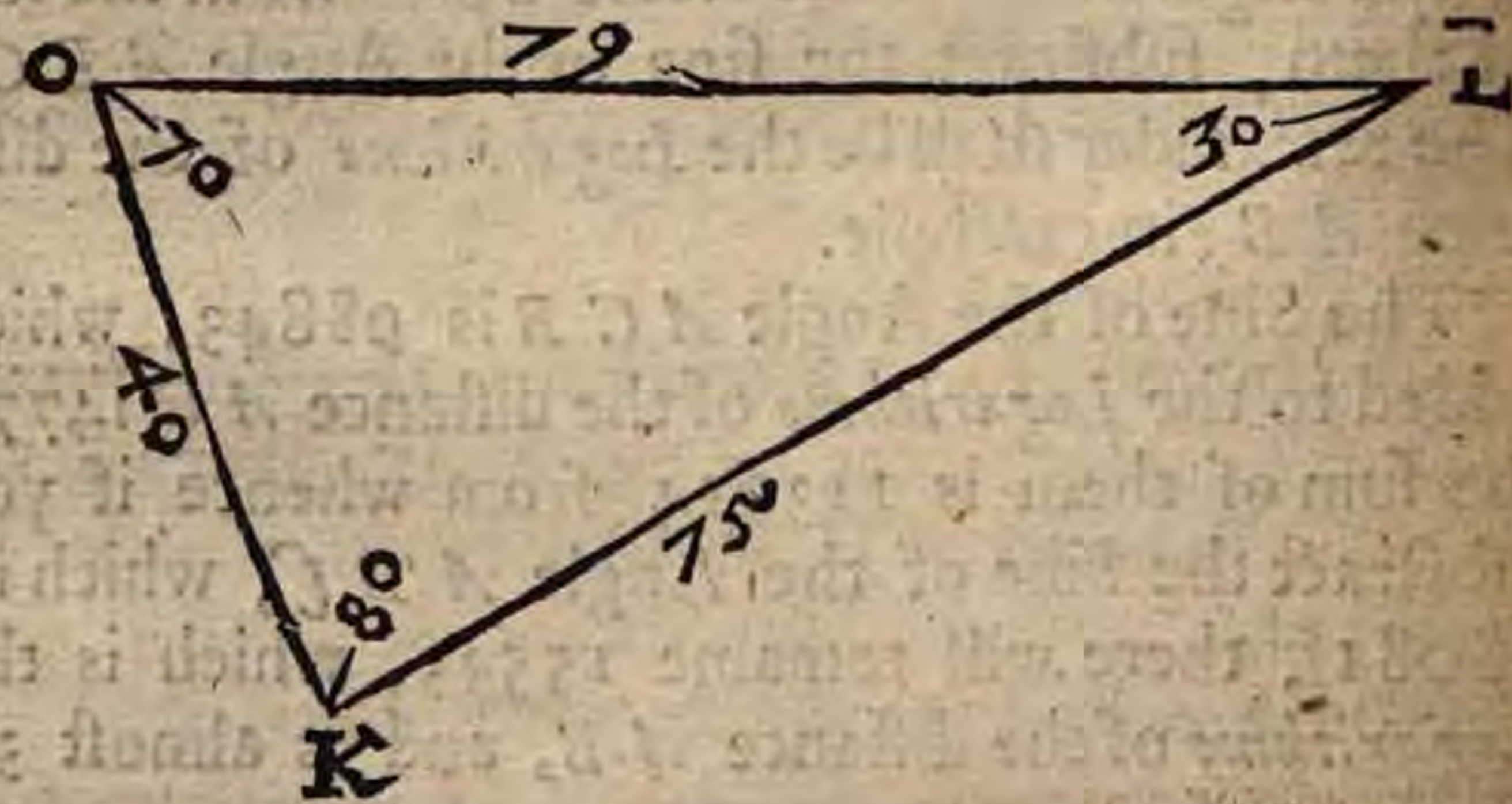
The Sine of the Angle ACB is 98843, which added to the *Logarithme* of the distance AC 14771 the sum of them is 113614 from whence if you subtract the Sine of the Angle ABC, which is, 98081, there will remaine 15533, which is the *Logarithme* of the distance AB, and is almost 36 yards.

I have been more large upon this particular than I intended, (having sufficiently insisted thereon before in the joynt use of the Sines and Logarithms) but that the Surveyour may not be ignorant of these necessary conclusions, I have in this used all the perspicuity I could imagine, so that in the subsequent Chapters I may be the briefer, for if he understand this one aright, he will be capable of any of the other at the first view.

To take an inaccessible distance at two stations, not regarding, whether the two stations and distance required make a right Angle.

Let O and K be two stations, from either of which it is required to find the distance to L .

Having placed your Instrument at O , the Ruler lying upon the Diameter or no degrees, direct your sights to L . and there stay your Instrument, then turn your Index about,



Till through your sights you espy your second station at K , noting the degrees cut by the Index, which let be 70, then removing your Instrument to K , and there make observation againe, by directing your sights first to O , and then to L , and suppose the degrees cut at this second observation, were 80: so in the Triangle $O L K$ have you two Angles given, viz. $L O K$, and $O K L$, and by consequence you have the third Angle $O L K$, 30 degrees, it being the Complement of the other two to 180 degrees, by the 15 Prop. of Chap. 16

and

and likewise you have given the distance $O K$ (which you may measure with a Chain or otherwise) 40 yards, and you are to finde the distances $O L$, and $K L$, which you may performe according to the last.

For

As the Sine of the Angle $O L K$ 30 degrees, is to the Logarithme of the distance $O K$ 40 yards, So is the Sine of the Angle $O K L$ 80 degrees, to the Logarithme of the distance $O L$.

Therefore if to the Logarithme of 40, you adde the Sine of 80, and from the sum of them substract the sine of 30, you shall have remaining the Logarithme of the distance $O L$.

See the following worke.

The Sine $O L K$ 30 degrees	96990
The Logar. of the distance $O K$ 40 yards	16021
The Sine of $O K L$ 80 degrees	99934
The sum of the second & third numbers	15995
The Sine of 30 degrees subtracted	} 96990
from the first Sine	
The Logarithme of the distance $O L$	18965.
The number answering thereunto is 79, and so many yards is the distance $O L$.	

By the same Rule you may likewise finde the distance $K L$.

For

As the Sine of the Angle $O L K$ 30 degrees, is to the Logar. of the distance $O K$ 40 yards, So is the Sine of the Angle $L O K$ 70 degrees, To the Logarithme of the distance $K L$.

Which by adding the Logarithme of 40, (the distance O

distance O

distance OK ,) to the Sine of 70, (the Angle LOK) and from the sum of them both subtract the Sine of 30, (the Angle OLK ,) you shall finde the *Logarithme* of the remainder to be 18761, the number answering whereunto is 75, and so many yards is the distance KL .

In all synicall proportions, observe this generall rule, that in all cases whatsoever, you must adde second and third termes (or number) together, and from the sum of them both you must subtract the first terme, and the remainder shall bee the third term, and answer to your question.

CHAP. XIX.

How to protract or lay down a distance thus taken upon Paper, or Past-board, by helpe of your Protractor, or line of Chords.

SUPPOSE it were required to draw upon Paper or Past-board, the Symetry or Proportion of the distance last taken.

First, draw a Line at length as OL , then upon one end thereof, as at O , place the Center of your *Protractor*, and lay the line GH of the *Protractor*, directly upon the Line OL , then because the Angle LOK is 70 degrees, against 70 degrees of your *Protractor*, make a marke upon your paper with your *Protracting* pin, (as is taught in Chapter II.) and draw the Line OK , upon which Line from O to K , set of 40 equall parts, from any of your *Scales*, (representing 40 yards, the distance of your two stations.)

stations,) then remove your *Protractor* to K , placing the Line GH of the *Protractor* directly upon the Line OK on your paper, and because the Angle OKL was 80 degrees, you must make a marke upon your paper, just against 40 degrees of your *Protractor*, and draw the Line KL , which will cut the Line OL in L , and then if you measure the tenth of the Lines OL , and KL , by the same Scale from whence you tooke off 40, for the Line OK , you shall finde the Line OL to containe 79, and the Line KL to containe 75, exactly agreeing with the calculation of that Chapter.

And here the *Surveyor* cannot but be abundantly satisfied, to see the congruity of his Operations. Considering what harmony there is betweene *Arithmetical* Calculation, and *Geometricall* Projection.

CAPH. XX.

How to take an accessible Altitude. by the Quadrant on the Index of your Plane Table.

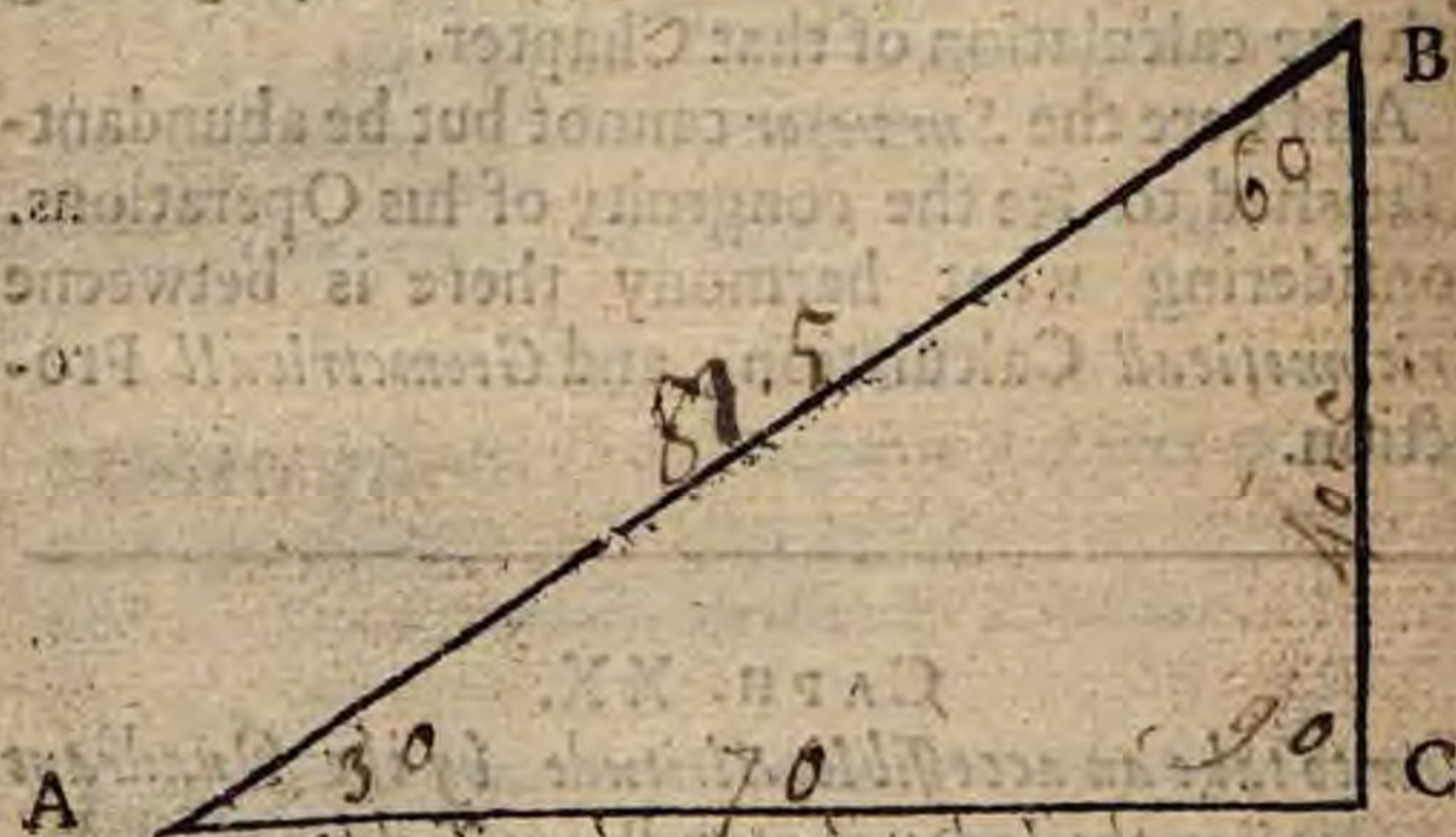
IMAGINE BC to be a Tree, Steeple, or other Altitude, whose height is required.

Place your Instrument exactly levell at A , the *Quadrant* being set upon the *Index* of your Table, then lift your *Quadrant* up, or downe, till through the sights thereof you espy the very top of the building at B , and observe what degrees of the *Quadrant* are cut by the fiduciall Line; for those degrees are equall to the Angle BAC , (which suppose to be 30,) then by consequence ABC

is 60, the Complement of the other to 90, likewise measure the distance from A , the place of your standing, to C , the base or foot of the thing to be measured, which suppose to be 70 foot, or yards, which known you have given in the Triangle ABC .

1. The Angle BAC . observed by your Instrument at A 30 degrees.

2. You have the Angle ABC , the complement of the former to 90 degrees, viz. 60 degrees.



3. And Lastly, you have given the distance AC , the distance from your station to the base of the Altitude to be measured 70 foot.

And you are to finde the side BC the Altitude required.

Which to performe say thus,

As the Sine of the Angle ABC 60 degrees,
is to the Logar. of the distance AC ,

So is the Sine of the Angle BAC ,

To the Logar of the Altitude BC .

Which according to the former worke of this nature,

nature, will be found to be about 40 foot and a halfe.

CHAP. XXI.

How to protract or lay the former observation on paper by helpe of the Protractor.

HAVING drawn a Line as AC , place the Center of your *Protractor* upon A , and the Line GH , of your *Protractor* on the Line AC , then with your *Protracting* pin make a marke upon your paper just by the side of your *Protractor* at 30 degrees, and from A through that point draw the Line AB , then because the distance AC was 70 foot, take 70 out of any of your Lines of equall parts, and set that distance from A to C , and from the point C erect the Perpendicular CB , which shall containe 40 foot and a halfe as before.

CHAP. XXII.

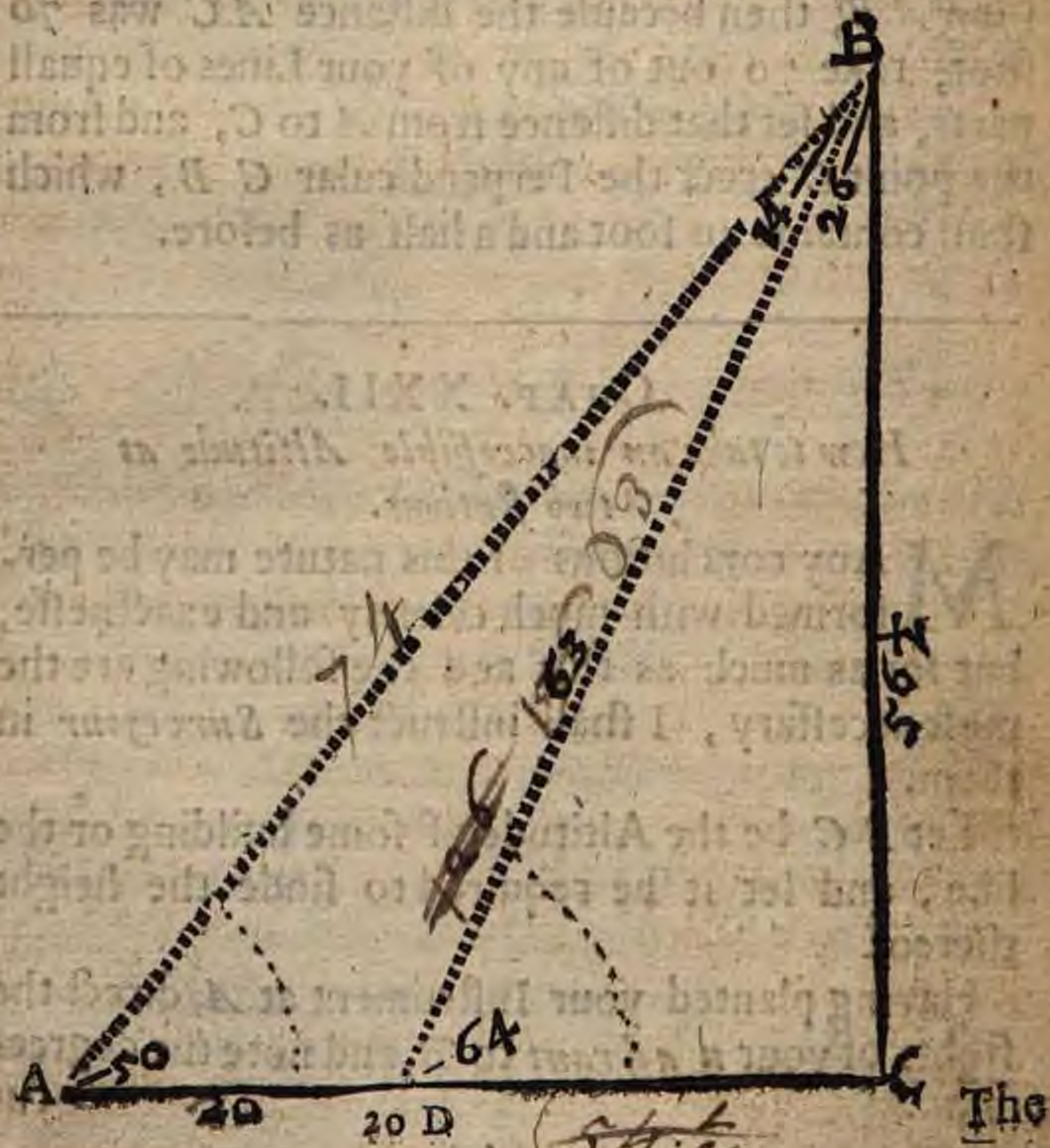
How to take an inaccessible Altitude at two stations.

MANY conclusions of this nature may be performed with much celerity and exactnesse, but for as much as this and the following are the most necessary, I shall instruct the *Surveyour* in them.

Let BC be the Altitude of some building or the like, and let it be required to finde the height thereof.

Having planted your Instrument at A , direct the sights of your *adrant* to B , and note the degrees cut

cut in the *Quadrant* by the fiduciall edge, which let be 50 degrees, and these degrees are the quantity of the Angle BAC , then because you cannot approach to the base of the building at C , measure from A towards C , so far as you can, which let be to D , and suppose that distance AD , to be 20 yards, then remove your Instrument to D , and there againe observe as you did at A , finding the Angle to be 64 degrees, which known, you may consider, that the Angle BDC observed at the second station being 64 degrees, the Complement thereof DBC must be 26 degrees, and likewise knowing the Angle BAC to be 50 degrees.



The Angle ABC must be 40 degrees, you must subtract the Angle DBC 26 degrees, and there will remaine the Angle ABD 14 degrees, by the knowledge whereof you may attaine the Altitude BC , by the directions of the last.

For in the Triangle ABD you have given,

1. The Angle BAD 50 degree.
2. The angle ABD 14 degrees.
3. The distance AD 20 yards, which by the former directions will help you to finde the length of the side DB thus.

As the Sine of the Angle ABD 14 degrees

Is to the Logar. of the side AD 20 yards.

So is the Sine of the Angle BAD 50 degrees,

To the Logarithme of the side DB .

Which by the working according to the former directions, will be found to be about 63 yards.

Then must you make a second worke in the Triangle BCD , in which you have given.

1. The Angle BDC 64 degrees.
2. The Angle DBC 26 degrees.
3. The side DB 63 yards.

And you are to finde the side BC , the Altitude required: wherefore say again,

As the Radius, or the Sine of 90 degrees (which is 10000.)

Is to the Logar. of the side DB 63 yards.

So is the Sine of the Angle BDC 64 degrees.

To the Logarithme of the Altitude BC .

Which according to the former Doctrine, will be 56 yards and a half.

CHAP. XXIII.

How to performe the worke of the last Chapter by Protraction.

Questions of this nature may many times be proposed, when a man may not be provided of all necessaries for the purpose; Suppose therefore you were destitute of your *Tables of Sines*, and *Logarithmes*, and had nothing to helpe your selfe withall but your *Protractor*: having therefore noted in a book, or otherwise, that the degrees cut at your first station at *A* were 50, and the degrees cut at the second station at *D* were 64. and that your stationary distance *AD* was 20 yards, you may immediatly proceed to Protraction.

First, draw the Line *AC*. in which Line let *A* represent your first station, whereon lay the Center of your *Protractor*, and make the Angle *BAC* to containe 50 degrees, (as hath been severall times before shewn,) and draw the Line *AB*. then upon the Line *AC*. set off the distance of your two stations 20 yards, which let be the distance *AD*. then bring your *Protractor* to *D* (which represents your second station,) and placing the Center of your *Protractor* therein, set off an Angle of 64 degrees, and draw the Line *DB*. then where these two Lines *AB*. and *DB*. intersect or meet, which is in the point *B*. from that point let fall the *Perpendicular BC* (as is before taught) the length whereof being measured upon the same Scale, from whence you took the distance *AD*. will give you 56 yards and a halfe, and that is the altitude required,

Chap.

CHAP. XXIV.

How to take the distance of severall places one from another, as also the distance of any of them from your place of standing, it being of excellent use to draw a plot of the most considerable marks, or bounds of a Town, Mannor, or the like.

REpaire to some place from which you may discern all those places, whose distances you require; at which place plant your Instrument, exactly levell, then move your *Index* about till through the sights you espy your first marke, and then observe what degrees your *Index* cutteth on the frame of the *Table*, which degrees note down in a Book: then turne your *Index* to your second mark, and there note the degrees cut as before and set them down, then direct your sights to your third mark, and note them down as before, and so if there be more or lesse, till you have gone over them all.

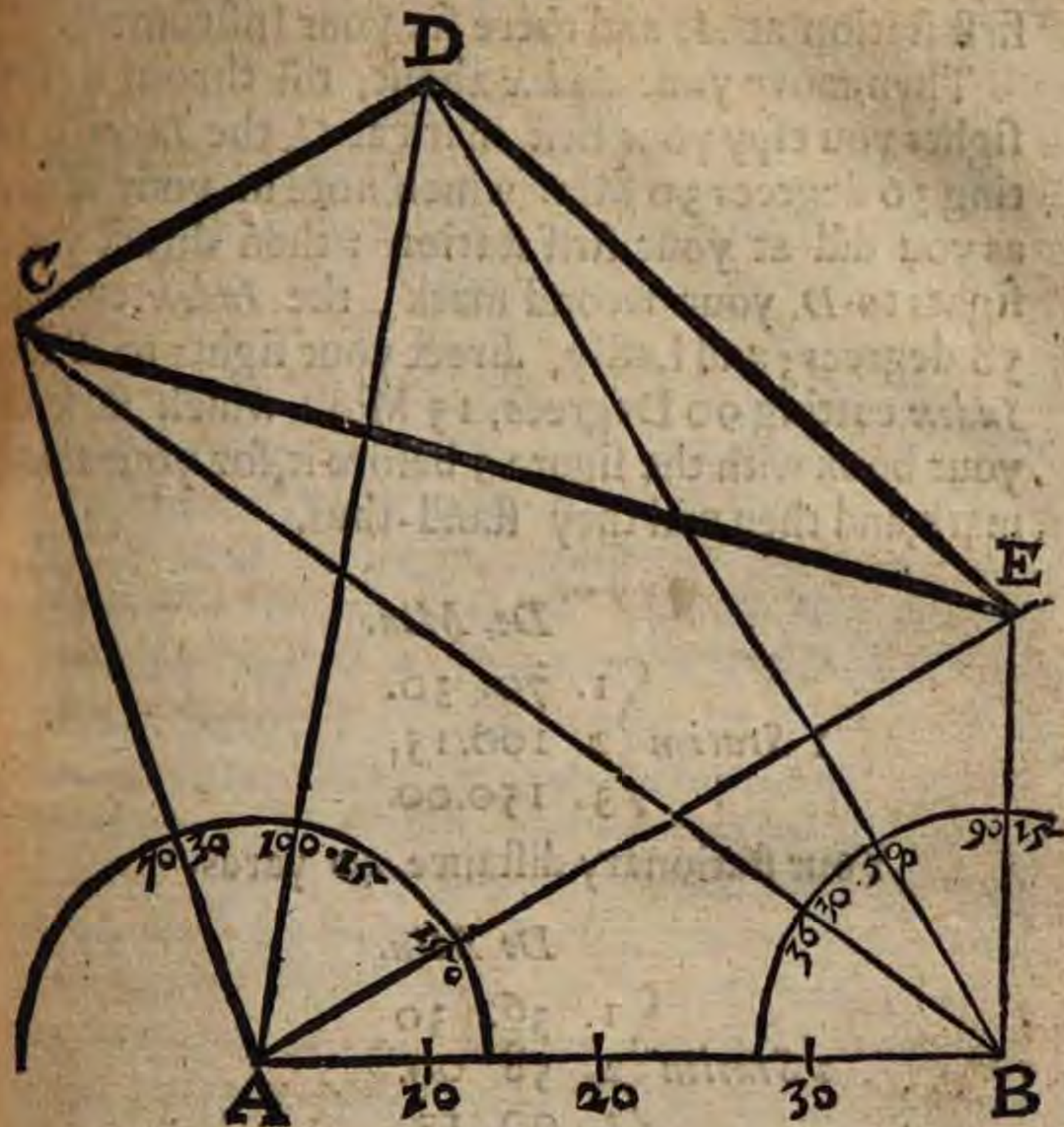
Then for your second observation make choise of some other convenient place; from whence you may discern all the marks as before, which stationary distance let be as large as your ground with convenience will permit, and so scituated that the *Index* lying on the *Diameter* of your *Table* at your first station, through the sights thereof, you may perceive your second station, and likewise at your second you may discern your first, so that in both stations the *Diameter* of the *Table* may be in a right

Line

Line ; At which second station you must make observation in all respects as before, by noting your degrees cut, and setting them down in a Book by themselves, setting a distinction betweene your first and second station, as also figures to your severall marks, as 1.2.3.4.5, &c. at both stations; So that you may not mistake when you come to *Protraction*.

Let *ABC* be three severall marks in the Fields, or other notable markes, as Churches, Town-Halls or the like, and let it be required to finde the distance of either of them from one another, as also the distance of any of them from *A*, or *B*.

Make choise, of your first station at *A*. where placing your Instrument, direct your sights to your first mark at *C*. And suppose your *Index* cuts 70 degrees, 30 Min. which 70 degrees, 30 Min. must be noted in a Booke, as you see here following with the figure 1 before it, signifying your first mark, then direct your sights to *D* your second marke, and suppose the degree cut to be 100 degrees, 15 Min. which must be likewise noted in your Book, as before, with the figures 2 before it, signifying your second Mark.



Then turne your *Index* about, till through the sights you espy your third mark at *E*, the *Index* cutting 150 degrees, which you must note now in your Book, with the figure 3 before it, signifying your third mark.

This done, bring your *Index* to the *Diameter* of your *Table*, that through your sights you may espy your second station at *B*. and measure the distance of your station *AB*. which let be 40 yards. Then bring your Instrument to *B*. and the *Index* lying on the *Diameter* thereof, move the Instrument about, till through the sights you espy your first

first station at *A*, and there fix your Instrument.

Then move your *Index* about, till through the sights you espy your first mark at *C*, the *Index* cutting 36 degrees 30 Min. which note in your book, as you did at your first station : then direct your sights to *D*, your second mark, the *Index* cutting 58 degrees ; and Lastly, direct your sights to *E*, the *Index* cutting 90 Degrees, 15 Min. which note in your book with the figure 3 before it, for your third mark, and then will they stand thus.

	<i>De. Min.</i>
1 Station	1. 70. 30.
	2. 100. 15.
	3. 150. 00.
Your stationary distance 40 yards.	

	<i>De. Min.</i>
2 Station	1. 36. 30
	2. 58. 00.
	3. 90. 15.

By help of this *Table* of your observations, you may at any time protract the same on Paper or otherwise, and making a *Scale* of equall parts, answerable to the parts of your Stationary distance, you may with your *Compasses* measure the distance of any of these marks, one from another, or from either of your Stations : the manner of Protracting whereof, is shewed in the next Chapter.

CHAP.

CHAP. XXV.

How to Protract the former observations upon paper, and to make a Scale to measure any of the distances.

Draw a Line at length, as *AB*, let the two ends thereof *A* and *B*, represent your two Stations ; then upon *A*, your first Station, lay the Center of your *Protractor*, with the *Meridian Line* thereof (which is noted with *GH*) directly upon the Line *AB* : then lay the *Table* of Observations before you, and perceiving thereby, that at your first observation your *Index* cut 70 degrees 30 Min. you must with your *Protracting Pin*, make a mark against 70 degrees 30 Minutes, of your *Protractor* : then againe, seeing that at your second observation, the *Index* cut 100 degrees 15 Min. Therefore with your *Protracting Pin*, you must make a mark on your paper, against 100 degrees 15 Min. of your *Protractor* ; and thirdly, seeing that at your third observation, your *Index* cut 150 degrees, you must there likewise make a mark, and through these marks from *A*. you must draw the streight Lines *AC*, *AD*, *AE*.

Then remove your *Protractor* to *B*, which signifies your second Station, laying the *Meridian line* thereof upon the Line *AB*, and note the Angles of your observations, made at your second station in all respects, as you did those of your first Station.

As first,

At the first observation of your second Station, the

G

the

the *Index* cut 36 degrees 30 Min. Therefore with your *Protracting* Pin make a mark upon the paper against 36 degrees 30 Min. and the degrees cut at your second Observation were 58 degrees. Therefore make a mark against 58 degrees of your *Protractor*: and Lastly, the degrees cut at your third Observation, were 98 degrees 15 Min. against which likewise make a marke: and then through these severall points, from the point *B*, draw streight Lines till they intersect those before drawn from *A*. which will be in these three points *C D*. and *E*; which three points beare a just proportion with the three markes which you observe in the Fields.

Now to finde the distance from *A*. to any of these marks, you may divide a Line into any number of equall parts, (as is before shewed) so that the distance from *A* to *B*, may containe 40 of them, and by taking in your *Compasses* the distance between *A* and *D*, or *A* and *C*, or from *D* to *C*, or from *B* to *C*, or the length of any line in the whole plot; and apply it to your *Scale* so made: it shall exactly shew you the true distance, or length of any Line, which is answerable to the like marks taken in the Fields.

And thus may you with speed, and exactnesse attain the true distance of any marke, or marks far remote, without approaching neare any of them. And thus in over-growne Lands, where you can neither go about it, nor measure within it, this Chapter will stand you in excellent stead.

C H A P. X X V I.

Of some generall Observations to be observed in the mensuration of heights, depths, and distances before shewed; as also in taking the plots of Inclosures, &c.

HAVING shewed you the manner of taking all sorts of heights, and distances: I shall now lay down some rules, by which you may remedy many inconveniences, that may oft-times arise; contrary to the examples before delivered. As, In taking of any Distance, or Altitude. If you at any time chance to meet with an obtuse Angle, or an Angle that exceedeth 90 degrees (seeing the *Table of Sines* extendeth but to 90 degrees) you must therefore in such a case, deduct the excesse of the Angle above 90 degrees, out of 90 degrees, and of that remainder, seek the *Sine* in the *Table*; which will performe your work as well, as if you had the absolute *Sine* of the whole *Angle*.

As, if the *Angle* whose *Sine* is required, were 132 degrees; The excesse whereof, above 90 degrees is 42. which being deducted out of 90 the remainder is 48 degrees. The *Sine* whereof is answerable to the *Sine* of 132.

Or you may performe the same more briefly thus: For, if you subtract your obtuse *Angle* from 180 degrees, the remainder shall be an Arch; whose *Sine* shall be answerable to the *Sine* of the obtuse *Angle* given.

Example.

1. Let the Arch given be the same as before, 132 degrees; This number being subtracted from 180 degrees, the remainder will be 48 degrees; the Sine whereof, shall exactly answer to the Sine of 132 degrees.

2. In taking of distances; the Sine of the *Angle* opposite to your Stationary distance, must be your first terme; your stationary distance must be your second, and the Sine of the *Angle*, opposite to the side required, must be your third term.

3. Remember alwayes in taking of inaccessible heights, and distances; as also in the plotting of unpassable grounds, that you take your stationary distance as large as may be.

4. If at any time you be required to take the Altitude of a Tree, or Castle standing on a Hill, or the like, you must performe it at two operations, First, by taking of the Altitude of the Tree and hill together, and secondly, by taking of the hill alone; then subtracting the height of the hill from the whole height, you may conclude the remainder to be the height of the Tree.

5. In taking of all manner of Altitudes, whether accessible, or inaccessible, you must adde together the height found, and the height of your Instrument from the ground.

Chap.

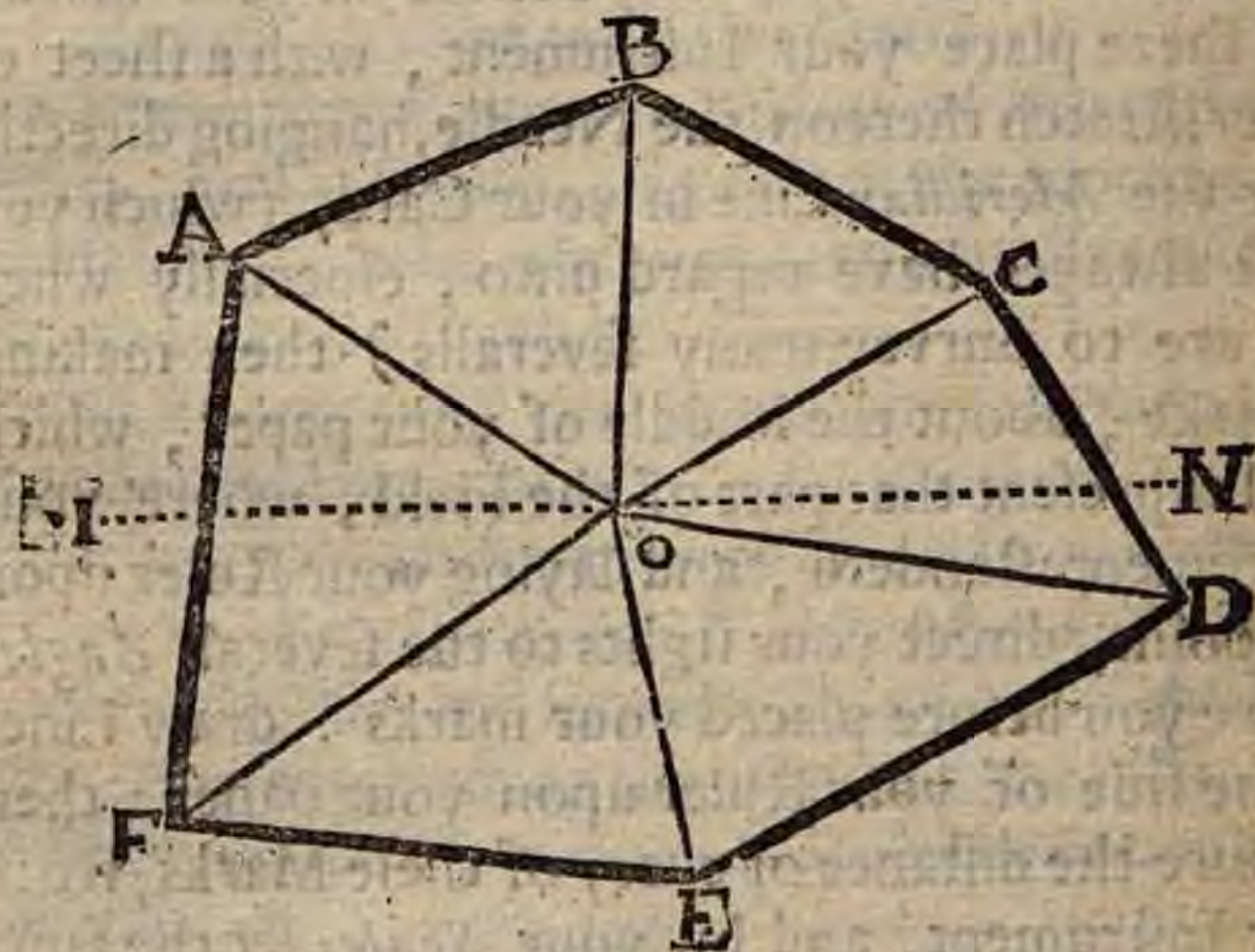
CAPH. XXVII.

How to take the plot of a Field (upon your Plaine Table) at one station, taken in any part of the same Field, from whence all the Angles of the Field may be perceived.

GOe round about the Field, placing marks at every *Angle* of the same, then make choise of some convenient place, about the middle thereof; from whence you may behold all your marks, and there place your Instrument, with a sheet of paper; stretch thereon the Needle, hanging directly over the *Meridian* Line in your Card, (which you must alwayes have regard unto, especially when you are to Survey many severalls) then making a marke, about the Middle of your paper, which shall represent that part of the Field, where your Instrument standeth, and laying your Ruler upon this point, direct your sights to the severall *Angles* where you before placed your marks: draw Lines by the side of your Ruler upon your paper: then measure the distance of every of these Marks, from your Instrument, and by your *Scales* set the same distances upon the Lines drawne upon your *Table*, making small marks with the points of your *Compasses*, or black lead at the end of every one of them; then, Lines being drawne by these points one to another, you shall have upon your *Table* the exact plot of the Field: all the Sides and *Angles* upon your *Table* being answerable to those in the Field.

Suppose you were to take the plot of the

Field $A B C D E F$. having placed marks in the severall *Angles* thereof, as at $A B, C D, E F$, make choise of some convenient place about the middle of the same Field, from whence you may behold all your marks before placed in the severall *Angles*; and there place your Instrument, which place let be O , then turne your Instrument about, till the Needle hang directly over the *Meridian* Line of the Card, noted at the South end with a *Crosse*.



And at the North end with a Flower-deluce, which Line is represented in the following figure with $M N$.

Your Instrument being thus placed, with a sheet of paper thereupon, make a marke with Black-lead, or otherwise upon the paper, which marke shall represent upon your paper the place of your standing in the Field; then, applying your *Index*

to

to this point, direct your sight to your first mark at A . and the *Index* resting there, draw a Line by the side there, then measure the distance from O . the place of your Instrument, to A the Marke; which suppose to be 40 Perches, then take 40 Perches from one of your *Scales*, and apply that distance on your *Table*, from O to A , and at A make a mark.

Then direct your sights to B your second mark, and draw a Line by the side of your *Index* as before: then measure the distance from your Instrument at O . to your marke B . which suppose 45 Perches; this distance must be taken from your *Scale*, and set upon your *Table* from O to B , and at B make another mark.

Then direct your sights to your third mark at C . and draw a Line by the side of the *Index*, and measure the distance from O to C , which suppose 42 Perches, this distance being taken from your *Scale*, and applied to your *Table*, from O to C . shall give you the point C . representing your third mark.

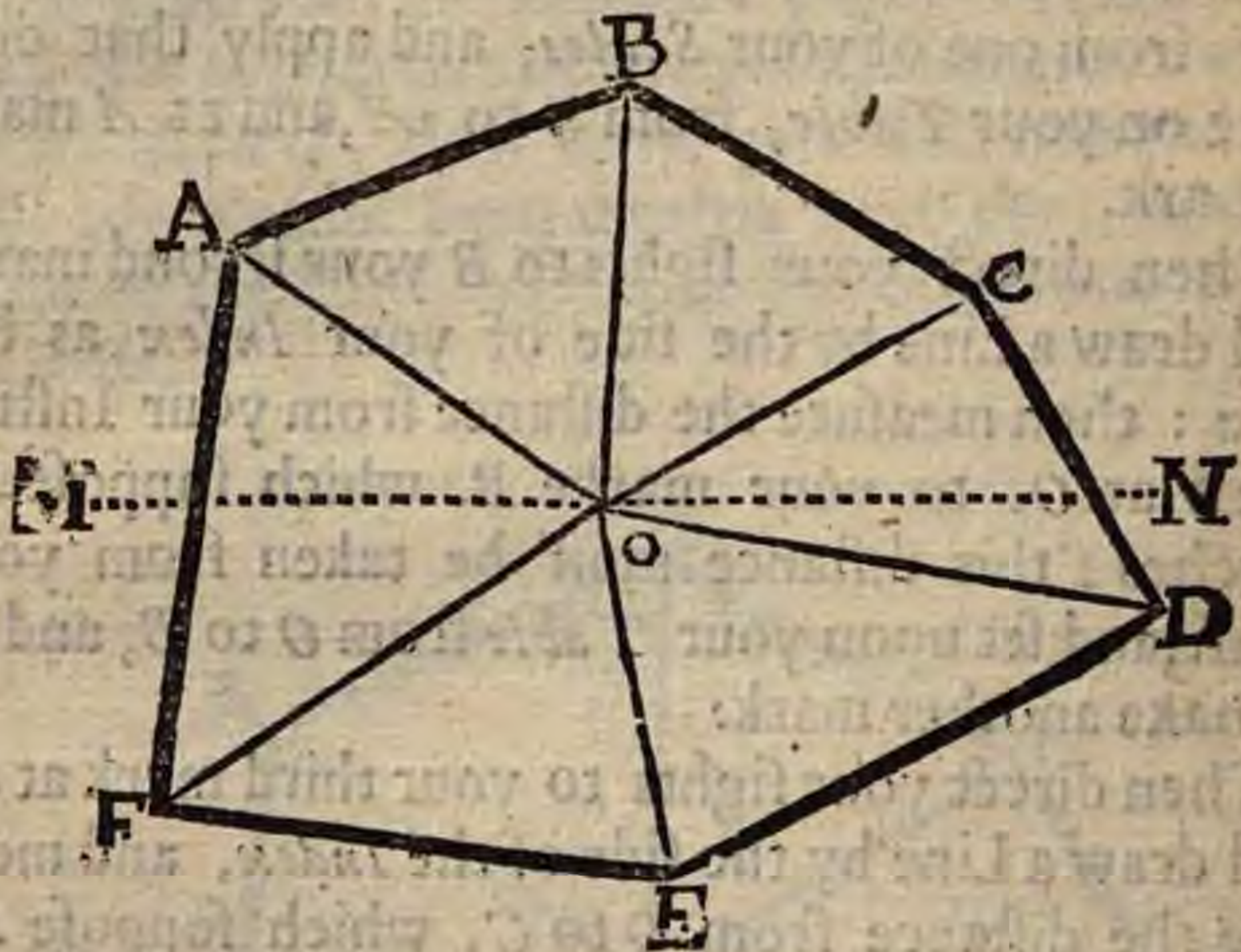
In this manner, you must proceede with the rest of the marks at $D E$ & F , and more, if the field had consisted of more *Angles*.

Lastly, when you have (according to the former directions) found all the marks, $A B C D E$ and F . upon your *Table*, you must draw Lines from one mark to another, till you conclude where you began: as suppose you began at A : and then to B and C . and so proceede round about the Field, till you come to A againe; Then draw a Line from A . your first mark, to B your second mark, and a Line from B your second mark, to C your

G 4

third

Third mark, and from *C* your third marke, to *D* your fourth marke, and likewise from *D* to *E*, from *E* to *F*. and from *F* to *A*. where you first began.



Then will the Lines *AB*, *BC*, *CD*, *DE*, *EF*. and *FA*. be the exact figure of the Field; the sides and *Angles* of the said figure, bearing an exact proportion to those in the Field, and the pricked Line *MN*. in this and the following figures representeth the *Meridian* Line.

C H A P.

C H A P. XXVIII.

How to take the plot of a Field by helpe of the Degrees on the frame of your Plaine Table, when by reason of Wind or Raine you cannot keepe a sheet of paper upon your Table, and by measuring as in the last Chapter.

HAVING placed marks at the severall *Angles* of the Field, as before is directed, and made choise of some convenient place about the middle thereof, from whence you may see all your former marks, place there your Instrument, the *Needle* hanging directly over the *Meridian* Line.

This done, direct your sights to your first mark at *A*. noting the degrees cut by the *Index* on the frame of the Table; which suppose 40 degrees 15 Minutes, these 40 degrees 15 Min. must be noted down in your Field-book, in the first and second Collumns thereof; Then measure the distance from *O*. the place of your Instrument to *A* your first marke, which let containe 40 *Perches*, these 40 *Perches* must be placed in the third Colunne of your Field-book, as hath been directed in the description thereof.

Then direct your sights to *B* your second mark, and note the degrees cut by the *Index*, which let be 88 degrees, and the distance *OB* 45 *Perches*, the 88 degrees must be noted in the first Colunne of your Field-book, and the 45 *Perches* in the third Colunne.

Then direct your sights to *C*. your third mark, and

and note the degrees cut by the *Index*, which let be 130 degrees 45 Min. and let the distance *O C.* be 42 *Perches*, the 130 Degrees 45 Minutes, must be noted in the first and second Columns of your Field-book, and the 42 *Perches* in the third Columne.

Then direct your sights to *D.* your fourth mark, and note the degrees cut by the *Index* on the frame of the *Table*, which let be 200 degrees 30 Minutes.

And here you must note, in the using of the degrees on the frame of your *Table*, that after you have passed 180 degrees, which is the Line *M N.* (representing also the *Meridian* Line) you must then count the degrees backward, according as they are numbred on the frame of the *Table*; from 190 to 360.

Then measure the distance *O D.* which let be 60 *Perches* 4 *Primes*, these 200 degrees 30 Minutes must be noted in the first and second Columnes of your Field-book, and the 60 *Perches* 4 *Primes*, in the third and forth Columnes thereof.)

Then direct your sights to *E.* your fifth mark, the *Index* cutting 250 degrees, and the distance *O E* being 39 *Perches*, these must be noted in your book as before, the 250 degrees in the first Columne, and the 39 *Perches* in the third.

See the Figure Page 88. and 94.

Lastly.

Lastly, direct your sights to *F.* your last mark, the *Index* cutting 310 degrees, and the distance *O F* being 50 *Perches*, these must be noted down in your Field-Book in all respects as the former, *viz.* the 310 degrees in the first Columne, and the 50 *Perches* in the third, and then will your notes collected in your Field-book stand as in the following *Table*.

	Deg.	Min.	Per.	Pri.
A	40	15	40	0
B	88	00	45	0
C	130	45	42	0
D	200	30	60	4
E	250	00	39	0
F	310	00	50	0

CHAP. XXIX.

How to protract or lay down upon paper, any Observations taken according to the directions of the last Chapter.

UPon a sheete of white paper, draw a Line at length, which shall represent the line *M N.* in the foregoing figure, then make choice of some point or other in that Line, to represent your station or place of standing in the Field, upon which point place the *Center* of your *Protractor*, so that the Line *N S,* of your *Protractor* may lie directly upon

upon the Line MN ; then laying your Field-book before you, and seeing that at your first observation noted with A . the *Index* cut 40 degrees 15 Min. of your *Protractor*, make a marke upon your Paper, which mark let be represented with the Letter A .

2. Seeing the degrees cut at your second observation were 88. you must make a marke upon your paper against 88 degrees, which marke let be B .

3. The degrees cut at your third Observation were 130. and 45 Minutes, therefore against 130 degrees 45 Min. make a mark upon your paper, which mark let be C .

4. The degrees cut by the *Index* at your fourth Observation, being 200 and 30 Min. (because it is above 180 degrees, you must therefore turne the *Semicircle* of your *Protractor* downwards, the Line NS . lying upon the Line MN . as before) you must against 120 degrees 30 Min. of your *Protractor* make a mark upon your paper, which mark is signified by D .

5. Seeing the degrees cut at the fifth observation were 250. Therefore make a marke against 250 degrees, which mark is E .

Lastly, the degrees cut at your last observation were 310. Therefore against 310. make a mark which will be F .

Having thus *Protracted* all the degrees of your severall Observations, you must take away your *Protractor*, and laying a *Ruler* to the Center O , draw Lines by those points, which Lines will be OA . OB . OC . OD . OE . and OF .

This

This done, you must observe by your Field-book the length of every Line.

1. As the Line OA your first Observation was 40 *Perches*, Therefore 40 being taken from your *Scale*, and set upon your paper from O to A . shall give you the point A . upon your paper.

2. The length of your second Line being 45 *Perches*, you must take 45 from your *Scale*, and place it on your paper from O to B .

3. The Line OC . being 42 *Perches*, you must take 42 from your *Scale*, and set it upon your paper from O to C .

And in this manner must you proceede with all the rest of the Lines, as OD . OE . and OF .

Lastly, draw the Lines AB . BC . CD . DE . EF . and FA . so shall you have the exact figure of your Field upon your Paper.

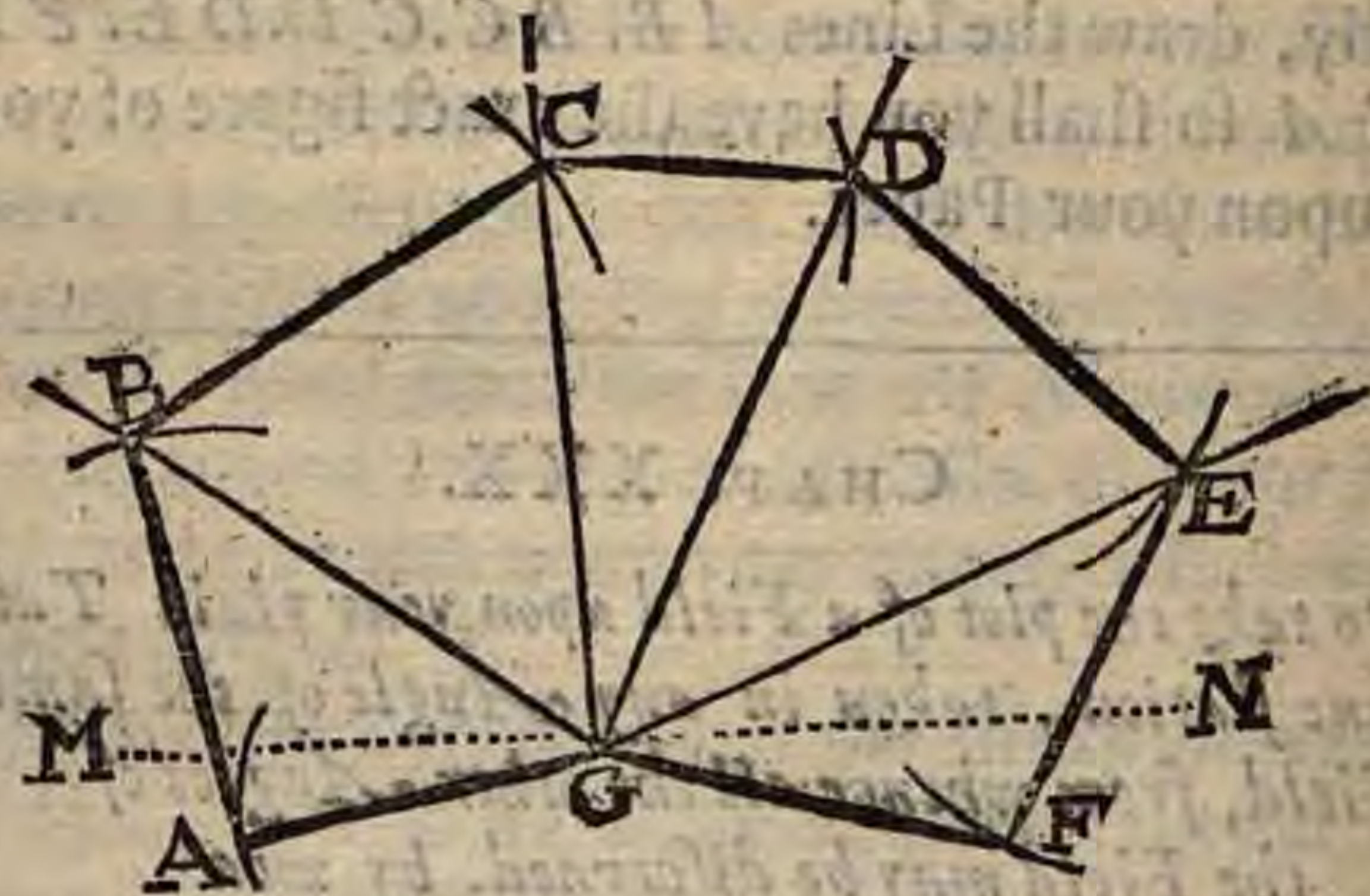
CHAP. XXX.

How to take the plot of a Field upon your plain Table at one station, taken in any Angle of the same Field, from whence all the other Angles of the Field may be discerned, by measuring from the stationary angle to all the other Angles.

REpaire to some *Angle* in the Field, (from whence all the other *Angles* of the said Field may be seen,) and there place your Instrument *Horizontall*, the *Needle* directly over the *Miridian* Line, and a sheet of paper stretched on your *Table*;

then

then make choice of a point on your Paper, which shall represent your station or place of standing, which let be *G*: then direct your sights to *A*. and draw a Line upon your paper as *G A*. and measure the distance *G A*. as was directed before; then direct your sights to *B*. your second mark, and there likewise draw a Line *G B*. measuring the distance *G B*. In like manner direct your sights to *C*. *D*. *E*. and *F*. drawing Lines by the side of your *Index* at every observation, and measuring (with your *Chain*) the distance from *G*. (the place of your standing) to the severall *Angles* of the Field *A B C D E* and *F*. which distances being taken in your *Compasses*



From your *Scale*, and set upon your Paper from *G*. upon the Lines *G A*. *G B*. *G C*. *G D*. *G E*. and *G F*. so shall you have upon your paper the marks *A B C D E* and *F*. by which markes draw Lines as *G A*. *A B*. *B C*. *C D*. *D E*. and *F G*. so shall you have described upon your paper the true figure of your Field.

CHAP. XXX I:

How to draw the plot of a Field at one station, taken in any *Angle* of the same Field, and by measuring round about the said Field without crossing the same.

Let the figure *A B C D E F G*. be the figure of a field to be measured.

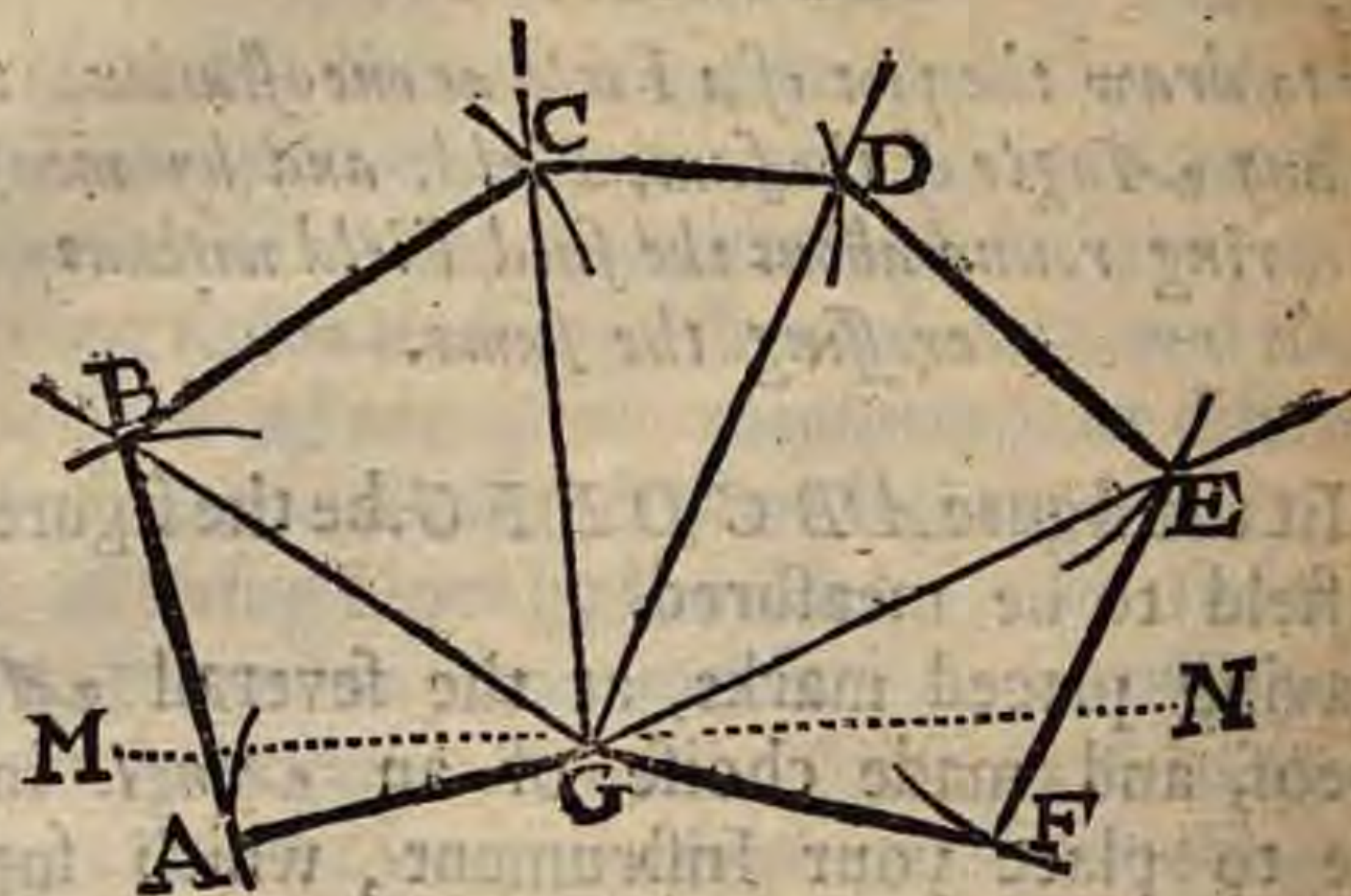
Having placed marks, at the severall *Angles* thereof, and made choice of an *Angle* in the same to place your Instrument, which suppose at *G*.

Then directing your sights to *A*. draw upon your Table the Line *G A*. then direct your sights to *B*. and draw the Line *G B* then directing your sights to *C*. draw the Line *G C*. and consequently the lines, *G D*. *G E* and *G F*.

1. Having thus done, measure with your *Chain* the distance from *G* to *A*. which let be 40 *Perches*, these 40 *Perches*, must be taken from your *Scale*, and one foot of the *Compasses* placed in *G*. with the other draw the Arch *A*. and draw the Line *G A*.

2. Measure with your *Chain* the side *A B*. which suppose 53 *Perches*, this being taken in your *Compasses* from the *Scale*, place one foot in *A*. and with the other foot draw the Arch *B*.

3. Measure the side *B C* 59 *Perches*, and that being taken in your *Compasses* from your *Scale*, place one foot in *B*. and with the other draw the Arch *C*.



4. Measure the side *C D*. 28 *Perches*, and take that distance in the *Compasses*, placing one foot in *C*. and with the other draw the Arch *D*.

5. Measure the side *D E*. 54 *Perches*, and take that distance from the *Scale*, placing one foot of the *Compasses* in *D*. and with the other describe the Arch *E*.

6. Measure the side *E F*. 49 *Perches*, and taking that distance from the *Scale*, place one foot of your *Compasses* in *E*. and with the other draw the Arch *F*.

So shall these severall Arches cut the severall Lines *G A. G B. G C. G D. G E. & G F*. in the points *A. B. C. D. E.* and *F*.

Lastly, by these points draw Lines from one to another, as, *A B. B C. C D. D E. E F. F G.* and *G A*. so shall you have upon your paper on your *Table*, the exact figure of the Field, the sides, and *Angles* thereof, being in all respects proportionall to those taken according to the Doctrine of the last.

How to take the plot of a Field at one Station, taken in any Angle thereof, from whence all the other Angles may be seen by helpe of the degrees described on the frame of the *Plaine Table*, and by measuring from your Station to every of the other Angles.

Planting your Instrument at *G* as before, direct your sights to *B*. as your first marke [for the Line *G A*. lying under the *Meridian Line M N*. must be measured in the last place.] Noting the degrees cut by the *Index* on the frame of the *Table*, which suppose 47 degrees, which must be noted in the first Column of your *Field-book*, (as hath been before sufficiently taught,) then with your *Chain* measure the distance from your Station at *G*. to the Angle *B*. which let be 50 *Perches*, which place in the third Column of your *Field-book*, according to former directions.

2. Direct your sights to *C*. noting the degrees there cut, which suppose 88 degrees 15 Min. these Degrees and Minutes place in the first and second Columns of your *Field-book*, then measure the distance *G C*. 60 *Perches*, and note them in the third Column of your *Field-book*.

3. Direct your sights to *D*. the degrees cut being 120. and the distance *G D* 65 *Perches*, note these in your *Field-book* as before.

And in this manner must you deale with the other marks: *E F.* and *A*. and then having noted

them all, your collected notes in your Field-book must be as followeth :

	Deg.	Min.	Per.	Pri.
B	47	00	50	0
C	88	15	60	0
D	120	00	65	0
E	165	30	56	7
F	193	00	40	2
A	348	45	34	0

CHAP. XXXIII.

How to Protract, or lay down any Observations taken according to the Doctrine of the last Chapter.

HAVING collected into your Field-booke, the quantity of your severall Angles, and the length of your Lines, you may proceed to Protraction in this manner.

1. Draw the Meridian Line MN. then make choise of a point therein, representing your stationary Angle, as at G. to which point apply the Center of your Protractor, the Semicircle upwards, then laying your Field-book before you, you may perceive that at your first observation, (which was at B.) your Index cut 47 degrees, therefore make a marke against 47 degrees, and draw the Line GB.

2. The

2. The degrees cut at your second observation at C. being 88 degrees 15 Min. make a mark likewise against 88 degrees 15 Min. of your Protractor, and draw the Line GC.

3. The degrees cut at your third Observation being 120 degrees, make likewise a mark against 120 degrees of your Protractor, and draw the line GD.

And in this manner must you proceed with the rest of your Observations, namely, with the Lines GE. GF. GA.

Having thus finished your Angular Observations, proceed now to your lineall, namely, to the length of your Lines noted in the third, and fourth columns of your Field-book.

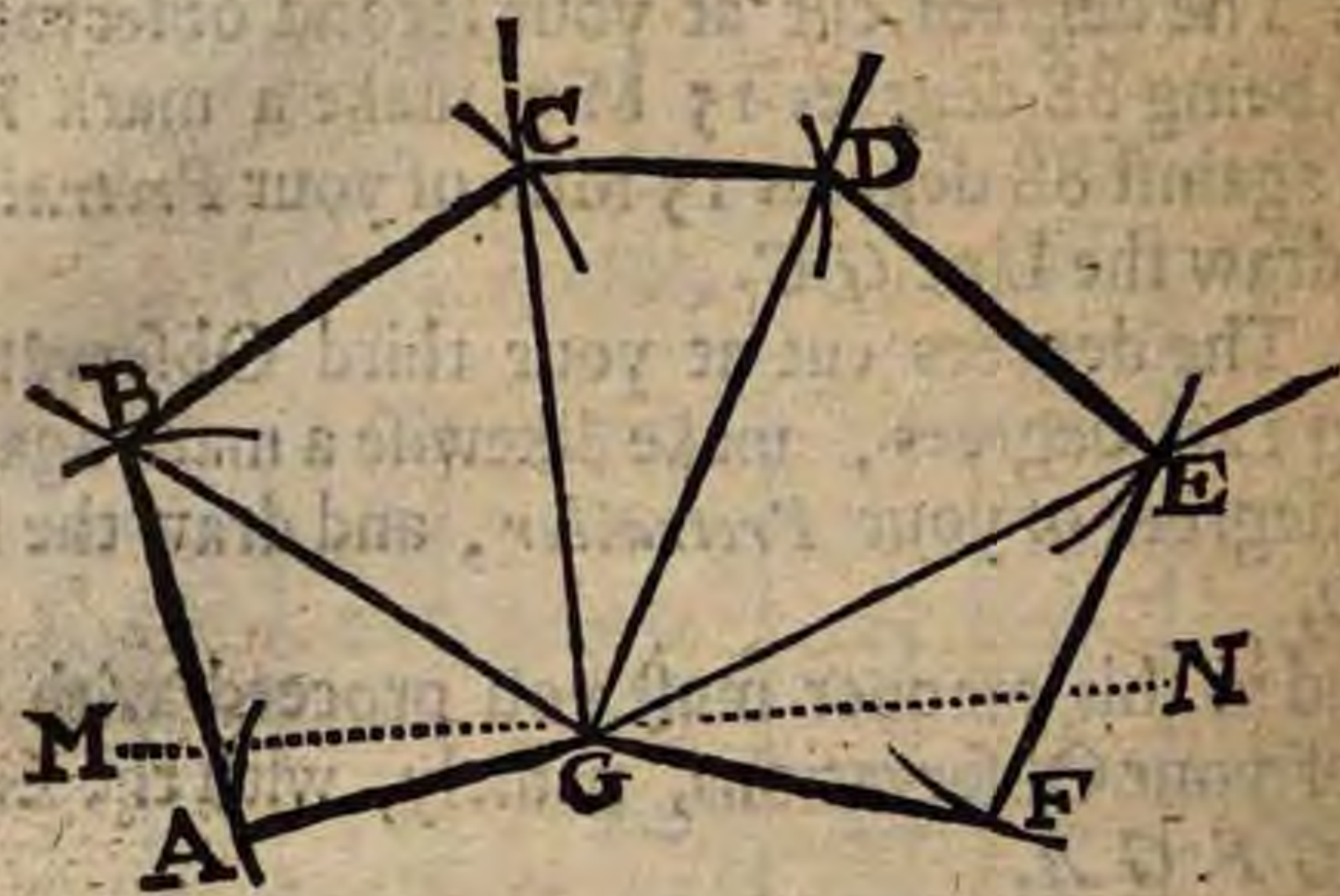
1. And seeing, that the length of your first Line GB. was 50 Perches, you must take 50 from your Scale, and apply that distance to your paper from G to E.

2. The distance of the second Line GC. being 60 Perches, take 60 Perches from your Scale, and apply that distance to your Paper from G to C.

3. The distance of your third marke GD. being 65 Perches, take that distance from your Scale, and apply it to your paper from the point G. unto D.

H 2

AN



In all respects as before, you must proceed with the measuring of all the other Lines about the Field, were there never so many.

Lastly, if you draw the Lines, AB . BC . CD . DE . EF . FG . and GA . you shall have upon your paper the exact figure of the Field.

And herein you may receive abundant satisfaction to see your severall Instrumentall operations, and your *Geometricall* protraction so exactly to agree: and if at any time you make severall observations of any one piece of ground, according to the directions of the three last Chapters, or otherwise, if you finde them not exactly to agree, you may be sure you have failed in one or other of your Observations, and therefore, before you proceed farther, it is best to reforme your first error.

CHAP.

CHAP. XXXIV.

How to take the plot of a Field at two stations, upon a sheet of paper stretched on your Table, and by measuring from the stations to the visible Angles, the field being so irregular, that from no one place thereof all the Angles can be seen.

YOU may suppose $ABCDEFGHI$. to be the figure of a Field to be drawne upon your Plain Table: Now because you cannot from any one place thereof behold all the Angles at once, you must therefore make choise of two severall Stations, which two Stations let be O & Q .

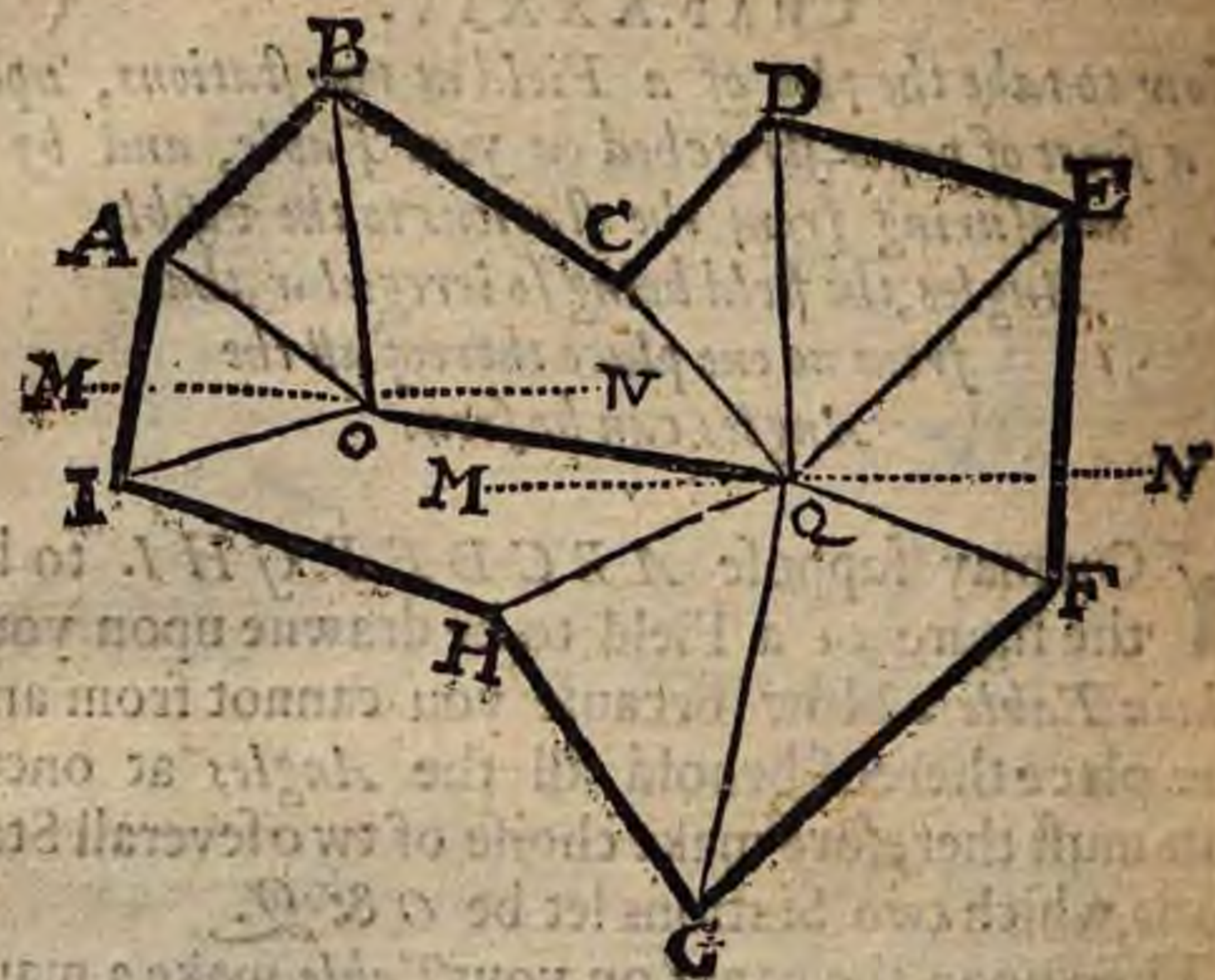
Then upon the paper on your Table, make a mark as Q . representing your first Station.

This done, place your Instrument at Q . the Needle hanging directly over the Meridian Line of your Card, as is represented by the Line MN .

The Instrument being there fastned, direct your sights to C . and draw upon your Table the Line QC . measuring the distance from Q . to C . and setting that distance on the Table from Q . to C . (2) direct your sights to D . and draw the Line QD . measuring the distance QD as before. (3) direct your sights to E . and draw the Line QE . (4) direct your sights to F . and draw the Line QF . (5) direct your sights to G . and draw the Line QG . (6) direct your sights to H . and draw the Line QH . (7) direct your sights to O . your second Station, and draw the Line QO . measuring the distance from Q . to O .

H 3

And



And by your *Scale* and *Compasses*, set off your *Stationary* distance upon your *Table* from Q to O .

Having thus made *Observation* of all the *Angles* visible, from the *Station*, Q . and draw *Lines* from Q upon your *Table*, and likewise measuring the distance from Q to every of them, you may then (according to former directions,) draw the *Line* CD . DE . EF . FG . and GH . so have you that part of the *Field* finished from your first *Station* at Q .

Then remove your *Instrument* to O . your second *Station*, and place it in all respects as before, the *Needle* hanging over the *Meridian* *Line* of your *Card*, represented in your second *Station* by the *Line* MON .

Having thus placed your *Instrument* at O . make obser-

observation of your *Angles* I . A and B . in all respects as you did before with the *Angles* $CDEFG$. and H . and having drawn the *Lines* OI . OA . OB . and measured their distances from O . you may draw the *Lines* HI . IA . AB . and BC . so shall you have upon your *Table* the exact figure of your *Field*, no way deviating in proportion from the *Field* it selfe.

CHAP. XXXV.

How to performe the worke of the last Chapter, by the degrees on the frame of the Table.

THIS differeth nothing from the worke of the 28. Chapter, having therefore placed your *Instrument* at Q according to the directions of the last Chapter, direct your sights to G . noting the *Degrees* and *Minutes* cut by your *Index* on the frame of your *Table*, which *Degrees* and *Minutes* must be placed in your first, and second *Columnes* of your *Field-book*; then measure with your *Chain* the distance from your *Station* Q . to the *Angle* C . and note that distance down in the third, and fourth *Columnes* of your *Field-book*, as hath been before declared at large.

In this manner you must doe with all the *Angles* visible at your first *Station*, namely, with the *Angles* C . D . E . F . G . and H measuring the distances of every *Line* as before.

Then remove your *Instrument* to O your second *Station*, and there make observation of the sever-

all Lines and *Angles I. A. and B.* in all respects as you did before with the Lines and *Angles, C. D. E. F. G. and H.* which being collected into your Field-book, according to directions of the forecited Chapter, they will stand as followeth :

	Deg.	Min.	Per.	Pri.	
1. Station Q.	C	47	15	25	2
	D	88	00	37	0
	E	135	30	35	1
	F	200	00	28	0
	G	270	15	48	4
	H	341	00	33	0

The Stationary distance *O Q.* 50 *Perches*, and the *Angle O. Q. M.* or *NO Q.* 10 Degrees, being the declination of your Stationary Line from the *Meridian Line.*

	Deg.	Min.	Per.	Pri.	
2. Station O.	I	341	30	23	0.
	A	30	00	21	1.
	C	84	45	35	4.

CHAP.

CHAP. XXXVI.

How to Protract or lay down any Observations taken according to the directions of the last Chapter.

As the operation of the last Chapter differeth nothing from that of the 27. so the *Protraction* thereof differeth nothing from that of the 29 Chapter.

Therefore upon paper or otherwise, draw the Line *M Q N.* and placing the *Center* of your *Protractor* upon *Q.* your first Station, and make marks against every of the degrees of the *Angles*, as they are noted in your Field-book : as namely,

- For the first *Angle* at *C.* 47. Degrees 15. Min.
- For the second at *D.* 88 Degrees.
- For the third at *E.* 135 Degrees, 30 Min.
- And so for the rest.

Then because the Stationary Line *O Q.* declineth 10 Degrees from the *Meridian Line M Q N*; Therefore before you move your *Protractor* from *Q.* make a mark against 10 degrees thereof, and draw the Line *O Q.* which is your Stationary Line, and likewise upon that Line from *Q.* to *O.* set off 50 *Perches* for your Stationary distance.

Then draw the Line *M O N.* parallel to the Line *M Q N.* and upon the point *O.* place the *Center* of your *Protractor*, making marks at the *Angles A. and B* : then turning the *Semicircle* of the *Protractor* downwards, make a marke at the *Angle I.*

Lastly,

Lastly, if you draw Lines from one *Angle* to another, as the Lines *A B. B C. C D. D E. E F. F G. G H. H I.* and *I A.* you shall have upon your paper the exact proportion of the field, answerable to those drawn by the directions of the two precedent Chapters.

According to the directions of the 30. 31. 32. and 33 Chapters, together with the assistance of this Chapter, you may take the plot of any plaine field whatsoever by severall Stations taken in severall *Angles* of the same field, if that from one *Angle* you cannot perceive all the other. So that now I think the *Surveyor*, being well exercised in the performance of these twelve last Chapters, he may attempt the drawing of the plot of any field whatsoever, and herein practice is better than many words.

Yet notwithstanding, suppose a field were unpassible in respect of waters or the like, I will adde the next Chapter, shewing how to take the plot of any field at two Stations taken within the same field, so that all the *Angles* thereof may be seene from both the Stations, and by measuring onely the Stationary distance.

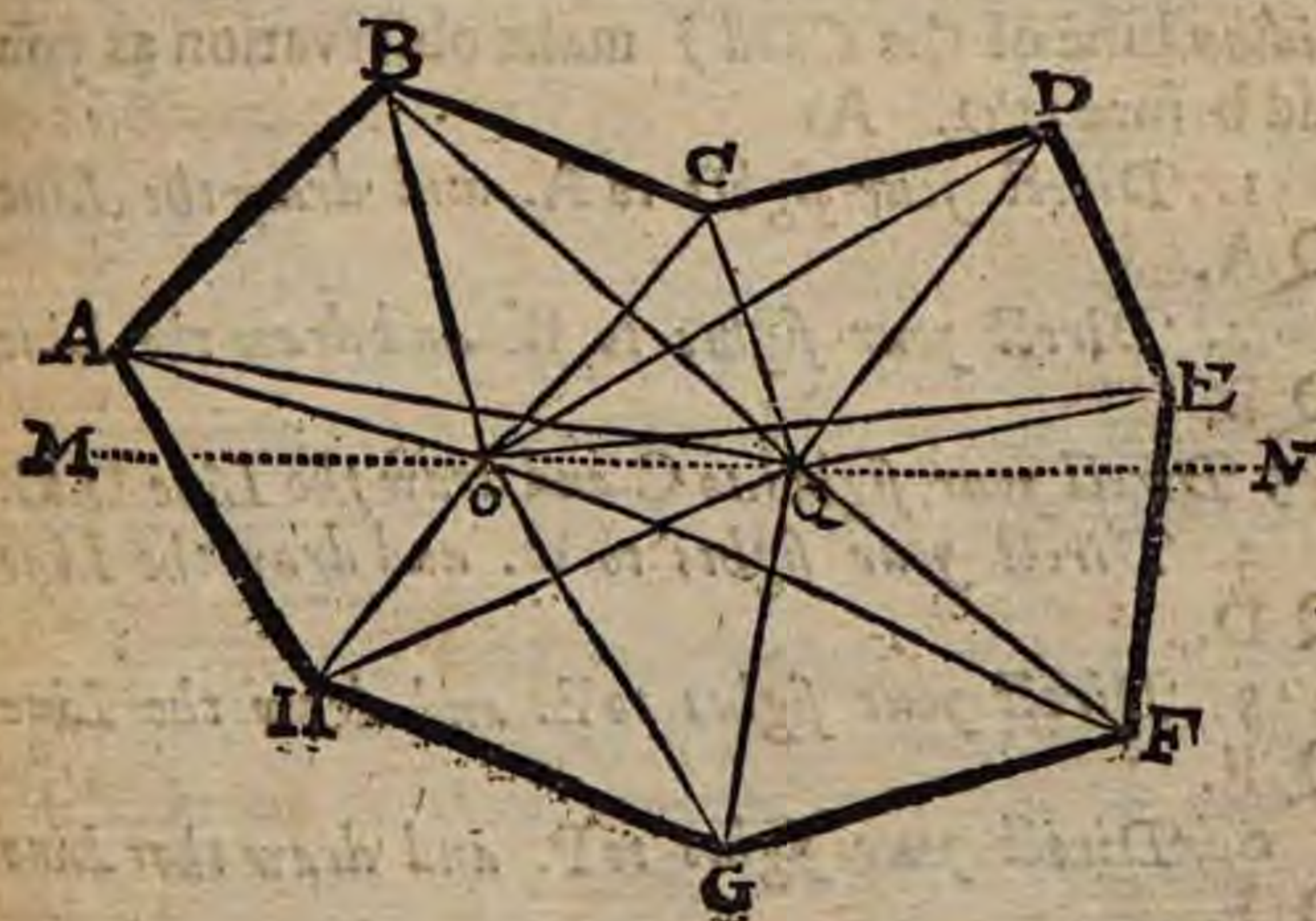
C H A P.

C H A P. X XXVII.

How to take the plot of a field upon your Plain Table, at two Stations taken within the same field, without tedious travailing about the same, by measuring onely the Stationary distance.

Necessity may sometimes require the plotting of a field according to the directions which I shall deliver in this Chapter; yet I would advise the *Surveyor* to make as little use thereof as he can, in regard of the acutenesse of the *Angles*, which is more liable to error than any of the former ways, though grounded upon a firme *Geometricall* principle.

Let *A. B. C. D. E. F.* and *G.* be the figure of a field, and let the two stations within the same be *O,* and *Q.*



Hayin

Having placed your Instrument at *O*. for your first Station, the Needle hanging directly over the Meridian Line of the Card;

You must

1. Direct your sights to your first Angle at *A*. and draw the Line *O A*.

2. Direct your sights to *B*. and draw the Line *O B*.

3. Direct your sights to *C* and draw the Line *O C*.

4. Direct your sights to *D*. and draw the Line *OD*.

5. Direct your sights to *E*. and draw the Line *O E*.

6. Direct your sights to *F*. and draw the Line *O F*.

7. Direct your sights to *G*. and draw the Line *O G*.

8. Direct your sights to *H*. and draw the Line, *O H*.

This done, direct your Sights to your second Station at *Q*. and draw the Line *O Q* upon your Table: then (with your Chain) measure out your Stationary distance *O Q*. 40 Perches, and removing your Instrument to *Q*. (the Needle over the Meridian Line of the Card) make observation as you did before at *O*. As

1. Direct your sights to *A*. and draw the Line *Q A*.

2. Direct your sights to *B*. and draw the Line *Q B*.

3. Direct your sights to *C* and draw the Line *Q C*.

4. Direct your sights to *D*. and draw the Line *Q D*.

5. Direct your sights to *E*. and draw the Line *Q E*.

6. Direct your sights to *F*. and draw the Line *Q F*.

7. Direct

7. Direct your sights to *G*. and draw the Line *Q G*.

8. Direct your sights to *H*. and draw the Line *Q H*.

Now you may plainly perceive by the figure, where the correspondent lines at each station intersect: As

1. The Lines *O A*. and *Q A*. intersect or cross each other at *A*.

2. The Lines *O B*. and *Q B*. intersect each other at *B*.

3. The Lines *O C*. and *Q C*. intersect each other at *C*.

4. The Lines *O D*. and *Q D*. intersect each other at *D*.

5. The Lines *O E*. and *Q E*. intersect each other at *E*.

6. The Lines *O F*. and *Q F*. intersect each other at *F*.

7. The Lines *O G*. and *Q G*. intersect each other at *G*.

8. The Lines *O H*. and *Q H*. intersect each other at *H*.

Therefore if from these points of intersection you draw Lines from one to another, you shall have upon your paper the exact Symmetry or proportion of your field, as namely, the Lines *A B*. *B C*. *C D*. &c.

And in this kinde of plotting, you cannot but perceive a wonderfull quick dispatch, you being neither to observe degrees cut, nor to measure any distances, save onely betweene your Stations, but by reason of the acutenesse of the Angles, (with

(without exact and curious drawing of your Lines, and observing the precise points of interfections,) you may runne into grosse absurdities, and mistakes.

I might now proceede to shew you the manner of taking of the plot of any field, without approaching nigh the same; but in regard the performance thereof differeth nothing at all from that which is already taught, I shall therefore in this place passe it over as superfluous.

CHAP. XXXVIII.

How to take the plot of a Wood, or other over-grownie ground upon your Plaine Table, by going round about the same, and making observation at every angle, when by reason of the thicknesse of the Wood, or otherwise, you can neither see the Angles from any Station taken in the midst thereof, nor from any one Angle to all the rest.

WE have hitherto treated of Plaine, and open grounds; let us now say something concerning Wood-lands and such like.

Suppose therefore *A.B.C.D.E.F.* and *G.* were a piece of Wood-land-ground to be measured, and by reason of the thicknesse of the Wood or other opposition, you cannot come to measure the inside thereof, you must therefore work without.

1. Place



1. Place your Instrument at the *Angle A.* and directing your sights to the next *Angle* at *B.* and by the side thereof draw a Line upon your *Table*; As the Line *B A*: then measure by the hedge side, from the *Angle A.* to the *Angle B.* which suppose *66 Perches*, then from your *Scale* take *66 Perches*, and set that distance upon your *Table* from *A.* to *B.*

2. Remove your Instrument from *A.* and set up a mark in the place thereof, and place your Instrument at your second *Angle* at *B.* then lay the *Index* upon the Line *A B.* and turne the whole Instrument about, till through the sights you espy the mark which you set up at *A.* and then with your screw fasten the Instrument there: then laying the *Index* upon the point *B,* direct your sights to the third *Angle* at *C.* and draw the Line *B C,* upon your *Table*; then measuring the distance *B C,* *63 Perches,* take that distance from your *Scale,* and set it on your *Table* from *B* to *C.*

3. Re-

3. Remove your Instrument from *B*, and set a mark in the room thereof, and place your Instrument at *C*, laying the *Index* upon the Line *CB*, and turne the whole Instrument about till through the sights you espy your mark at *B*, and then fasten your Instrument; Then laying the *Index* on the point *C*, direct your sights to *D*, and draw upon your *Table* the Line *CD*, then measure from *C*, to *D*, 54 *Perches*, and set that distance upon your *Table* from *C*, to *D*.

4. Remove your Instrument to *D*, (placing a mark at *C*, where it last stood,) and lay the *Index* upon the Line *DC*, turning the whole Instrument about, till through the sights you espy the mark at *C*, and there fasten the Instrument; then lay the *Index* upon the point *D*, and direct your sights to *E*, and draw the Line *DE*: then with your *Chain* measure the distance *DE*, 79 *Perches*, and set that distance upon your *Table* from the point *D*, to *E*.

5. Remove your Instrument to *E*, (placing a mark at *D*, where it last stood,) and lay the *Index* upon the Line *DE*, turning the whole Instrument about, till through the sights you espy the mark at *D*, and there fasten the Instrument; Then lay the *Index* upon the point *E*, and direct your sights to *F*, and draw the Line *EF*, then measure the distance *EF*, 100 *Perches*, and set that distance upon your *Table* from *E* to *F*.

6. Remove your Instrument to *F*, (placing a mark at *E*, where it last stood,) and lay the *Index* upon the Line *EF*, turning the whole Instrument about, till through the sights you see your mark

at *E*. there fasten the Instrument, and laying the *Index* on the point *F*. direct your sights to *G*. and draw the Line *FG*. then measure the distance *FG* 69 *Perches*, and set off that distance upon your *Table* from the point *F* to *G*.

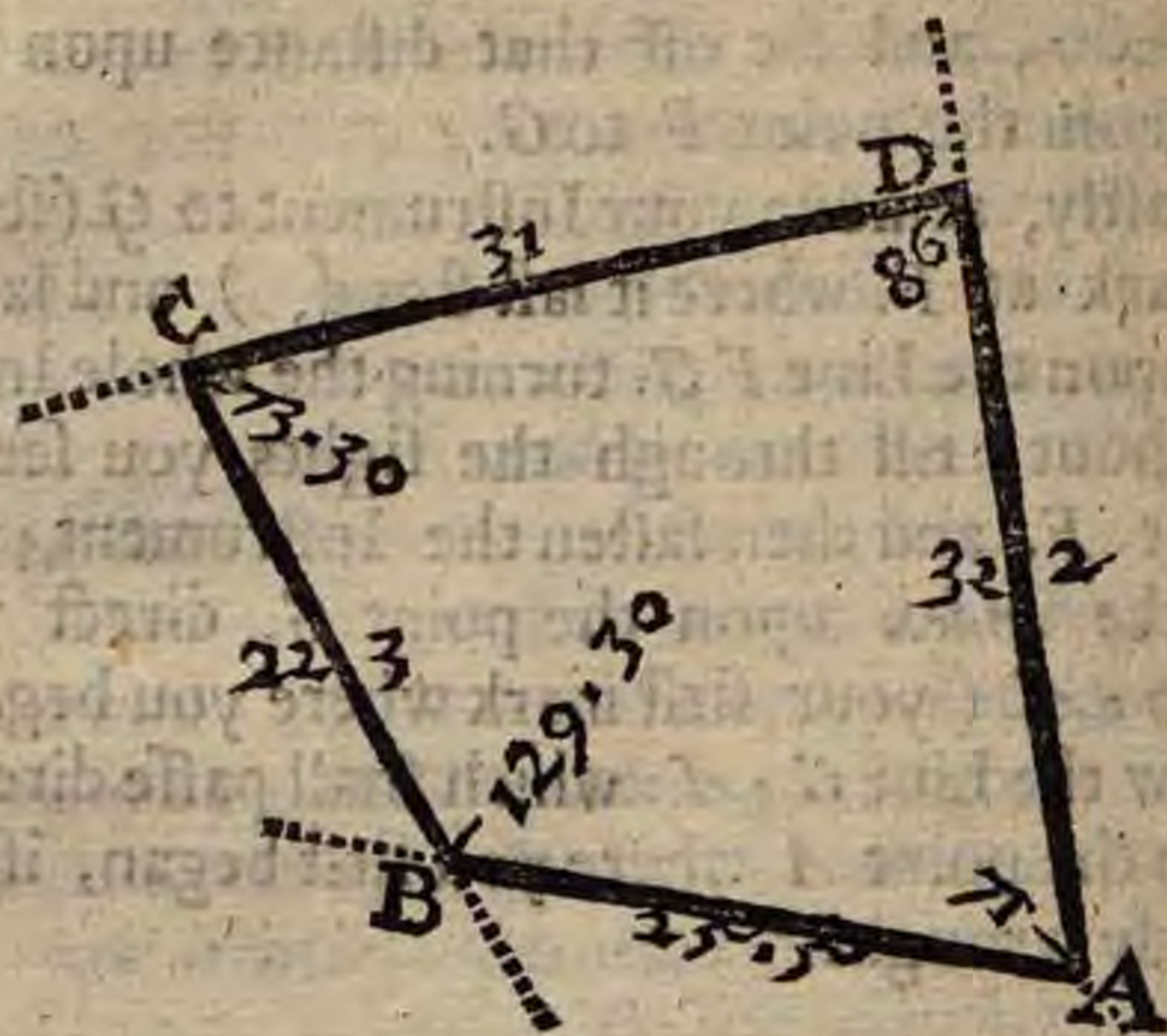
7. Lastly, remove your Instrument to *G*. (setting up a mark at *F*. where it last stood,) and lay the *Index* upon the Line *FG*. turning the whole Instrument about, till through the sights you see the mark at *F*. and then fasten the Instrument; then laying the *Index* upon the point *G*. direct your sights to *A* (your first mark where you began,) and draw the Line *GA*. which shall passe directly through the point *A*. where you first began, if you have truly wrought.

CHAP. XXXIX.

*How to draw the Plot of a great Champaign Plain
by help of the degrees on the frame of
the Table.*

Let *A.B.C.D.* be a large Champaign Plain, whose Plot is required, first place your Instrument at *A* laying the *Index* on the *Diameter* of the *Table*, and turning the whole Instrument about, till through the sights you see the *Angle* at *B*. then fix the Instrument there, and turn the *Index* about till through the sights you espy the *Angle* on the other side of your station at *D*. noting the degrees cut by the *Index*, which suppose 71, which is the quantity of the *Angle B A D*. then measure with-

your *Chain* the distance AD . which is 31 *Perches*, two *Primes*:



THe 71 degrees must be noted in the first Column of your Field-book, and the 31 *Perches*, two *Primes* in the third, and fourth Columns, as hath been before sufficiently shewen.

2. Remove your Instrument to the next *Angle* at D . and laying the *Index* on the *Diameter* thereof, direct your sights to your last station at A . and there fix the Instrument; Then turne the *Index* about till you see the next *Angle* at C . noting the degrees there cut, which suppose 86. which 86 degrees are the quantity of the *Angle ADC*, then measure the distance DC . 31 *Perches*, and note the 86 degrees in the first, and the 31 *Perches* in the third Columns of your Field-book.

3. Remove your Instrument to C . and laying the *Index* on the *Diameter* thereof, direct your sights

to D . and then fasten the Instrument, then turne the *Index* about till through the sights you espy the next *Angle* at B . noting the degrees cut, which suppose 73 Degrees, 30 Minutes, and measure the distance CB 22 *Perches*, 3 *Primes*, the 73 degrees, 30 Minutes must be placed in the first, and second Columns of your Field-book, and the 22 *Perches*, 3 *Primes*, in the third, and fourth Columns.

4. Lastly, remove your Instrument to B . and laying the *Index* on the *Diameter* thereof, direct your sights to C . and then fix the Instrument; then move the *Index* about, till through the sights you see the *Angle* at A . where you began, noting the degrees cut, which are 129 Degrees 30 Minutes, which is the quantity of the *Angle CBA*. then measure with your *Chain* the distance from B . to A 25 *Perches*, 5 *Primes*, which must be noted in your Field-book as before, then will they stand thus.

Deg. Min. Per. Pri.

A — 71 — 00 — 32 — 2.

D — 86 — 00 — 31 — 0.

C — 73 — 30 — 22 — 3.

B — 129 — 30 — 25 — 5.

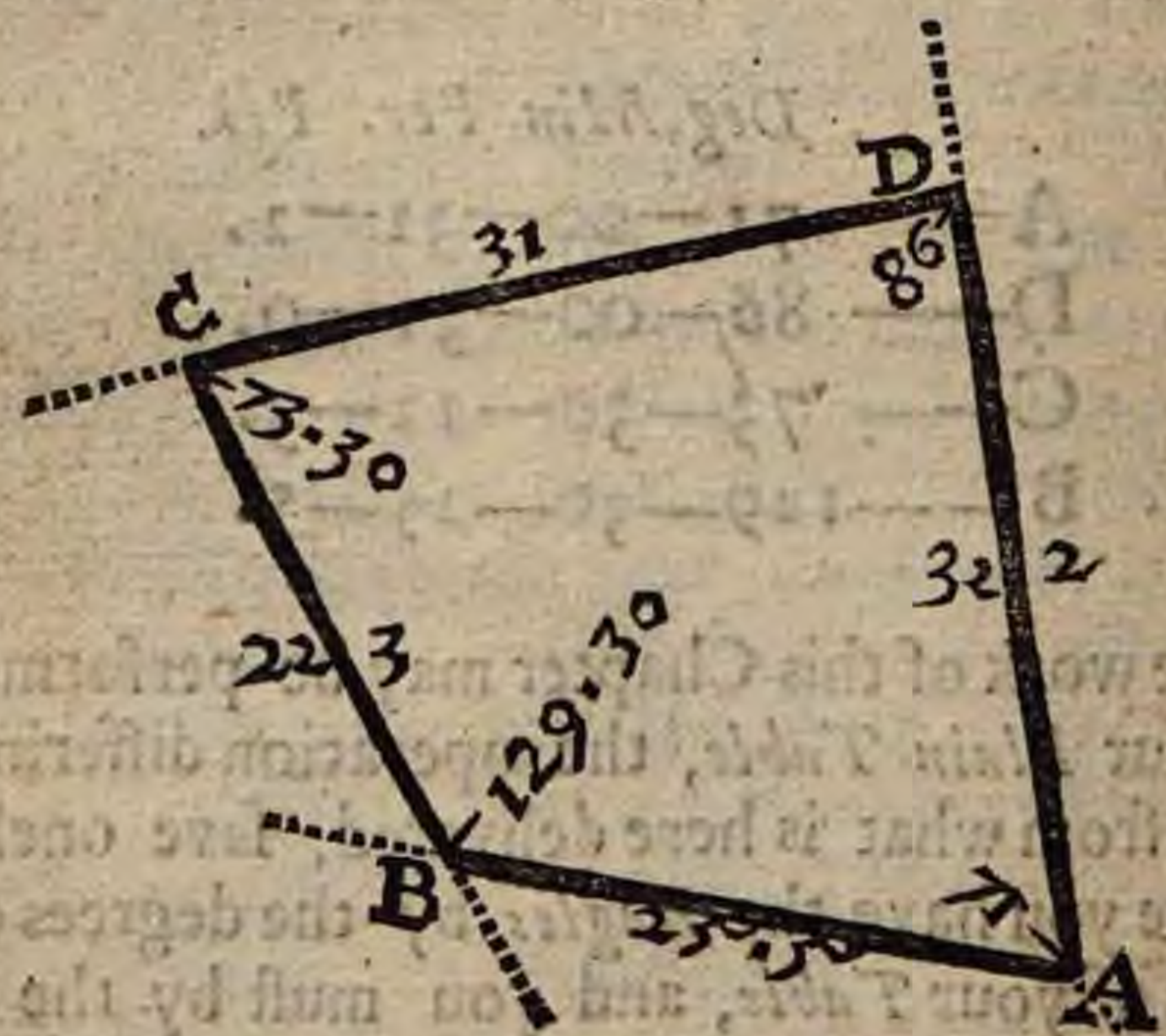
The work of this Chapter may be performed upon your *Plain Table*, the operation differing nothing from what is here delivered, save onely that as here you have the *Angles* by the degrees on the frame of your *Table*, and you must by the other attaine them by drawing of Lines upon the *Table*.

CHAP. XL.

How to protract or lay down any Observations taken according to the directions of the last Chapter.

Consider which way your plot will extend, and accordingly draw the line *B A*. then upon the point *A*. protract an *Angle* equall to the *Angle B A D* 71 Degrees, and draw the line *A D*. then from your *Scale* take 32 *Perches*, two *Primes*, and set it upon your paper from *A* to *D*.

Then on the point *D*. protract an *Angle* equall to the *Angle C D A*. 86 Degrees, and draw the Line *D C*. then from your *Scale* take 31 *Perches*, and set it upon your Paper from *D* to *C*.



Then

Then on the point *C*. protract an *Angle* of 73 Degrees, 30 Minutes, equall to the *Angle D C B*, and draw the line *C B*. then shall the line *C B*. intersect the line *B A*. in *B*; and so the *Angle C B A*, which contains 129 Degrees 30 Minutes, as before, and the Lines *C B*, and *B A*. being measured upon your *Scale*, will give you the exact lengths as you found them by measuring in the field.

CHAP. XLI.

How to know whether you have truly wrought, and whether your plot will close or not, when you make Observation at every *Angle* of a field.

You must collect the quantity of all the *Angles* found, at your severall Observations into one summe: then you must multiply 180 Degrees, by a number lesse by $\frac{2}{100}$ than the number of a *Angles* in the field, and if the Product of this Multiplication be equall to the totall summe of all your *Angles*, then have you wrought right, otherwise not.

Example.

Let us take the Worke of the last Chapter save one, where the *Angles* found were as followeth; the summe of them being 360 Degrees; Now because the field consisted but of foure sides, you must multiply 180 Degrees by two, (which is a number lesse by two than the number of *Angles*

in the Field) and the product will be 360. which exactly agreeth with the sum of all the *Angles* in the Field, as you found them by Observation.

Deg.	Min.
71	00
86	00
73	30
129	30
<hr/>	
360	00.

CHAP. XLII.

How to examine whether you have truly wrought, when you onely measure about your plot.

AD the *Logarithmes* of the length of each Line, unto the Sine, and also unto the Cosine of the *Angle*, that each Line maketh with the *Meridian*; and the summs shall be the *Logarithmes* of the difference of Longitude, and Latitude of each Line.

Example.

In the following plot *ABCDEF*. The Line *AB*. is directly East 210 *Perches*. The Line *BC*. is Eastward from the South 35 degrees, and 153 *Perches* in length.

The <i>Logarithme</i> of 153	2,1847
The <i>Sine</i> of 35 degrees	9,7586
The <i>Logarithme</i> of 088	1,9433
The difference of Longitude of that Line <i>BC</i> .	

The

The <i>Logarithme</i> of 153	2,1847
The <i>Sine</i> of 55 degrees	9,9134
The <i>Logarithme</i> of 125	3,0981
The difference of Latitude of the Line <i>BC</i> .	

The Line *CD*, is from the South towards the West 32 degrees, and 162 *Perches* in length.

The <i>Logarithme</i> of <i>CD</i> 162	2,2095
The <i>Sine</i> of 32 degrees	9,7242
The <i>Logarithme</i> of 086	1,9337
The difference of Longitude of the Line <i>CD</i> .	

The <i>Logarithme</i> of <i>CD</i> 162	2,2095
The <i>Sine</i> of 58 degrees	9,9284
The <i>Logarithme</i> of 137	2,1379
The difference of Latitude of the line <i>CD</i> .	

The Line *DE* is from the South towards the West 80 degrees, and 300 *Perches* in length.

The <i>Logarithme</i> of 300	2,4771
The <i>Sine</i> of 80 degrees	9,9934
The <i>Logarithme</i> of 295	2,4705
The difference of Longitude of the Line <i>DE</i> .	

The <i>Logarithme</i> of <i>DE</i> 300	2,4771
The <i>Sine</i> of 10 degrees	9,2397
The <i>Logarithme</i> of 252	1,7158
The difference of Latitude of the Line <i>DE</i> .	

The Line *EF*, is 189 *Perches*, and from the North towards the East 35 degrees.

The <i>Logarithme</i> of <i>EF</i> 189	2,2765
The <i>Sine</i> of 35 degrees	9,7586
The <i>Logarithme</i> of 108	2,0351
The difference of Longitude of the Line <i>EF</i> .	

14

The

The *Logarithme* of EF 189 ———— 2,2765

The *Sine* of 55 Degrees ———— 9,9134

The *Logarithme* of 155 ———— 2,1899

The difference of Latitude of the line EF .

Lastly, the line FA is 161 *Perches*, and from the North towards the West 9 degrees.

The *Logarithme* of FA 161 ———— 2,2068

The *Sine* of 9 Degrees ———— 9,1943

The *Logarithme* of 025 ———— 1,4011

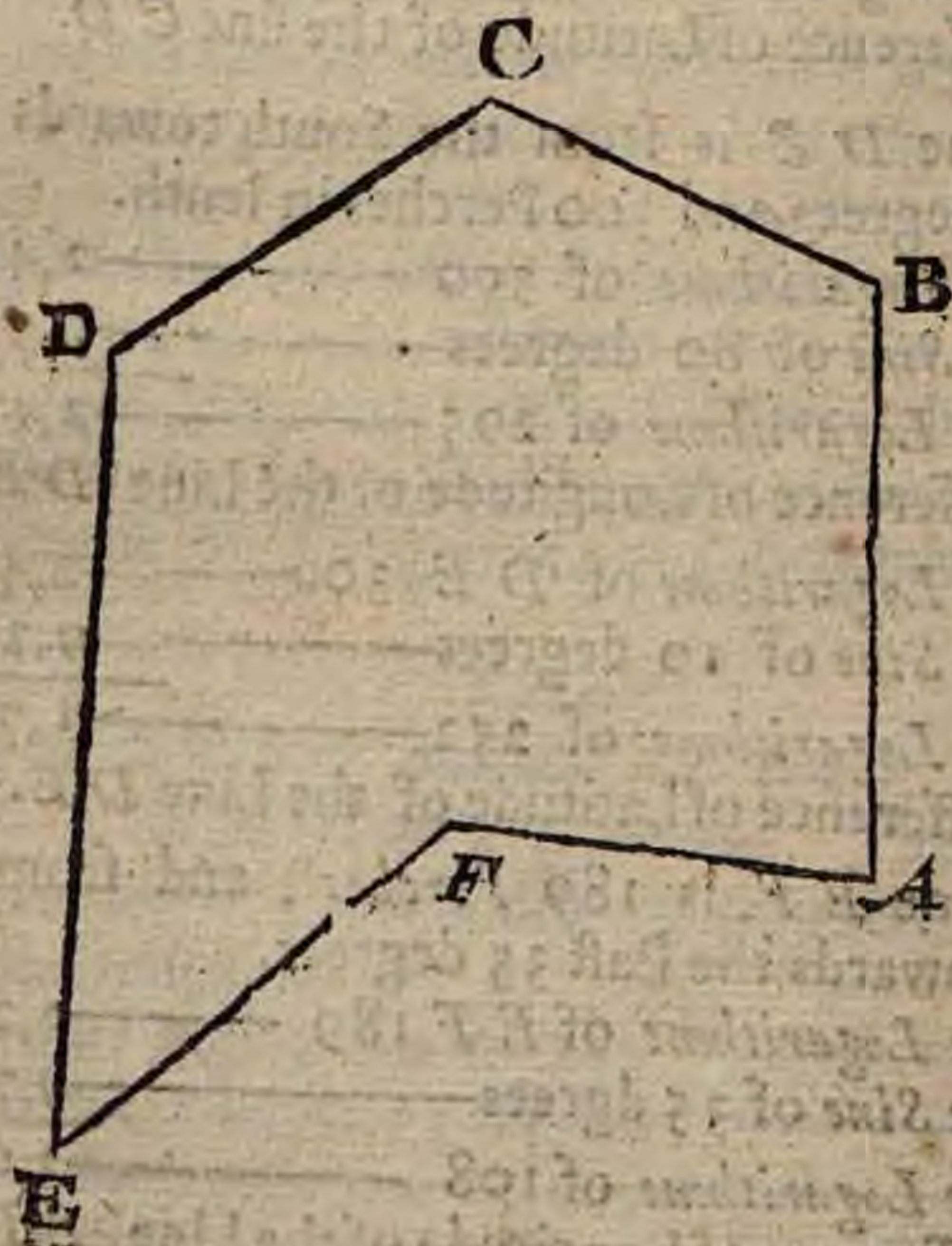
The difference of Longitude of the line FA .

The *Logarithme* of FA 161 ———— 2,2068

The *Sine* of 81 Degrees ———— 9,9946

The *Logarithme* of 159 ———— 2,2014

The difference of Latitude of the line FA .



After

After you have found the difference of Longitude, and Latitude of each line, as before is shewed, draw foure Columns, (as in the following example) intituled, North, South, East, West; and then set down the difference of Latitude of those lines that are neare to the North, in the North Column. And the difference of Latitude of those lines that are neare the South, in the South-Column. And set down the difference of Longitude of those lines that lie neare the East, in the East Column. And the difference of Longitude, of those lines that lie near the West, in the West-column.

And then sum up each Column; and if you find the East, and West equall, and also the North, and South equall, (as in the example,) you may be assured that your worke is exact. But if there be much difference; you must correct your plot, by more circumspect observation of the sides, and their *Angles*.

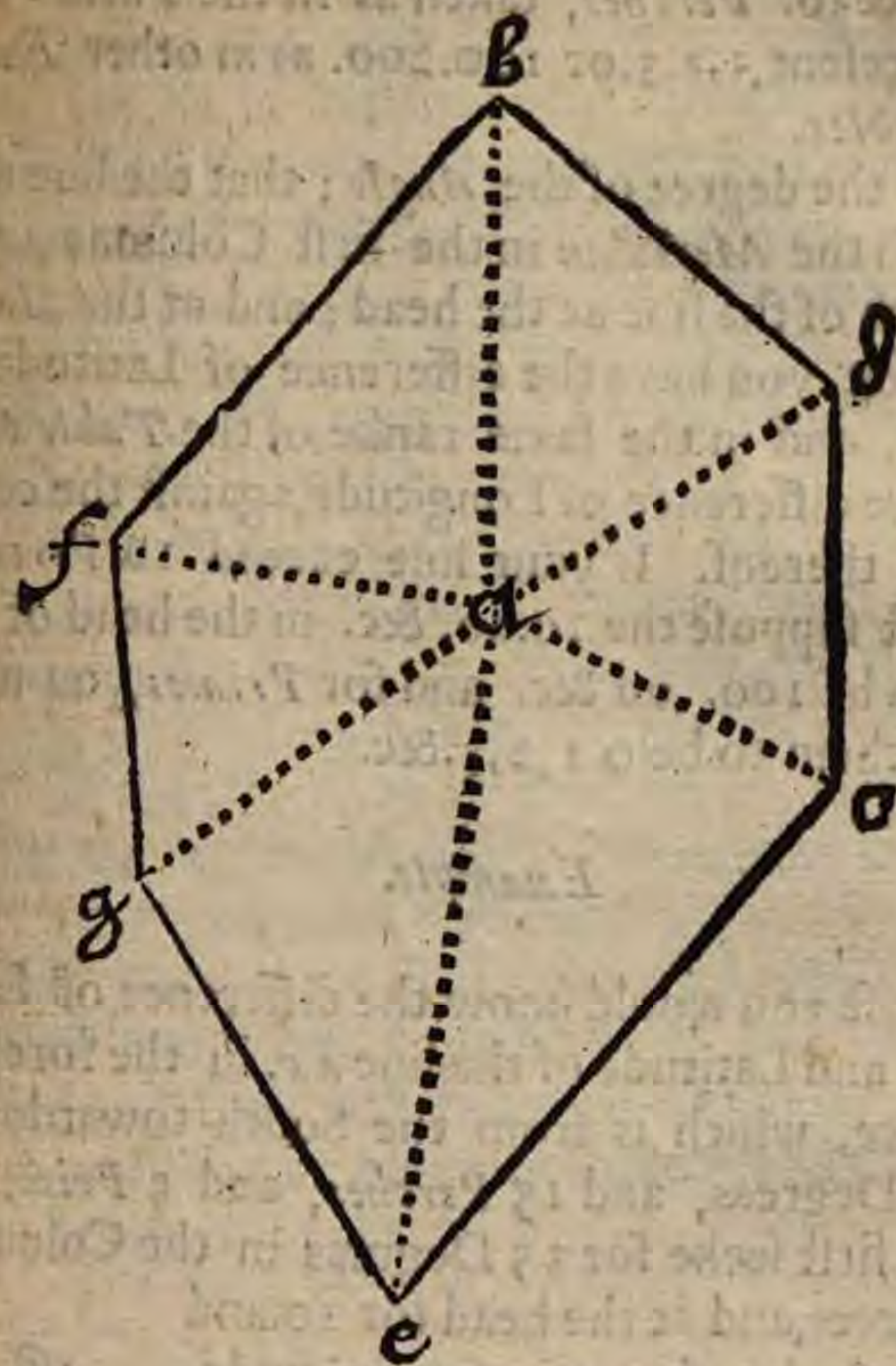
	North.	South.	East.	West.
AB			210	
BC		125	088	
CD		137		086
DE		052		295
EF	155		108	
FA	159			025
	314	314	406	406

In the foregoing plot, the Line AB is East, therefore in the East Column, I set downe 210. The line BC . being betweene the South and East, I

set downe the difference of Latitude 125. in the South Columne, and 088 in the East Columne, being the difference in Longitude. The line CD . is betweene the South, and West; therefore I put 137, the difference of Latitude in the South, and 086, the difference of Longitude in the West Columns. The line DE . is also betweene the South and West, therefore I put 052 the difference of Latitude, in the South, and 295 the difference of Longitude; in the West Columns. The line EF . is between the North and East, therefore I put 155. the difference of Latitude in the North, and 108. the difference of Longitude in the East Columns. Lastly, the line FA . is betweene the North, and West, therefore I put the difference of Latitude 159 in the North, and 025. the difference of Longitude in the West Columns. Then summing up each Column; I finde the North, and South to be equall 314, and the East and West Columnes to be equall 406, proving the worke to be exact.

In like manner may you prove your Work, when you observe from the middle of the plot at on Station, or from any part thereof, at two Stations; knowing the length of each line, and their inclination on to the *Meridian*.

As in the following figure, the line ab . is equall in length to the line AB in the former, and also East and West. The line ac . is answerable unto BC . ae , unto DE . af . unto FA . and ag , unto EF . Wherefore the prooffe of the plot $bcdefg$, taken from the middle a , will be the same as in the foregoing plot $ABCDEF$, taken by measuring about the same.



CAPH. XLIII.

Shewing how to performe the worke of the last Chapter, by a decimall Table.

IN the first Columne of the following Table, towards the left hand, you have the degrees of the *Quadrant*, together with their complements unto 90 degrees in the same ranke of the Table, and on the head of the Table you have 10. 20. 30. &c. being

Degrees	Distanc.	North.	South.	East.	West.
90 East.	per. pri. 21.0	per. pri.	per. pri.	per. pri. 21.0	per. pri.
SE 35	10.0 5.0 0.3		8.2 4.1 2	5.7 2.9 2	
SW 32	10.0 6.0 0.2		8.5 5.1 2		5.3 3.2 1
SW 8	30.0		5.2		29.5
NE 35	10.0 8.0 0.9	8.2 6.6 7		5.7 4.6 5	
NW 9	10.0 6.0 01	9.9 5.9 1			1.6 9 0
		31.4	31.5	40.6	40.6

And

And you will finde the summe of the East, and West Columns equall, and the summe of the North, and South equall, within one *Prime*, which is not considerable.

This way of examining your Worke, is to be preferred before all other. That way by the *Angles* in Chapter 41 doth indeed prove the *Angles* to be truly observed, but yet notwithstanding, the sides may not be truly measured; but this way proveth the truth of your Observation of the *Angles*, and the measure of the sides, both together.

This *Table* (would the narrowness of the pages afforde it a larger *Radius*,) might serve to find Heights, Depths, Distances, &c. but for those, you have sufficient Rules by the *Sines*, and *Logarithmes*. It is also of excellent use in Navigation, to keepe account of the Ships way in Longitude, and Latitude. For which it was principally intended.

A

A Decimall Table shewing the difference of Longitude and Latitude of any Line, at every degree of intersection with the Meridian.

D	10	20	30	40	50	60	70	80	90	100
1	100	200	300	400	500	600	700	800	900	1000
89	002	004	005	007	009	011	012	014	016	018
2	100	200	300	400	500	600	700	800	899	999
88	003	007	010	014	017	021	024	028	031	035
3	100	200	300	400	500	599	699	799	899	999
87	005	010	016	021	026	031	037	042	047	052
4	100	200	299	399	499	599	698	798	898	998
86	007	014	021	028	035	042	049	056	063	070
5	100	199	299	398	498	598	697	797	897	996
85	009	017	026	035	044	052	061	070	078	087
6	099	199	298	398	497	597	696	796	895	995
84	010	021	031	042	052	063	073	083	094	104
7	099	198	298	397	496	596	695	794	893	993
83	012	024	037	049	061	073	085	098	110	122
8	099	198	297	396	495	594	693	792	891	990
82	014	028	042	056	070	083	096	111	125	139
9	099	198	296	395	494	593	691	790	889	988
81	016	031	047	063	078	094	109	125	141	156
10	099	197	296	394	492	591	689	788	886	985
80	017	035	052	069	087	104	121	139	156	174

A Decimall Table, &c.

11	098	196	294	393	491	589	687	785	883	981
79	019	038	057	076	095	114	134	153	172	191
12	098	196	293	391	489	587	685	783	880	978
78	021	042	062	081	104	125	146	166	187	208
13	098	195	292	390	487	585	682	780	877	974
77	022	045	067	090	112	135	157	180	202	225
14	097	194	291	388	485	582	679	776	873	970
76	024	048	073	097	121	145	169	194	218	242
15	097	193	290	386	483	580	676	773	869	966
75	026	052	078	103	129	155	181	207	233	259
16	096	192	288	384	481	577	673	769	865	961
74	028	055	083	110	138	165	193	220	248	276
17	090	191	287	383	478	574	669	765	861	956
73	026	058	088	117	146	175	205	234	263	292
18	095	190	285	380	475	571	666	761	856	951
72	031	062	093	124	154	185	216	247	278	309
19	094	189	284	378	473	567	662	756	851	945
71	032	065	098	130	163	195	228	261	293	326
20	094	188	282	376	470	564	658	752	846	940
70	034	068	103	137	171	205	239	274	308	342
21	093	187	280	373	467	560	653	747	840	934
69	036	072	107	143	179	215	251	287	323	358
22	093	185	278	371	464	556	649	742	834	927
68	037	075	112	150	187	225	262	300	337	375

A Decimall Table, &c.

D	10	20	30	40	50	60	70	80	90	100
23	092	184	276	368	460	552	644	736	828	920
67	039	078	117	156	195	234	273	312	352	391
24	091	183	274	365	457	548	639	731	822	913
66	041	081	122	163	203	244	285	325	366	407
25	091	181	272	362	453	544	634	725	816	906
65	042	084	127	169	211	250	296	338	380	423
26	090	180	270	360	449	539	629	719	809	899
64	044	088	131	175	219	263	307	351	394	438
27	089	178	267	356	445	535	624	713	802	891
63	045	091	136	182	227	272	318	363	409	454
28	088	177	265	353	441	530	618	706	795	883
62	047	094	141	188	235	282	329	376	422	469
29	087	175	262	350	437	525	612	700	787	875
61	048	097	145	194	242	291	339	388	436	485
30	087	173	260	346	433	520	606	693	779	866
60	050	100	150	200	250	300	350	400	450	500
31	086	171	257	343	429	514	600	686	771	857
59	051	103	154	206	257	309	306	412	463	515
32	085	170	254	339	424	509	594	678	763	848
58	053	106	159	212	265	318	371	424	477	530

A Decimall Table, &c.

33	084	168	252	335	419	503	587	671	755	839
57	054	109	163	218	272	327	381	436	490	545
34	083	166	249	332	414	497	580	663	746	829
56	056	112	168	224	280	335	391	447	503	559
35	082	164	246	328	410	491	573	655	737	819
55	057	115	172	229	287	344	402	459	516	574
36	081	162	243	324	404	485	566	647	728	809
54	059	118	176	235	294	353	411	470	529	588
37	080	160	240	319	399	479	559	639	719	799
53	060	120	180	241	301	361	421	481	542	602
38	079	158	236	315	394	478	552	630	709	788
52	062	123	185	245	308	369	431	493	554	616
39	078	155	233	311	388	466	544	622	699	777
51	063	126	189	252	315	378	440	503	566	629
40	077	153	230	306	383	460	536	613	689	766
50	064	129	193	257	321	386	450	514	579	643
41	075	151	226	302	377	453	528	604	679	755
49	066	131	197	262	328	394	450	525	590	656
42	074	149	223	297	372	446	520	594	669	743
48	067	134	201	268	333	401	468	535	602	669
43	073	146	219	292	366	439	512	585	658	731
47	068	136	205	273	341	409	477	546	614	682
44	072	144	216	288	360	432	503	575	647	719
46	069	139	208	278	347	417	486	556	625	695
45	071	141	212	283	353	424	495	566	636	707

CAPH. XLIII.

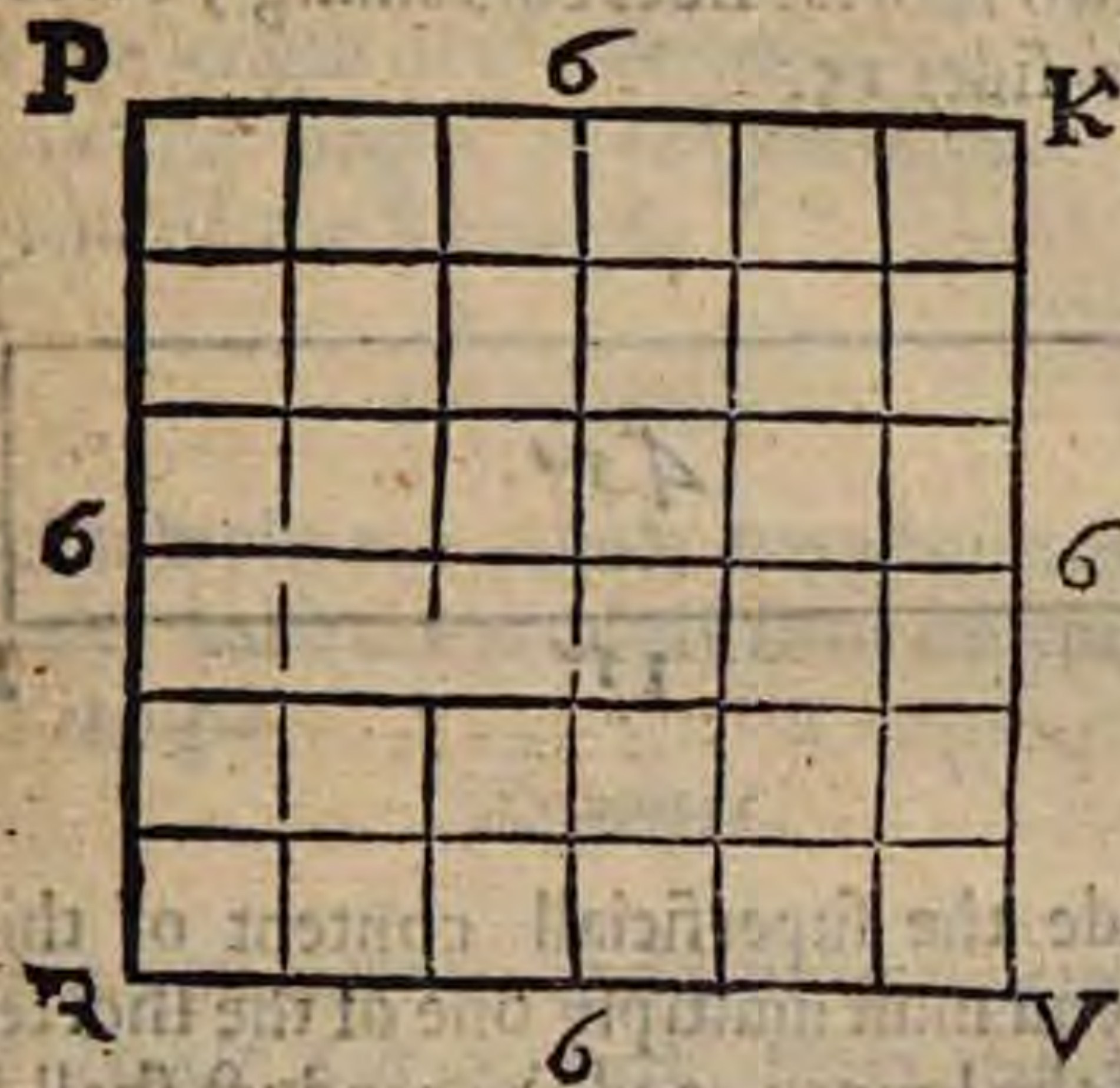
How to find the Area, or Superficial content of any plaine figure, and to reduce irregular figures into regular formes, and to finde the content thereof.

HAVING shewed how to draw the plot of any Field, or other Inclosure upon paper, it is now necessary to shew how the content thereof may be attained, that is to say; how many Acres, Roods, and Perches, any field so plotted doth containe; for the performance whereof, we must consider that the originall of the mensuration of all superficial figures, such as Land, Board, Glasse, or the like, do depend upon the exact measuring of certaine regular figures, as the *Geometricall Square*, the long square, the *Triangle*, the *Circle*, and the *Trapezium*: so that any plot of Land to be measured, if it be not in the forme of one of these figures, it must (before it be measured) be reduced into some of these formes. I will therefore in the first place shew you how to measure any of the said figures severally by themselves, and then how you shall reduce any other figure (how irregular soever it be) into some of these formes, and then how to measure it by the same Rules: and first,

Of the Geometricall Square.

A *Geometricall Square* is a figure consisting of foure equall sides and *Angles*, as is the Square $P K R V$. whose sides $P K$, $K V$, $V R$, and $R P$, are all

all equall, namely 6 (either) Inches, Feet, Perches, or any other measure whatsoever.



Now to finde the superficial content thereof, you must multiply any of the sides in it selfe; and the product of that multiplication shall be the content of the Square.

Example.

Suppose the Square $P K R V$ to be a piece of Land, and the side thereof to containe 6 *Perches*, therefore multiply 6 in it selfe (that is 6 by 6) and the product will be 36. and so many *Perches* doth the Square piece of Land $P K R V$ containe, as you may perceive by counting of the little squares within the great one.

Of the long Square.

A long Square is a figure consisting of foure sides

sides whereof are equall, as the sides *A B.* and *C D.* and likewise the two other opposites *A C.* and *B D.* the two shorter sides containing 3 *Perches*, and the longer sides 15.



To finde the superficial content of this long Square, you must multiply one of the shorter sides by one of the longer, and the product shall be the superficial content thereof.

Example.

The longer side of the Square contains 15 *Perches*, and the shorter three *Perches*; now if you multiply 15 by 3. the product will be 45. and that is the content of the Square in *Perches*.

Of the Triangle.

Though there be severall kindes of *Triangles*, yet in respect they are all measured by one and the same rule; I will therefore adde but one Example for all, which take for a generall rule.

In all right Lined *Triangles* whatsoever, halfe the length of the base being multiplied by the length

length of the perpendicular, shall be equall to the *Area*, or content of the *Triangle*.

Or,

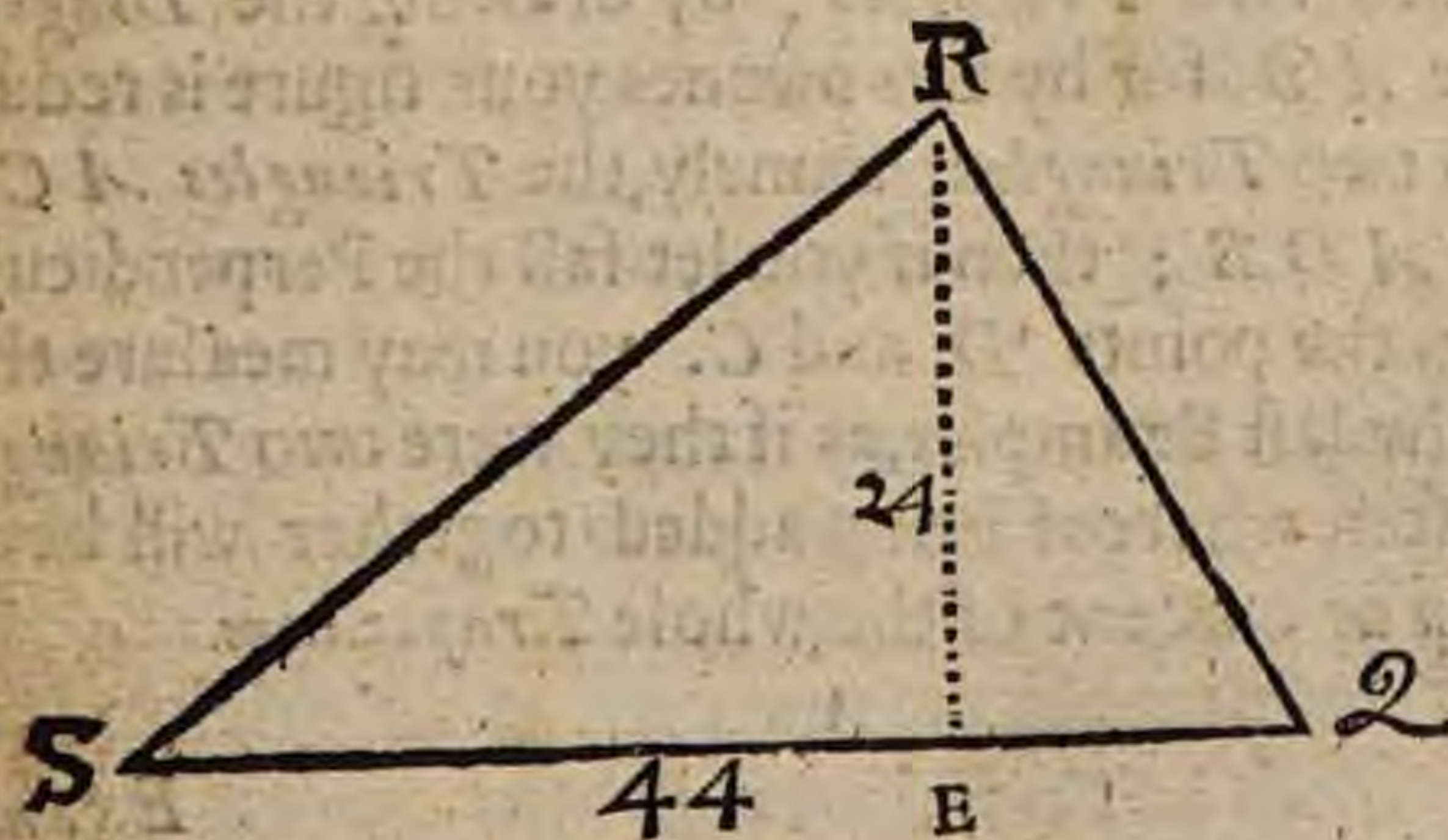
Halfe the length of the Perpendicular being multiplied in the length of the whole base, shall be the content of the *Triangle*.

Or againe;

If you multiply the whole Perpendicular by the whole base, halfe the product shall be the content of the *Triangle*.

Example.

Suppose you were to finde the *Area* or content of the *Triangle S R Q.* first, from the *Angle R.* you must let fall the Perpendicular *R E.* let the length thereof be 24 *Perches*, and the length of the base 44 *Perches*.



Now if you multiply 12 (which is halfe the length of the Perpendicular) by 44. (the length of the whole

whole base,) the product will be 528. and that is the *Area* or content of the *Triangle*.

Or,

If you multiply 24 (the whole length of the perpendicular) by 22 (the length of halfe the base) the product will be 528 as before.

Or againe,

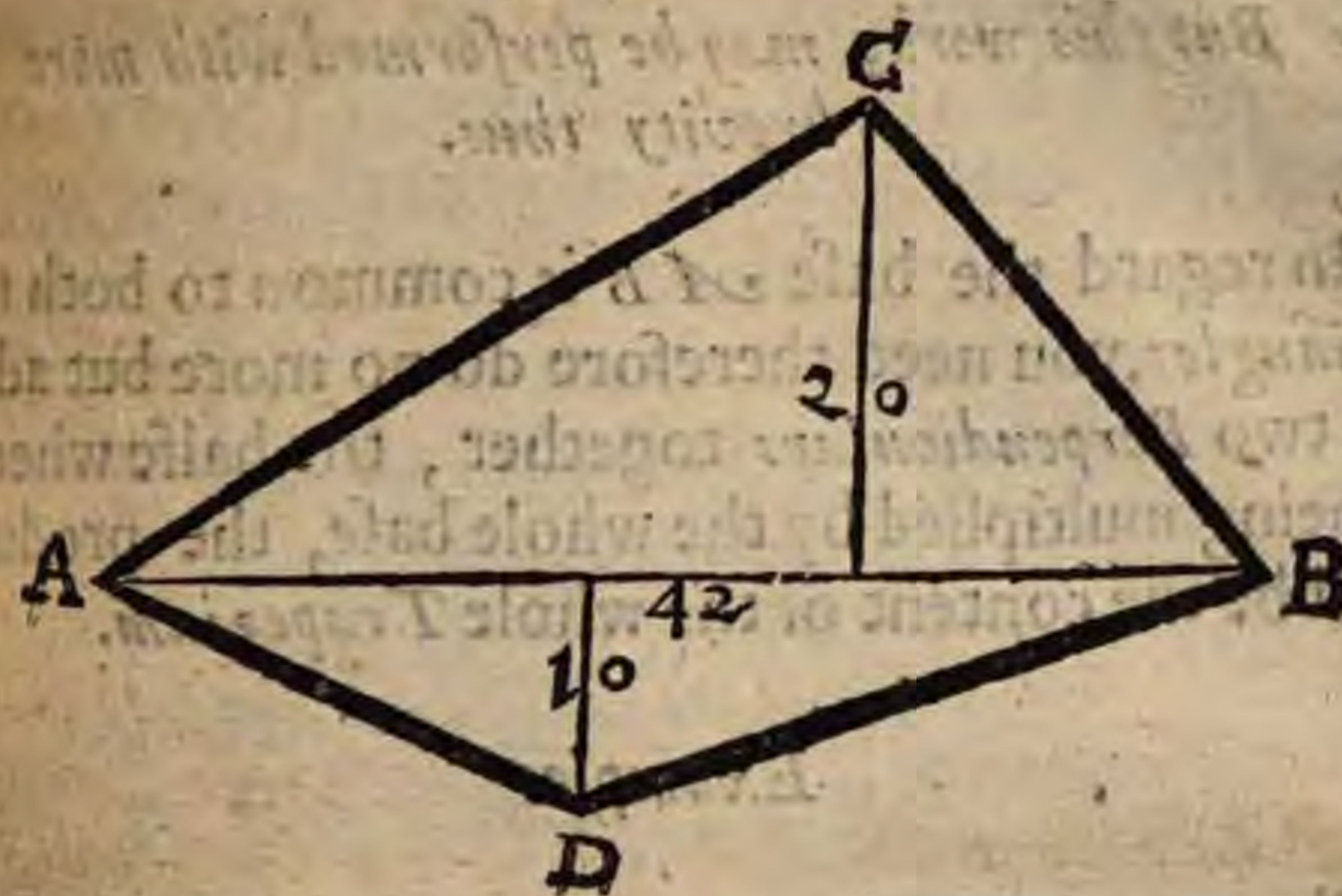
If you multiply 44 (the whole length of the base) by 24 (the whole length of the perpendicular) the product will be 1056. the halfe whereof will be 528. the *Area*, or content of the *Triangle*, as before.

Of the *Trapezium*.

A *Trapezium* is a figure consisting of foure unequal sides, and as many unequal *Angles*, as is the figure *ACBD*.

To measure this *Trapezium*, you must first reduce it into two *Triangles*, by drawing the *Diagonall* Line *AB*. for by this meanes your figure is reduced into two *Triangles*, namely, the *Triangles ACB*. and *ADB*; then if you let fall the *Perpendiculars* from the points *D* and *C*. you may measure them by the last *Examples*, as if they were two *Triangles*, the sum whereof being added together will be the *Area* or content of the whole *Trapezium*.

Example



Example.

Having drawn the Line *AB*. and so reduced the figure into two *Triangles*, and let fall the *Perpendiculars* from *C* and *D* (the base *AB* being common to both *Triangles*) suppose the *Perpendicular* at *C*. were 20 *Perches*, the *Perpendicular* at *D*. 10 *Perches*, and the base *AB* (serving for both *Triangles*) 42 *Perches*.

If now according to your former directions you multiply 42. the base, by 10. halfe the *Perpendicular*, the product will be 420 for the content of the *Triangle ACB*.

In like manner if you multiply 42. the base, by 5. halfe the other *Perpendicular*, the *Product* will be 210 for the content of the *Triangle ADB*.

Now if you adde the contents of these two *Triangles* together, namely 420 and 210. the sum of them is 630. and that is the content of the whole *Trapezium ACBD*.

But

But this worke may be performed with more brevity thus.

In regard the base AB is common to both the *Triangles*, you need therefore do no more but adde the two *Perpendiculars* together, the halfe whereof being multiplied by the whole base, the product shall be the content of the whole *Trapezium*.

Example.

The two *Perpendiculars* 10 and 20. being added together, the sum of them is 30. the halfe whereof is 15. this number being multiplied by 42. the whole length of the common base, giveth 630. the content of the whole *Trapezium*.

Or,

You may multiply the sum of the *Perpendiculars* by the length of the base, and halfe the product shall be the content.

Of the reducing irregular figures into Trapezium and Triangles, and to cast up the contents thereof.

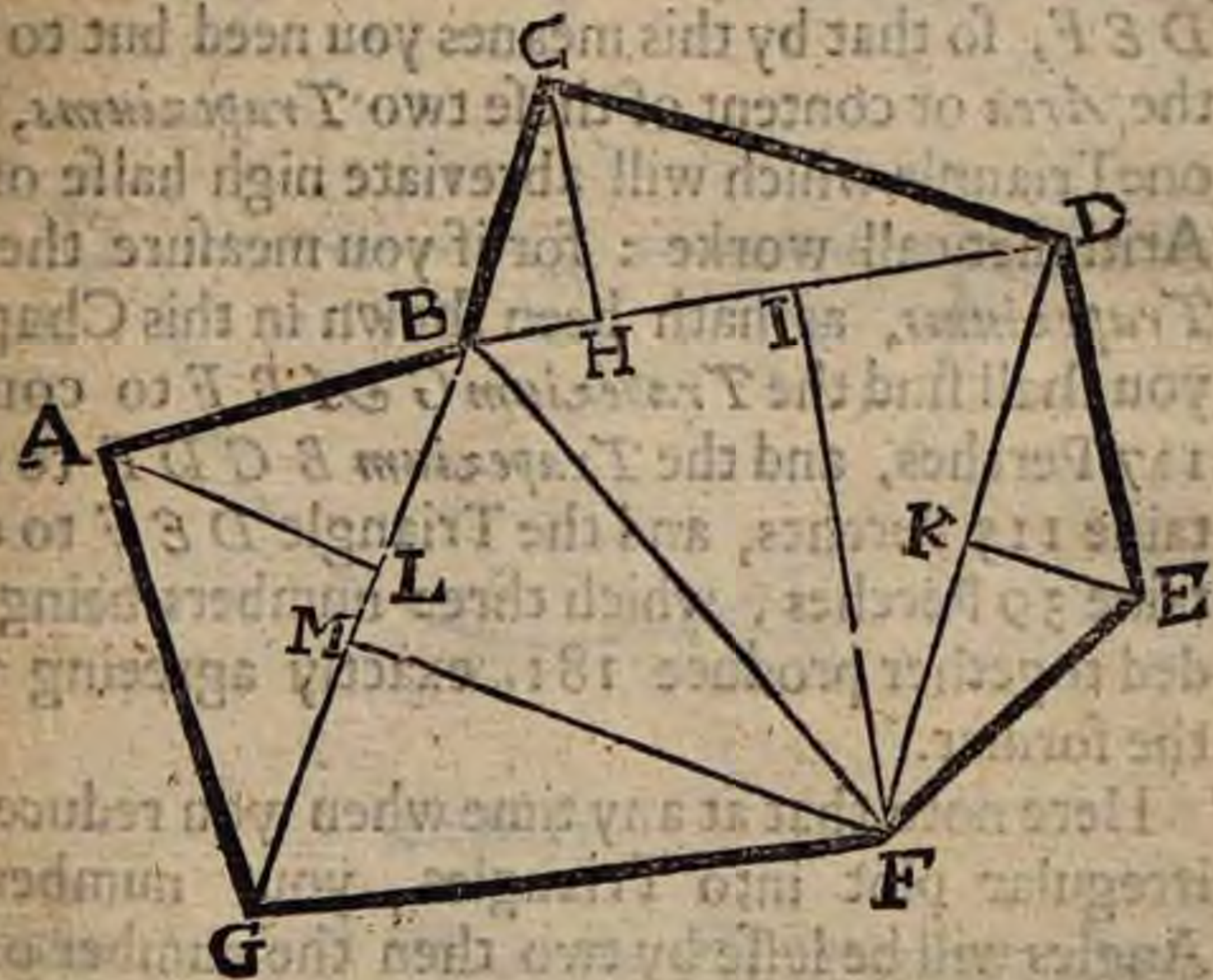
Let $ABCDEFG$ be the figure of a field drawn upon your plaine Table, or otherwise protracted upon paper, according to any of the former directions.

In regard that the field is irregular, that is to say, it is neither a *Circle*, *Triangle*, *Square*, or *Trapezium*, it must therefore (before it be measured) be reduced into some of these forms, which

to

to performe, doe thus, draw Lines to every other *Angle*, as the Lines GB , BD , DF , and FB . then will the whole figure be reduced into five *Triangles*.

- As;
1. The Triangle GAB .
 2. The Triangle BCD .
 3. The Triangle DEF .
 4. The Triangle FBG .
 5. The Triangle FBD .



These five *Triangles* must be all measured severally, according to the directions before given, and then the contents of all the five *Triangles* being added together in one sum, that sum shall be the *Area* or content of the whole field.

As suppose, the Triangle GAB should containe

tain 53 Perches, the Triangle $B C D$ 47 Perches, the Triangle $D E F$ 39 Perches, the Triangle $G B F$ 74 Perches, and the Triangle $B F D$ 68 Perches.

These five numbers being added together make 281 Perches, and that is the Area or content of the whole field in Perches.

But for an abbreviation of this work you need not to finde the Area of every Triangle, but of every Trapezium, for the figure is as well divided into Trapeziums as Triangles, as namely the Trapeziums $A B F G$, and $B C D F$, and the Triangle $D E F$, so that by this meanes you need but to finde the Area or content of these two Trapeziums, and one Triangle which will abbreviate nigh halfe of the Arithmetical worke: for if you measure the two Trapeziums, as hath been shewn in this Chapter, you shall finde the Trapezium $G A B F$ to contain 127 Perches, and the Trapezium $B C D F$ to containe 115 Perches, and the Triangle $D E F$ to containe 39 Perches, which three numbers being added together produce 181. exactly agreeing with the former.

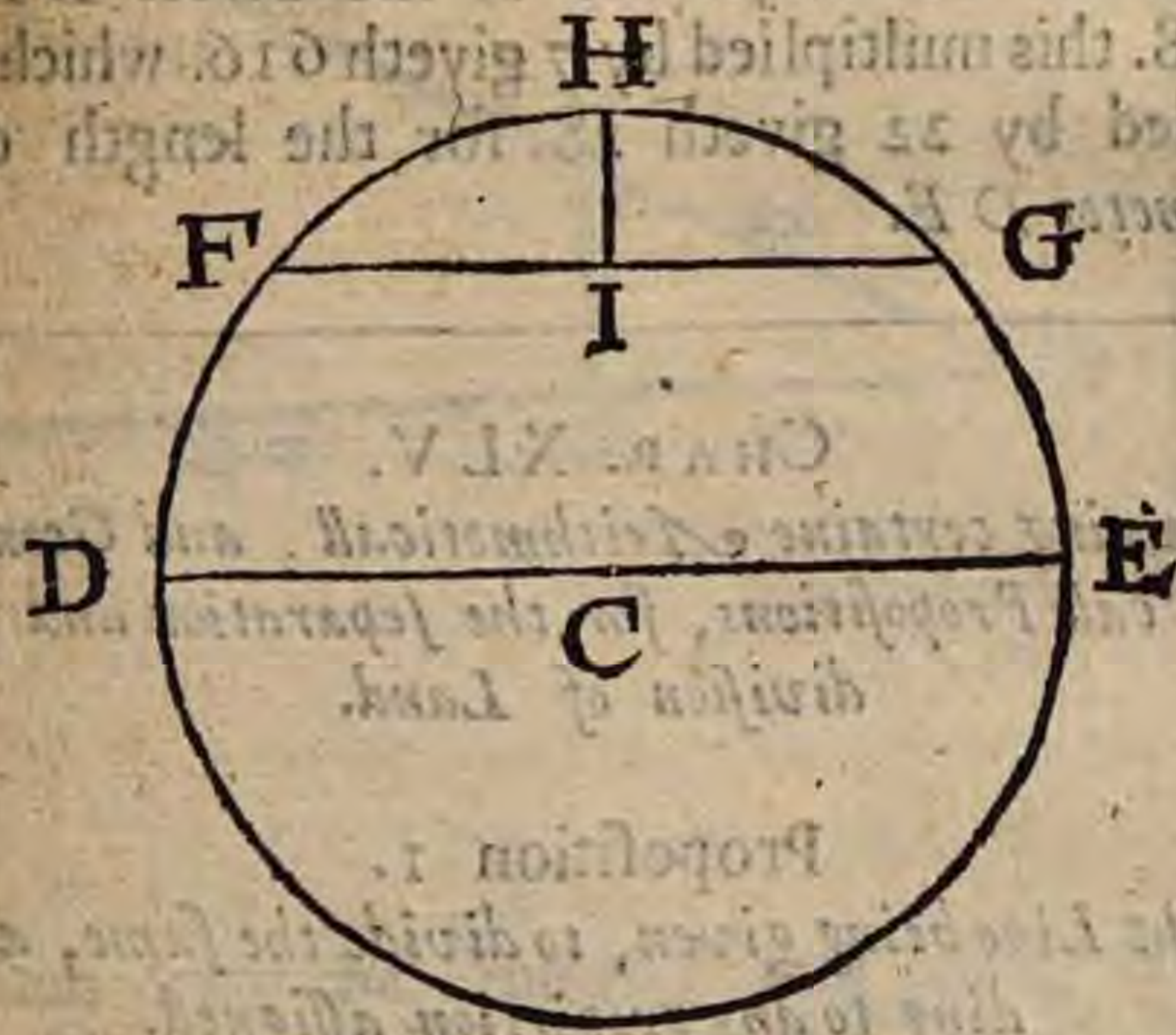
Here note that at any time when you reduce any irregular plot into Triangles, your number of Angles will be lesse by two then the number of the sides of your plot, as in this the plot consisted of 7 sides, and you see it is reduced into five Triangles.

Of the Circle.

The proportion of the Circumference of any Circle is to his Diameter as 7 to 22. (or in larger terms, as 10000 to 31416. Now

Now to finde the Area or content of any Circle, you must multiply the Diameter thereof in it selfe, and multiply that sum by 11. which product being divided by 14 shall give you the Area of the Circle.

Or, Multiply the Semi-diameter, and the Semi-circumference, the product shall be the Area of the Circle.



Example.

In the Circle $D F G E$. let the Diameter thereof $D E$ be 28. which multiplied in it selfe giveth 784. this number being multiplied by 11 giveth 8624, which being divided by 14 the quotient will be 616. and that is the Area of the Circle.

The

The Circumference of a Circle being given to find the Diameter.

Multiply the Circumference by 7. and divide the product by 22. the quotient shall be the length of the Diameter.

Example.

Let the Circumference of the Circle D E F G. be 88. this multiplied by 7 giveth 616. which being divided by 22 giveth 28. for the length of the Diameter D E.

CHAP. XLV.

Containing certaine Arithmetical, and Geometrical Propositions, for the separation and division of Land.

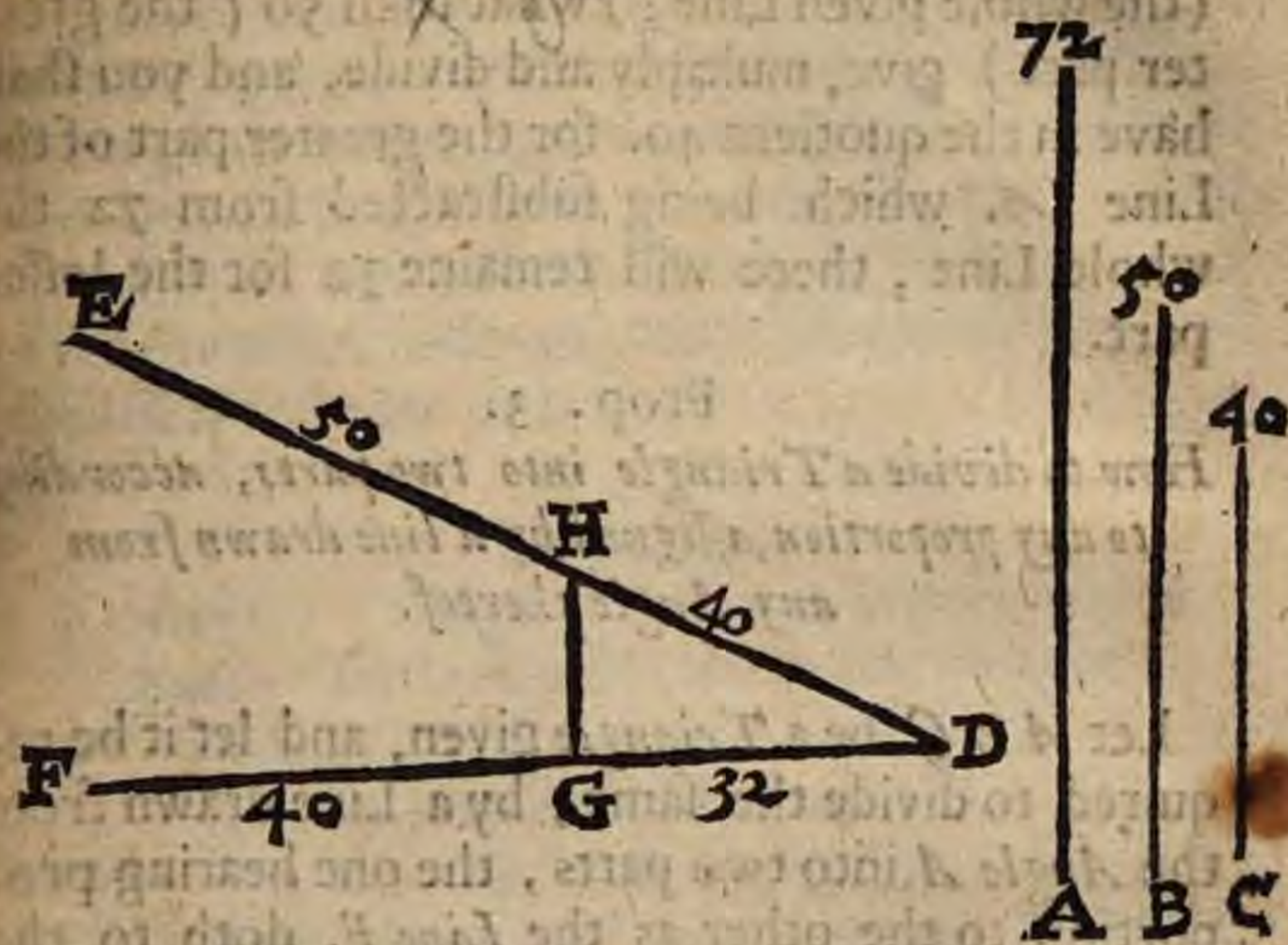
Proposition 1.

A right Line being given, to divide the same, according to any proportion assigned.

Suppose A be a Line given, and let it be required to divide the same into two parts bearing proportion the one to the other, as the Line B. doth to the Line C.

First, draw the Line F D. equal to the given Line A. then draw the Line E D. (to containe any Angle at pleasure, and from D to H place the Line C. and from H to E. place the Line B.

Then



Then draw the Line E F. and lastly, draw the Line H G parallel to the Line E F. which shall cut the Line F D in the point G. so is the Line F D. (which is equal to the given Line A) divided in the point G. in proportion as the Line B. is to the Line C.

Prop. 2.

To performe the same Arithmetically.

Let the Line A be 72. and let the Line B be 50. and the Line C 40. according to which proportion let it be required to divide the Line A.

First

First, say by rule of proportion, if 90 (which is the sum of the two proportionall termes) give 72 (the whole given Line;) what shall 50 (the greater part) give, multiply and divide, and you shall have in the quotient 40. for the greater part of the Line *A*. which being substracted from 72 the whole Line, there will remaine 32 for the lesser part.

Prop. 3.

How to divide a Triangle into two parts, according to any proportion, assigned, by a line drawn from any Angle thereof.

Let *ABC* be a Triangle given, and let it be required to divide the same, by a Line drawn from the Angle *A*. into two parts, the one bearing proportion to the other, as the Line *F*. doth to the Line *G*.

By either of the two last propositions, divide the base of the Triangle *BC* in the point *D*. in proportion as the Line *F*. is to the Line *G*. then draw the Line *AD* which shall divide the Triangle, according to the given proportion.

Prop. 4.

The base of the Triangle being known, to performe the former proposition by Arithmetick.

Suppose the base *BC* to be 40. and let the proportion, into which the Triangle is to be divided, be as 2 to 3.

First,

First, adde the two proportionall termes together, 2 and 3. which makes 5. then say by the rule of proportion, if 5. (the sum of the proportionall termes) give 40 (the whole base,) what shall 3. (the greater term) give? multiply and divide, and the quotient will give you 24. for the greater segment of the base *DC*. which being deducted from the whole base 40. there will remaine 16. for the lesser segment *BD*.

Prop. 5.

To divide a Triangle, whose Area or content is known, into two parts by a line drawne from an Angle assigned, according to any proportion required.

Let the Triangle *ABC*. containe 8 Acres, and let it be required to divide the same into two parts by a Line drawne from the Angle *A*. the one to containe 5 Acres, and the other 3 Acres.

First, you must measure the whole length of the base, which suppose 40. then say, if 8 Acres (the quantity of the whole Triangle) give 40. (the whole base) what parts of the base shall 5. Acres give? multiply and divide, the quotient will be 25 for the greater segment of the base *DC*. which being deducted from 40. (the whole base,) there will remaine 15. for the lesser segment of the base *BD*. then draw the Line *AD*. which shall divide the Triangle *ABC*. into the given proportion.

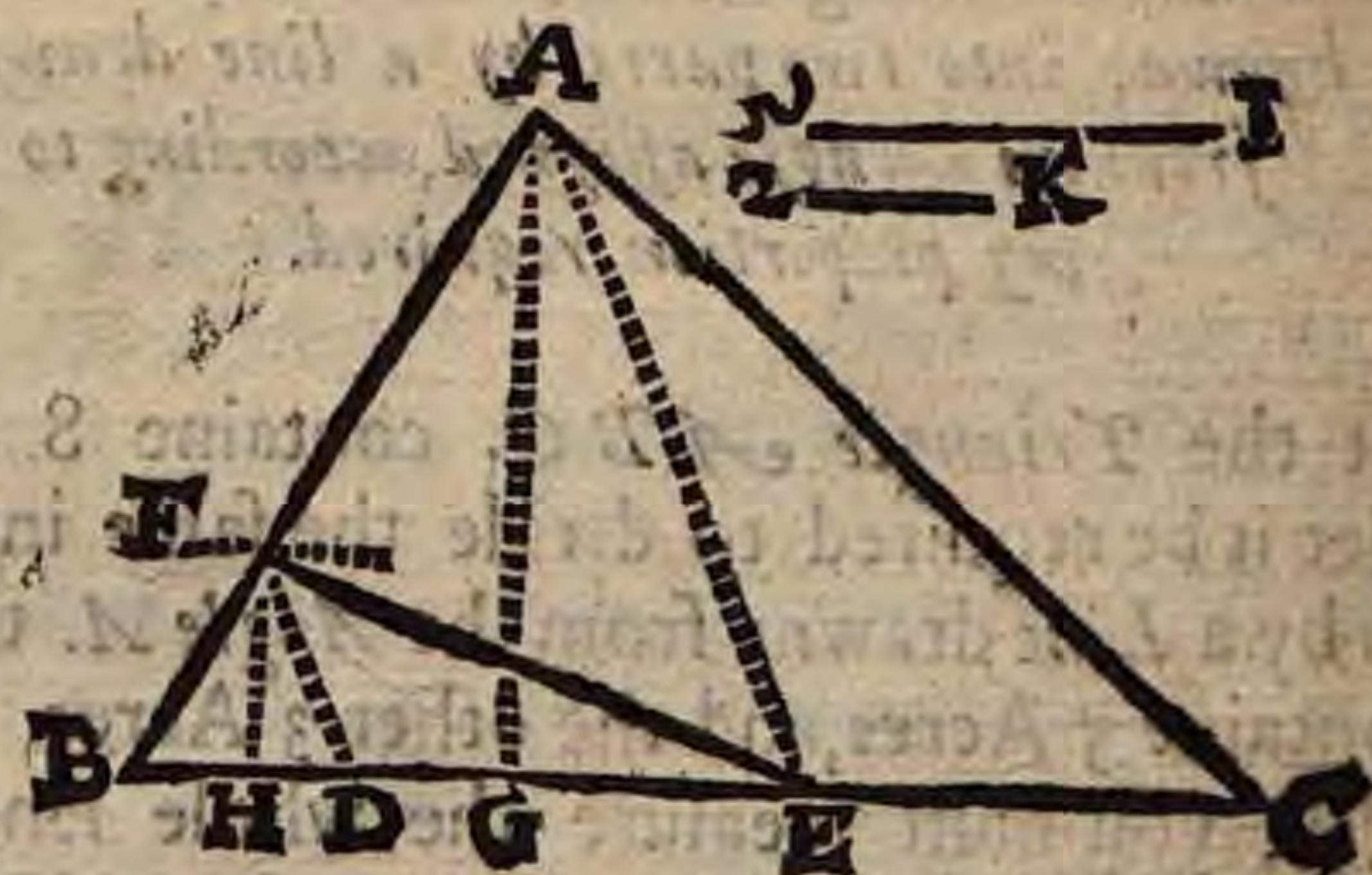
L

Prop.

Prop. 6.

To divide a Triangle given into two parts, according to any proportion assigned by a line drawn from a point limited in any of the sides thereof.

Let the Triangle given be ABC . and let it be required from the point E . to draw a Line that shall divide the Triangle into two parts, bearing proportion one to the other, as the Line I doth to the Line K .



First from the limited point E . draw a Line to the opposite Angle A . then divide the base BC . in proportion as I to C . which point of division will be at D . then draw DF . parallel to AE . Lastly, from F draw the Line FE . which shall divide the Triangle as I to K .

Prop. 7.

To performe the same Arithmetically.

Let it be required to divide the Triangle ABC . from

from the point E . into two parts in proportion, as 5 to 2.

First, divide the base BC according to the given proportion, then (because the lesser part is to be laid towards B .) measure the distance from E to B . which admit 30. then say by the rule of proportion, if EB . 30. give DB 12. what shall AG 40. (the perpendicular of the Triangle) give? Multiply and divide, the quotient will be 16. at which distance draw a parallel Line to BC . namely F . then from F draw the Line FE . which shall divide your Triangle, according to the required proportion.

Prop. 8.

To divide a Triangle, whose Area or content is known, into two parts, from a point limited in any side thereof, according to any number of Acres, Roods or Perches.

Let the Triangle ABC . whose quantity is 5 Acres, and 1 Rood, be given, let the limited point be E . in the base, and let it be required from E . to divide the Triangle into two parts between M . and N . namely to M . 3 Acres. 3 Roods thereof, and to N . 1 Acre. 2 Roods.

First, reduce the quantity of N . (being the lesse) into Perches, which makes 240. then (considering on which side of the limited point this part is to be laid, as towards B) measure that part of the base from E to B 30 Perches, whereof take halfe, which is 15. and thereby divide 240. the parts of N . the quotient will be 16. the length of the Perpendicular FH . at which parallel distance

from the base BC . cut the side AB in F . from whence draw the Line FE . which shall include the *Triangle* FBE . containing 1 *Acre*, 2 *Roods*, and the *Trapezium* $A FEC$ contains the residue, 3 *Acres*. 3 *Roods*.

Prop. 9.

To divide a given triangle by a parallel line to one of the sides, according to any proportion given.

Let the following *Triangle* ABC be given, and let it be required to divide the same into two parts by a line drawn parallel to the line AC . and in proportion as the line I to the line K .

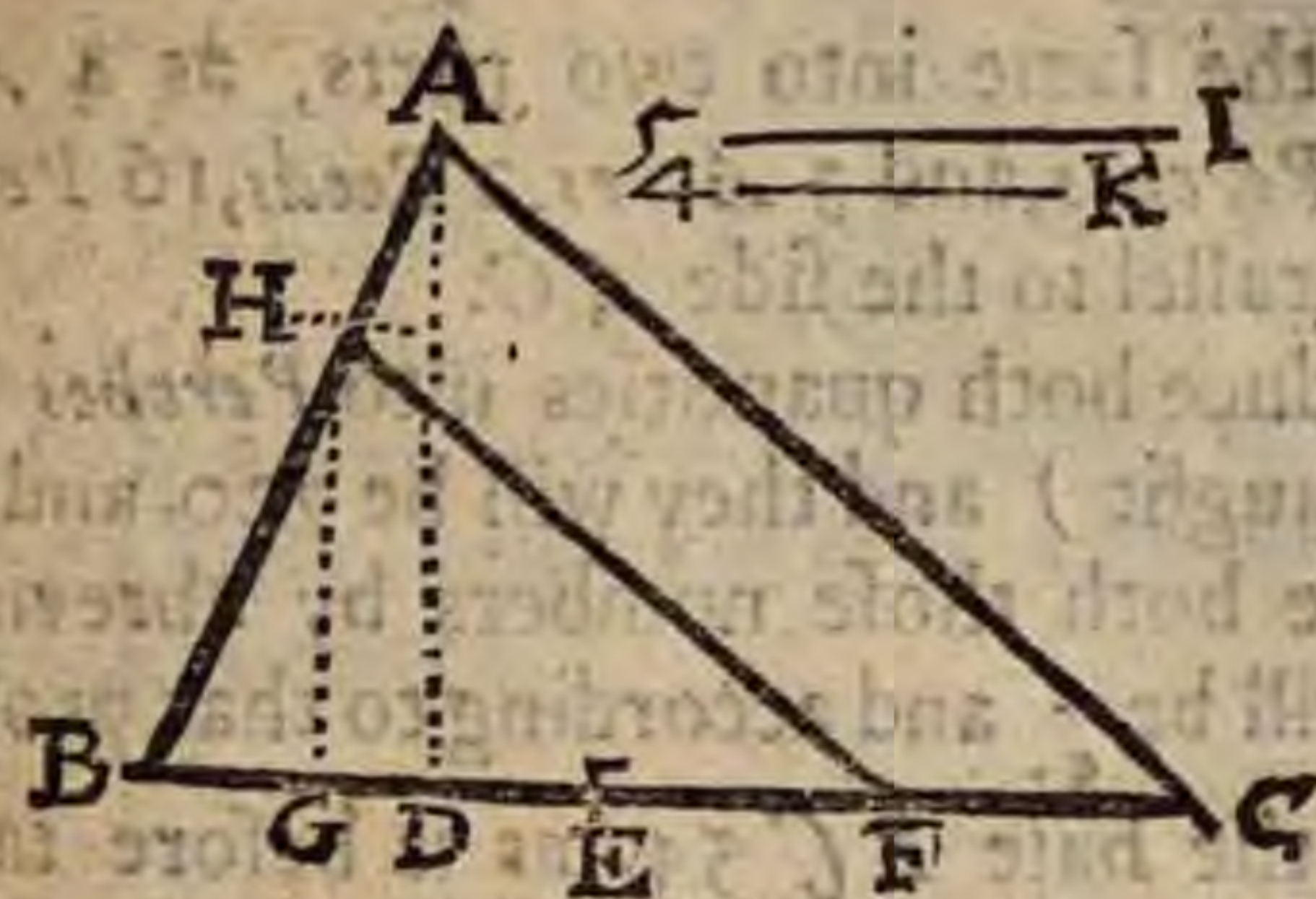
By the first proposition of this Chapter, divide the Line BC in E . as I to K . then finde the meane proportion between BE and BC . which let be BF . from which point draw the line FH . parallel to AC . which line shall divide the *Triangle* into two parts, the *Trapezium* $AHFC$ having small proportion to the *Triangle* HBF as I to K .

Prop. 10.

To performe the same Arithmetically.

Let the *Triangle* be ABC . and let it be required to divide the same by a parallel line to one of the sides into two parts, to be in proportion as 4 to 5.

First,



First, let the base BC 54 be divided according to the proportion given, so shall the lesser segment be BE 24. and the greater EC 30; then finde out a mean proportionall between BE 24 and the whole base BC 54 by multiplying 54 by 24. whose product will be 1296. the Square roote whereof is 36. the meane proportionall sought, which is BF . then by the rule of proportion say: if BF 36 give BE 24. what AD 48? The answer is, HG 32. at which distance draw a parallel line to the base, to cut the side AB in H . from whence draw the line HF parallel to AC which shall divide the *Triangle* as was required.

Prop. 11.

To divide a *Triangle* of any knowne quantity into two parts, by a parallel line to one of the sides, according to any number of *Acres*, *Roods*, and *Perches*.

Let the *Triangle* be ABC . whose quantity is *Acres* 8. *Roods* 0 *Perches* 16. and let it be required

to divide the same into two parts, as 4 Acres, 2 Roods 16 Perches, and 3 Acres, 2 Roods, 16 Perches, by a line parallel to the side AC .

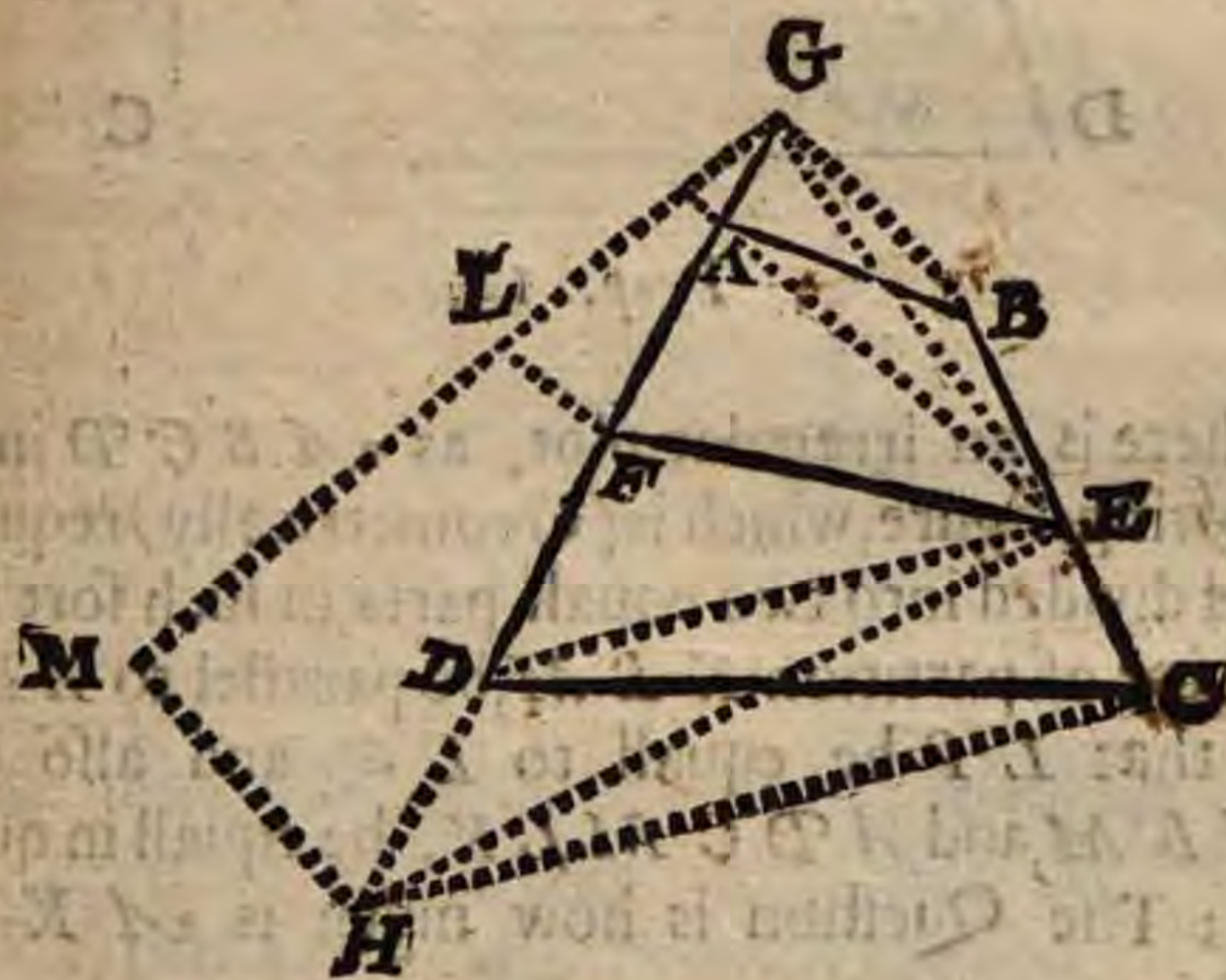
Frist, reduce both quantities into *Perches* (as is hereafter taught) and they will be 720. and 576. then reduce both those numbers by abbreviation, and they will be 4 and according to that proportion divide the base BC 54. as is before taught, which will be in E . then seeke the meane proportionall between BE , and BC . which is BF 36. of which 36 take halfe and divide 576. the lesser quantity of *Perches*, and the Quotient will be HG 32. at which distance parallel to the base cut the line AB in H . from whence draw HF . parallel to the side AC , which shall divide the triangle given into two parts according as required.

Prop. 12.

There is an irregular Quadrangle as $ABCD$, which is required to be divided into two parts, from the point E . as 20. to 11. so that FE DC and $ABEF$ be to each other in quantity according to that proportion.

Draw the line BC parallel to AE . and extend DA to G . then is $AE G$, equal to EAB , because that they stand both upon one base, draw CH . parallel to DE , and extend AB to H , then is the Triangle EDH , equal to the Triangle EDC , and the whole Triangle GHE , is equal to the whole plot

plot $ABCD$. draw a line from G at pleasure, that may represent the number of both the proportions, viz. 31. which is GLM . draw MH , from G to L is 11, and LM 20. draw LF parallel to MH . Lastly draw the line FE which shall divide the given Quadrangle $ABCD$ according to the proportion required.



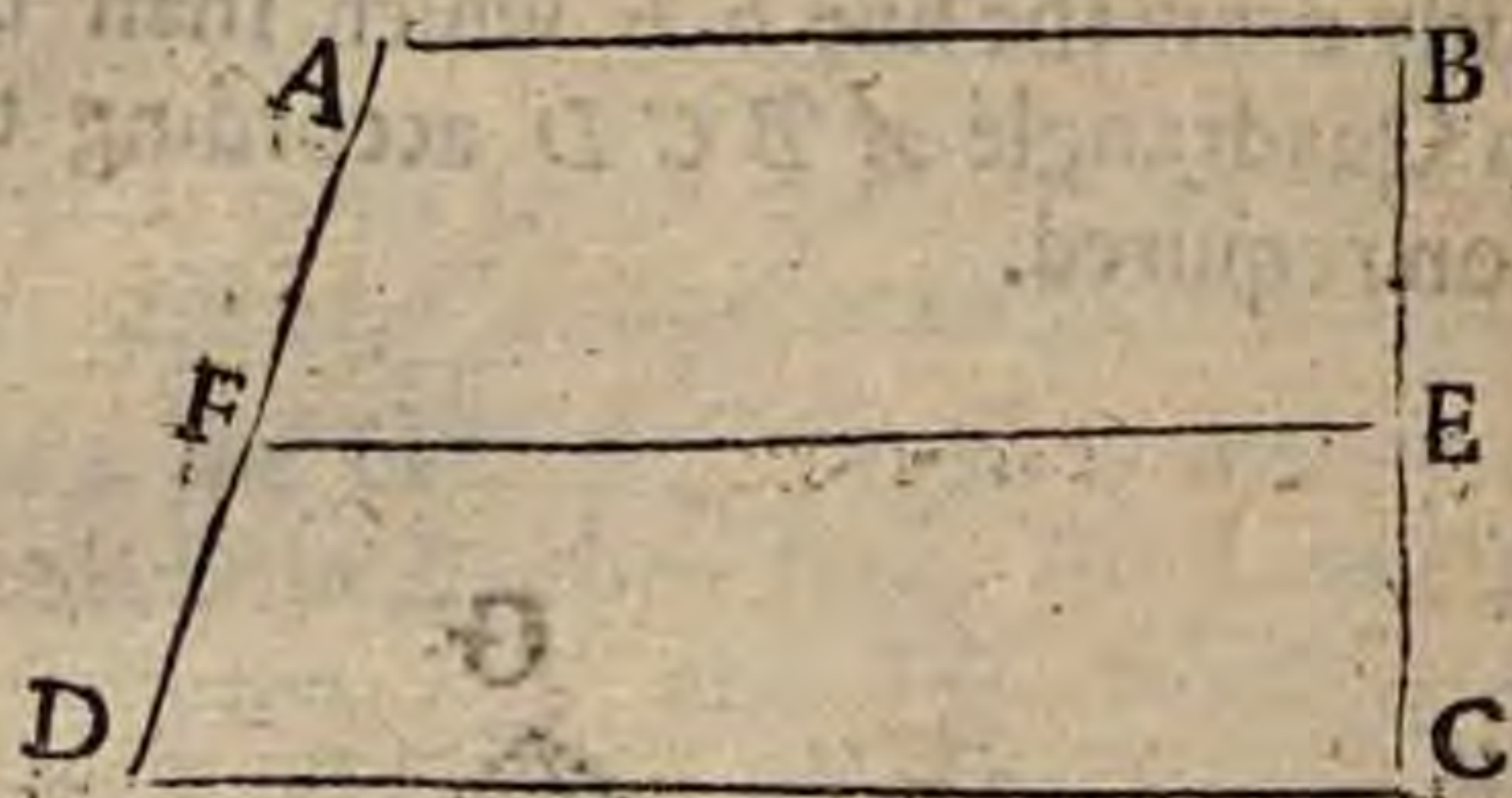
Prop. 13.

There is a piece of Land as $ABDC$, the Angles at B and C are right Angles, AB and DC are parallel, and AB 24. BC 16. DC 36. this piece is to be divided into two equal parts with a line from the middest of the line AD . as FE . the question is how much is EC and EB .

L 4

Ad

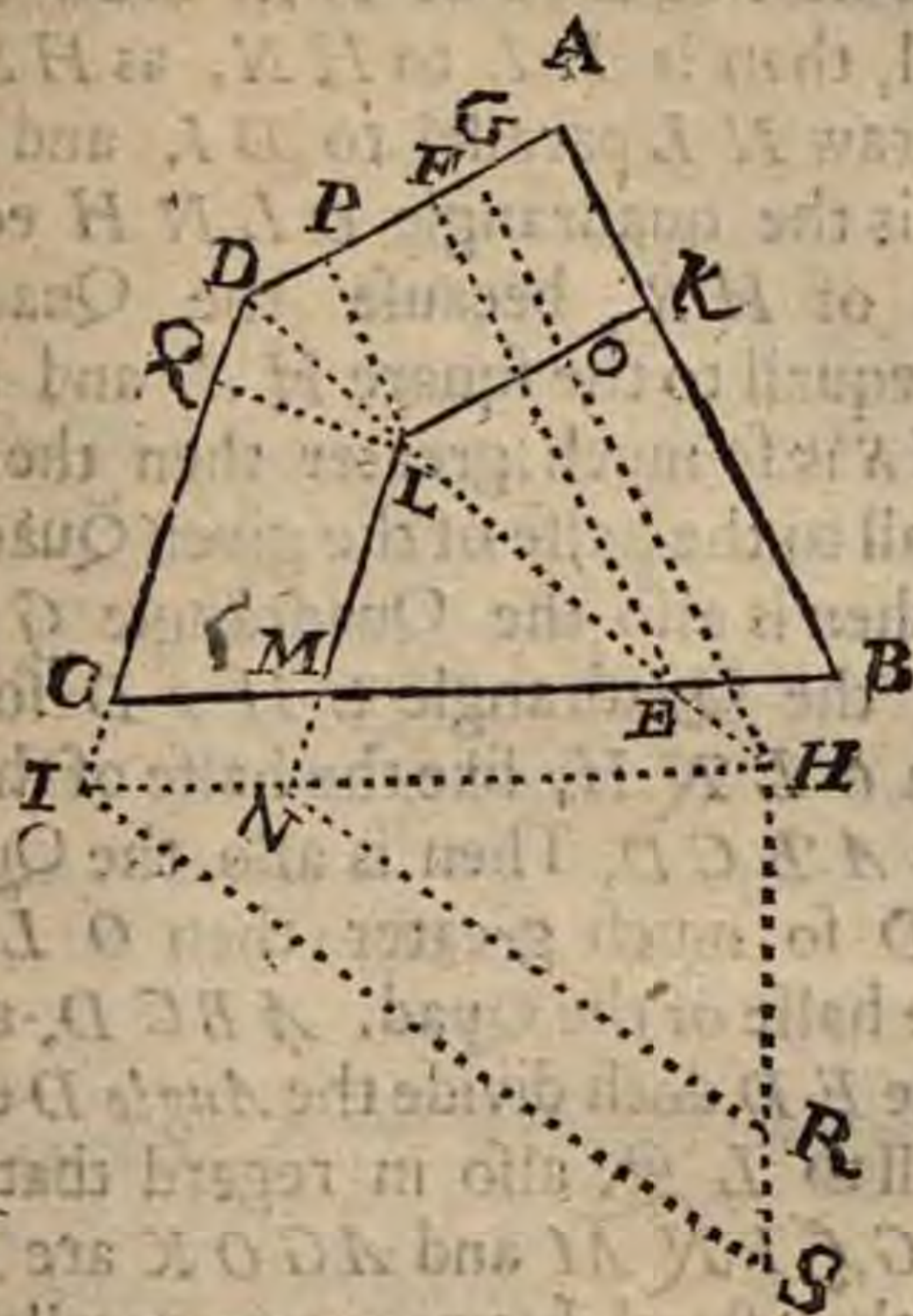
Adde AB 24, to DC 36. and it makes 60.
Then say as 60 to BC 16, so AB 24, to EC 6.4.
and so DC 36, to EB 9.6. as required.



Prop. 14.

There is an irregular plot, as $ABCD$ in the following figure, which is (Geometrically) required to be divided into two equall parts, in such sort that the Line of partition KLM , be parallel to ADC , and that LP be equall to LQ . and also that $BKLM$, and $ADCMLK$, be equall in quantity; The Question is how much is AK and CM .

First,



First, draw the Line ED , so that it divide the Angle at D into two equall parts; then draw the Line EF parallel to AB . from E the point of intersection of DE and CB , divide AF into two such parts, as that the one part GA , be to the other part GF , as DC is to FD , then prolong the Line DC to I , so that CI , be equall to AG , then is the *Quadrangle* $GHID$ of like proportion to $FECD$: Then make the halfe of the given *Quadrangle* $ABCD$ into a right angled square, and also $GHID$ into a square, the side of the square $GHID$ is HS , and if wee now from the *Quadrangle* $GHID$ subtract the said square of halfe the *Quadrangle* given $ABCD$, there shall remain

a square whose side shall be HR . draw IS and NR parallel, then is HI , to HN , as HS , is to HR , and draw NL parallel to DI , and LK to DA , then is the quadrangle $OLNH$ equall to the square of HR , because the Quadrangle $GHID$ is equall to the square HS , and also the square of HS is so much greater then the square of HR , equall to the halfe of the given Quadrangle $ABCD$, then is also the Quadrangle $GHID$, then is also the Quadrangle $GHID$ so much greater then $OLNH$, like the halfe of the given Quadrangle $ABCD$, Then is also the Quadrangle $GHID$ so much greater then $OLNM$ equall to the halfe of the Quad. $ABCD$, and because the line ED doth divide the *Angle D* equally, LP is equall to LQ , also in regard that CI is equall to AG , $CINM$ and $AGOK$ are equall, and because they stand between two parallel Lines, and the part $KADCML$, is like to $OGDINL$, and consequently halfe the given Quad. $ABCD$, and $BKLM$, the other halfe, divided by KLM , so that LP is equall to LQ , unto which AK and CM , are also equall as was required.

Prop. 15.

There is a plot as $BACD$, which is to be divided into two parts from a point within as O , so that the part towards BA , be to the part towards CD , as 10. to 7. the Line of partition in the example is QOP .

The

The Question is how this may be done Geometrically.



First, increase AD , BC , till they meete in H , then draw the Line BD , and draw IC parallel to BD , then draw BI ; then is BA, BI, AI , a triangle equall to $BCAD$; divide AI so that IK be 10, and KI 7; then by the point O , draw ML parallel to AD , from L , let fall a Perpendicular to AH , viz. LN , from N , draw MN parallel to BH ; Then take the square of EL , from the square of EM , and set it from N to P , then draw the Line QEP , which shall divide the plot as required.

Prop. 16.

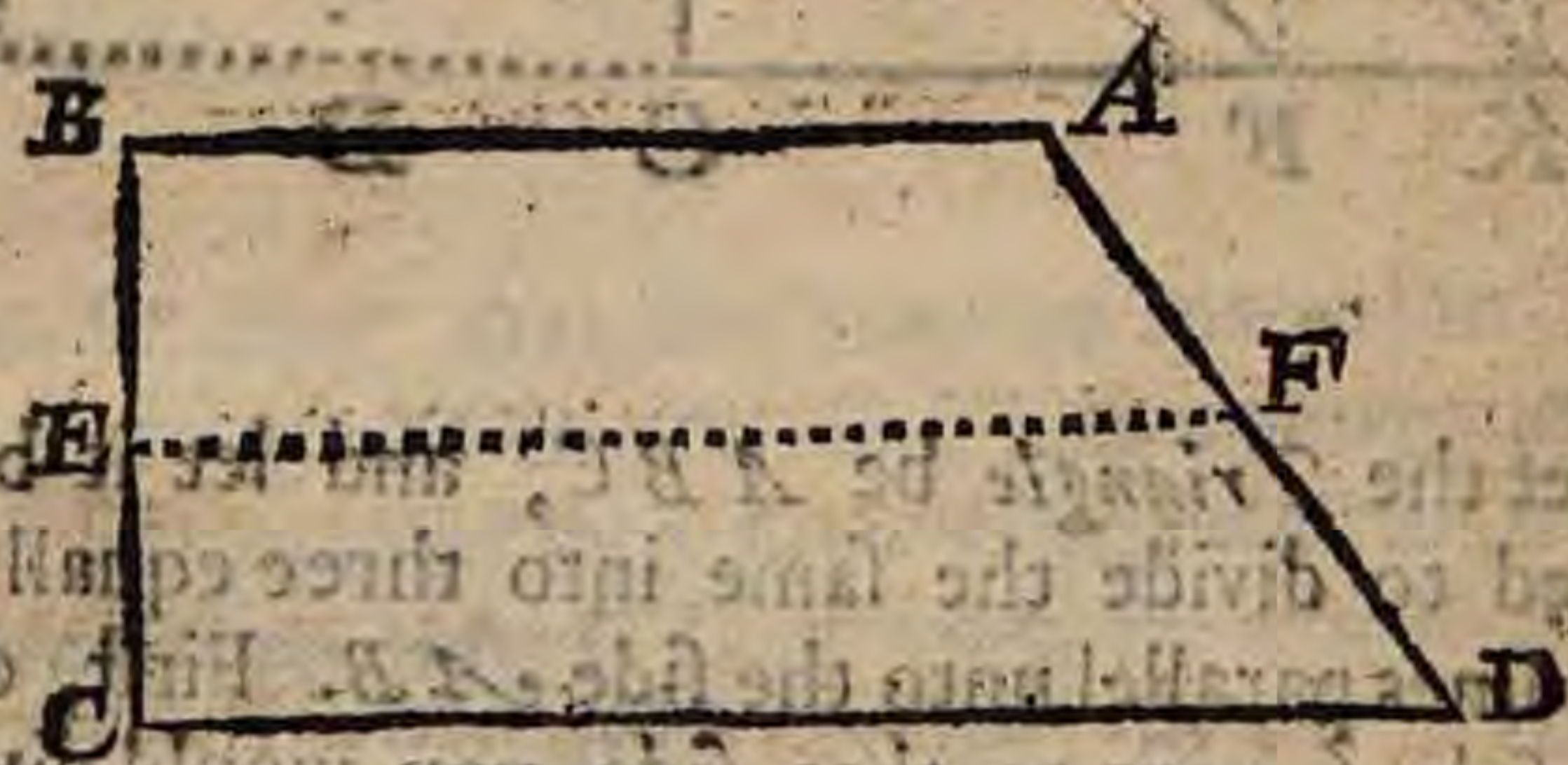
To divide an irregular plot as $BCDEFAB$, into two parts with a Line passing by a point within as OG , so that the part, $CDEVFOW$, be to $BWOFVAB$, as 10 unto 8. The question is how this may be done Geometrically.

Con

Prop. 18.

Two Brethren have a piece of Land, as $ABCD$, BA is 24 and CD 36 parallel thereto, the Angle at C is a right Angle BC is 16, and AD , is 20.

This piece of Land must be divided into two equall parts with a Line from the middle between B and C . viz. at E . The question is what breadth each part must have at the other end to make the parts equall.



Adde AB 24. and DC 36, together, which makes 60. Then as 60 to AD 20, so BA 24, to DF 8. Or as 60 to 20, so 36 to FA 12. and so must the side AD 20 be divided, viz. AF 12, and FD 8. to make the parts equall as was required.

Prop. 19.

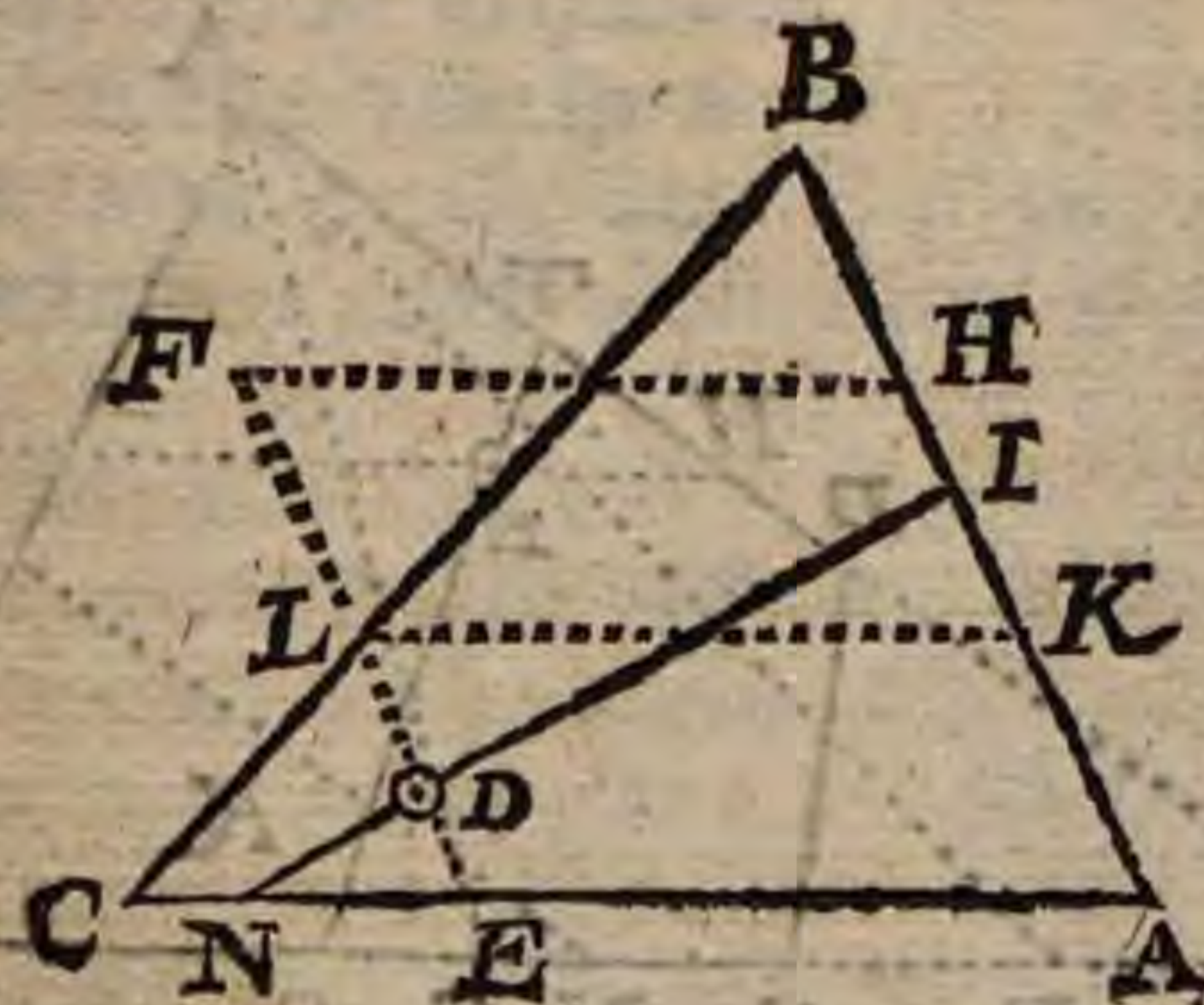
There is a piece of Land, as $ABCD$, Rectangled at B . AB is mesured 10, BC 32, DC 25, and AD 13. It is required to divide this Land into two equall parts by a Line parallel to the Line DC . The question is how much shall ED and FC . be.

First,

First, seeke how much the Perpendiculars DG . and AH are, and also DH . you will finde DG 15. DH 5. and AH 12: then as HD 5. to AH 12. So DG 15. unto KG 36; Having these Lines you may seeke the *Area* of the whole piece of Land, which is 300. the halfe whereof 150; the content of the *Triangle* KDC is 420. from whence take 150. and there remains 270 the *Area* of the *Triangle* KEF ; Then say if 420 give the square of KC 3136. 270 will give 2016. for the square of KF . whose root is 44.9. which substracted from 56 the root of the square of KC . there rests 11. 1. for FC . in like manner seeke ED . which you shall finde 6.32, as was required.

Prop. 20.

There is a *Triangular* piece of Land, as ABC , of unequall sides and *Angles*. It is required to be divided into two equall parts by a Line or Ditch, passing by a point within the same, as D . The question is how this may be done *Geometrically*?

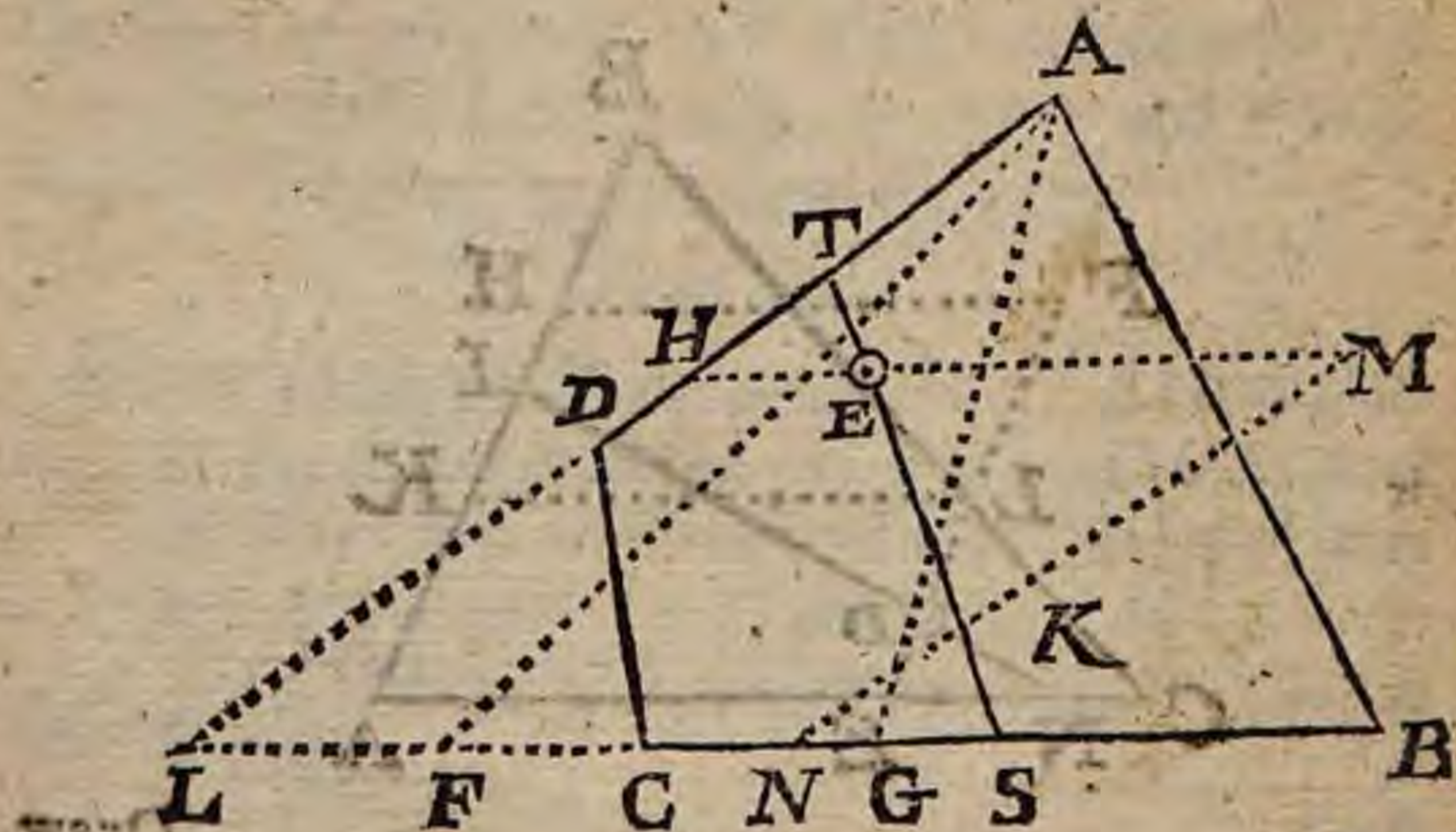


Dra

Draw first a Line through the point D , parallel to the side BA . viz. $FLDE$, make the *Quadrangle* $HAEF$, equall to the *Triangle* ABC , divide this *Quadrangle* into two equall parts by the Line LMK . Now seeing the *Triangles* IKM , MLD , and DEN are all of like proportion (as may appeare by their *Angles*;) Therefore from the square of DL , substract the square of DE , and there will remaine the square of IK ; The length of the Line IK being known, you may draw the Line NDI , which shall divide the *Triangular* piece of Land into two equall parts passing by the point D as required.

Prop. 21.

There is an irregular piece of Land formed as $ABCD$, belonging unto two men, who are desirous to have the same divided into two equall parts, and to have the Line of division passe through a pond, or lake in the same, viz. E . that both may have the benefit of the water.



Ex-

Extend the sides AD , and CB , untill they meet and make a *Triangle*; The *Triangle* made by the Line AEF divide into two equall parts with the Line AG , draw the Line HM , by E , and parallel to LB , and make the *Quadrangle* $HMLN$, equall to the *Triangle* AGL , in such sort that MN , be parallel to HL , then draw the Line TS , through the given point E , so that the *Triangles* EHT , and SKN , be together equall to EMK alone; Then is the *Triangle* SLT . equall to the *Quadrangle* $MHLN$, and equall to the *Triangle* AGL , wherefore if we take away from the *Triangle* TSL , the *Triangle* DCL , then is $TS CD$, the one halfe of the *Quadrangle* $ABCD$, and $TSBA$, the other halfe, the thing required.

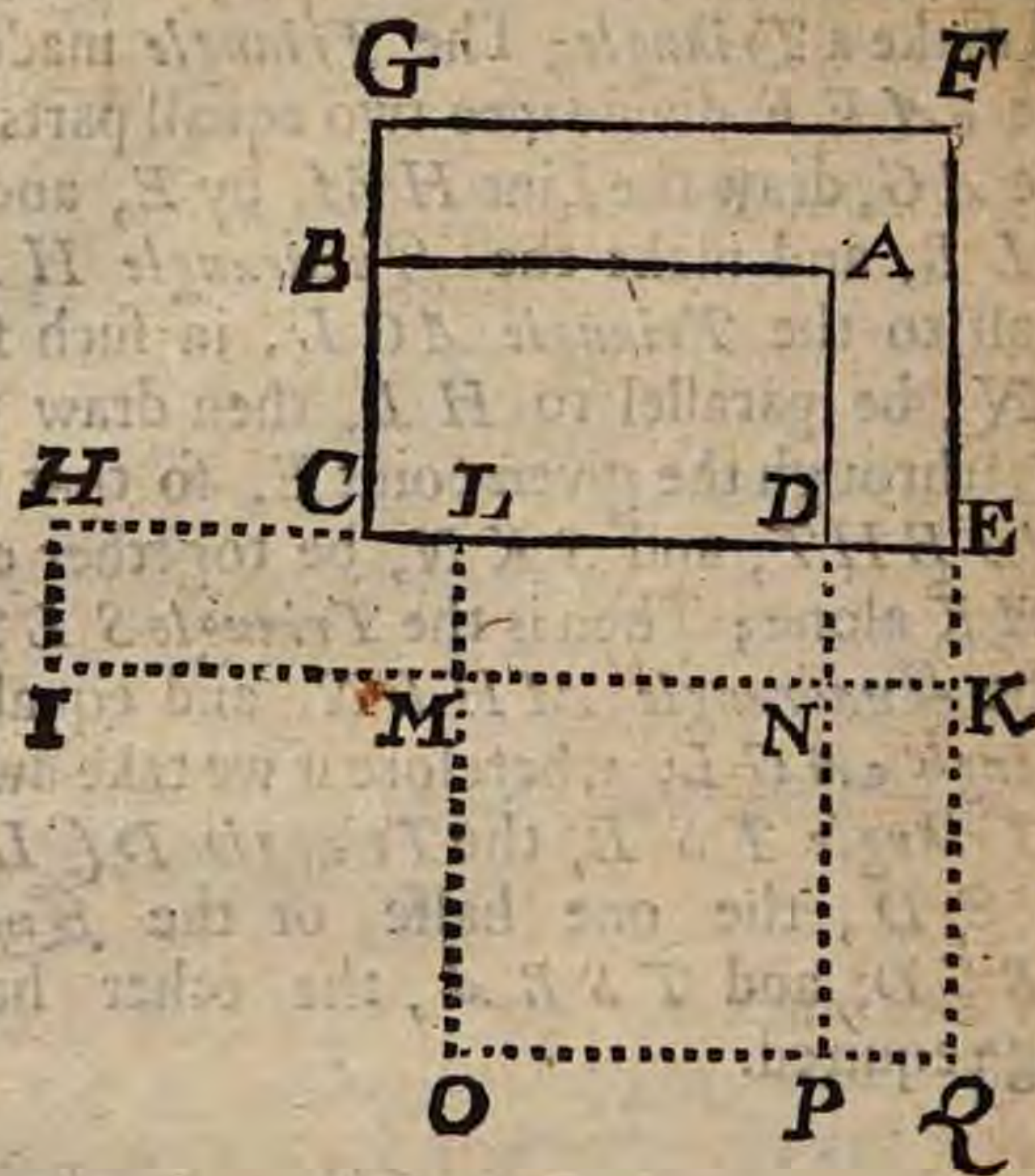
Prop. 22.

There is a Rectangled piece of Land as $ABCD$, whose length is 16, and breadth 10. about which it is required to make a Fish-pond or Moat, to be in quantity 120. as DAB , $G FED$ (in the Example:) BA and AD are to be parallel unto GF and FE . The question is, how much shall DE or BG , be.

M

Extend

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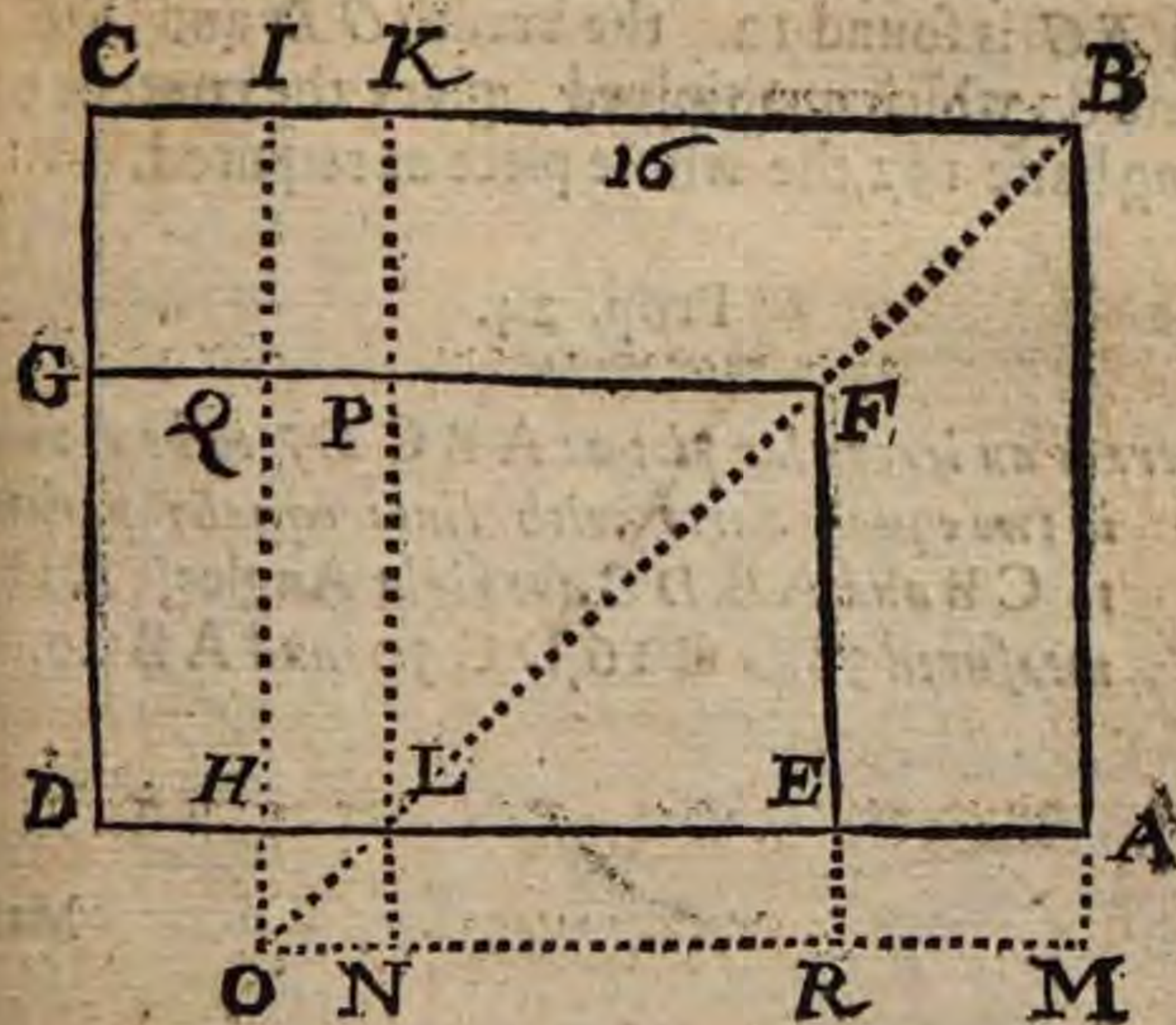


Extend DC so much longer than your plot as AD , then is DH equal to DA and AB added together, viz 26. Let EK be equal to ED , then is the parallelogram $EHIK$, equal to the Fish-pond $EDABGF$ and 120. Now divide $DIHN$ into two equal parts by the Line LM . Then is LD or LH 13. make $KNPQ$ equal to $LHIM$ and then is the Gnomon $QPNMLDEKQ$ also 120. And seeing that QK is equal to LH . viz. 13. adde the square thereof 169. to 120. the content of the Gnomon, and it makes 289. for $ELOQ$; whose root is 17. for EQ . the side of the square, from hence subtract 13. being KQ and there will remaine 4. for EK ,

EK , and so much is ED , and BG the thing required.

Prop. 23.

There is a right angled piece as $ABCD$, whose length is 16, and breadth 12, this piece is to be divided into two equal parts with lines equally distant from CB and BA , as GF and FE , the Quadrangle, $GFFE$ being for a Garden, and $CBAEFGC$ for a Copse or Wood to environ two sides thereof. The question is how much must be AE and CG .



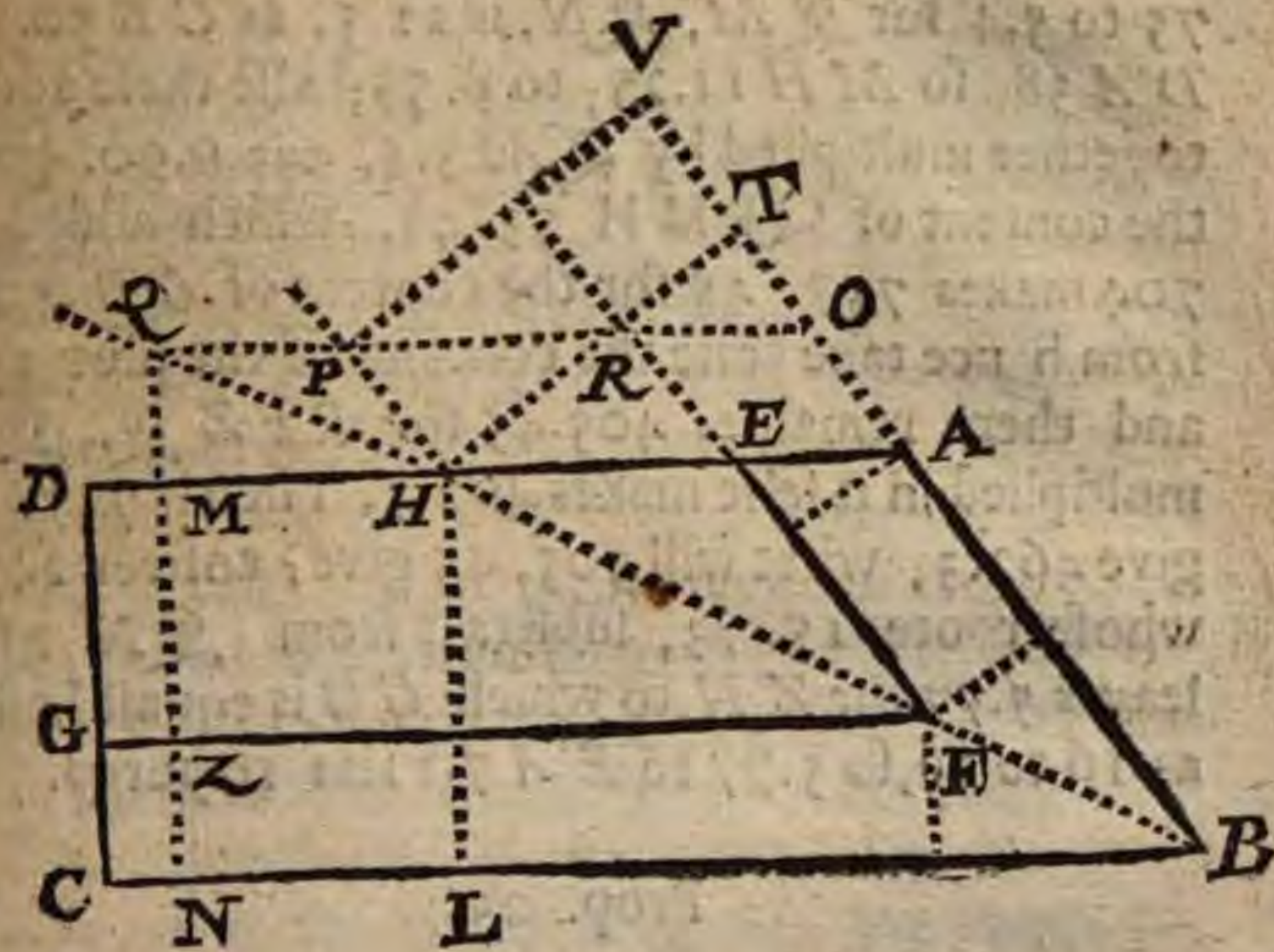
Draw the square $ABKL$, whose sides are 12, then will KC and LD be each 4. take halfe KL

$KLDC$ which is $IHD C$, and joyne it to AL , then is $ALNM$ equall to halfe $CKDL$, then is wanting of the square $BIO M$ the little square $LOHN$, then let us take it that the quadrangle $EFGD$ is halfe the content of $ABCD$. viz. 96. There is taken from $EFGD$ the part GDH , and that joyned to EL , and $ELNR$, is equall thereto, so that $RFHLNR$ is yet equall in content to $EFGD$ 96. now adde $LHON$ (which being the sides two makes 4) unto 96. and it makes 100. whose root is 10 for the side RO , to this 10 adde 2 and there is 12 for ED , also take LH two from EH and rests EL 8. which is equall to EF or DG ; The length of ED and FG is found 12. the bredth GD and FE is found 8, which multiplied, gives the content 96. being halfe 192. the whole piece as required.

Prop. 24.

There is an irregular plot as $ABCD$, to be divided in two equall parts with lines equally parallel to CB and AB . DC are right Angles, AD is measured 38. DC 16, BC 50. and AB 20.

Make

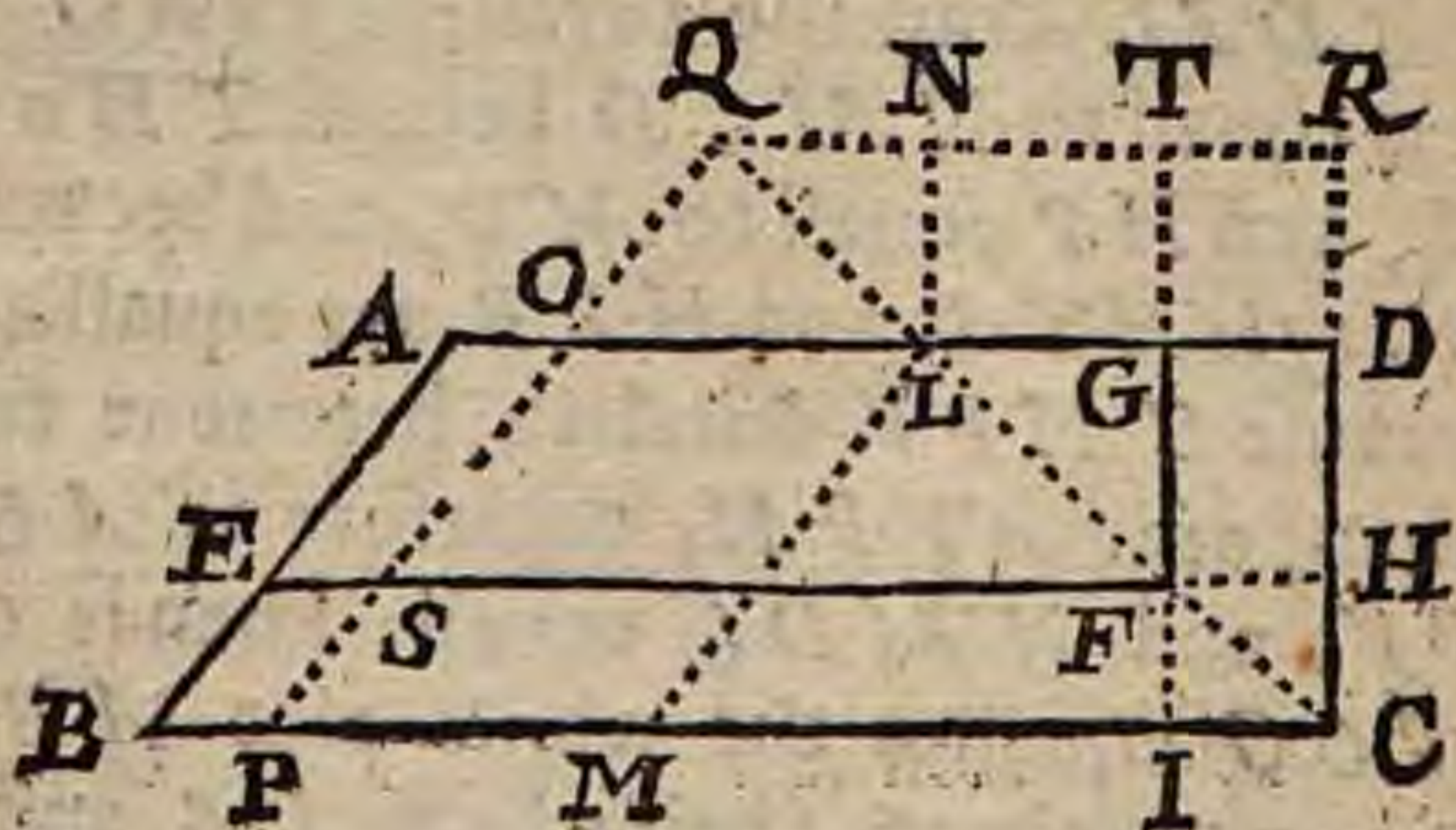


Make AH equal to AB , draw BH so that the Angle at B be equally divided, then is DH 18, and HA 20. HD must be so divided that HM , be to MD , as BL , to BA , LC being equal to DH . viz. 18. LB will be 32. then as 32 to 20, so 18 to 11.25 for MH , which subtracted from 18 leaveth 6.75 for DM , draw the parallelogram $OAPH$ which is equal to $NMCD$ because TH is equal to HL , and HP equal to MD , and because that the Triangle HTB and HLB are equall angled, and because $THPV$ standeth betweene two parallel lines, viz. $AVPH$, therefore is $AOPH$, $THPV$, and $NMDC$ equal; Then is $OBNMHP$ equal is the whole plot $ABCD$, viz. 704. multiply 26 (being halfe LB and HA added together) by 16. and the product 416 is the

content of $ABLH$, then say as 20 to 16, so 6.75 to 5.4 for QM , QN , is 21.5, as CB 50. to DA 38, so MH 11.25, to 8.55, halfe these added together multiplied by QM 5.4, viz. 9.90. gives the content of $QPMH$ 53.45, which added to 704 makes 757.45 for the content of $OBQN$, from hence take halfe the content of the plot 352, and there remains 405.45 for $RFZQ$, QN multiplied in it selfe makes 462.3, Then if 757.45 give 462.3, what will 505.45 give? answer 247.4 whose roote 15.73, subtract from QN 21.5, leaves 5.77 for ZN , to which GC is equall. Lastly, as 16 to 20, so 5.77 to EA 7.21. as required.

Prop. 25.

There is a plot of Land as $ABCD$, the sides are BC 50. AD 38, AB 20. and DC 16. D and C rectangles, it is required to be divided in two equall parts with lines equally parallel unto BC and DC . The Question is how much is BE , and GD .



Take

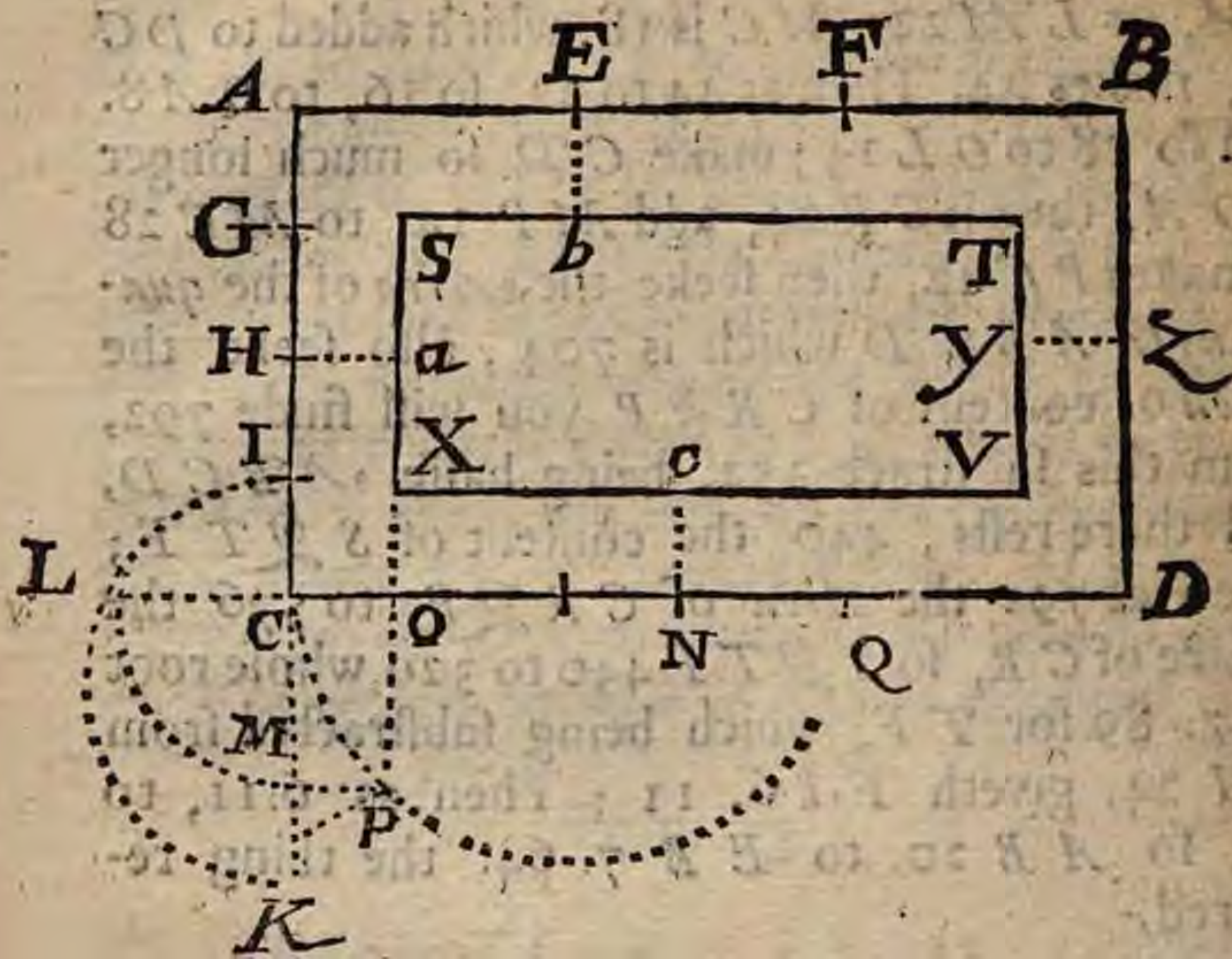
Take DC 16. from DA 38, and there rests for LA , or LM 22. MC is 18, which added to DC 16, makes 44. Then as 44 to 22, so 16, to OA 8. and so 28 to OL 14; make CD so much longer as OA , then is CR 24, add MP 14, to MC 28 it makes PC 42, then seeke the Area of the quadrangle $ABCD$ which is 704, also seeke the Area or content of $CRQP$ you will finde 792, from this subtract 352, being halfe $ABCD$, and there rests, 440, the content of $SQTF$; Then as 792 the Area of $CRQP$, to 576 the square of CR , so $SQTF$ 440 to 320, whose root is 17.89 for TF , which being subtracted from TI 24, giveth FI 6.11; Then as 6.11, to 16, so AB 20. to EB 7.64. the thing required.

Prop. 7.

A quadrangular piece of Land as $ACDB$, is required to be divided into two unequal parts, in such wise that the part cut off round about, be equally distant and parallel unto AB , AC , CD , and BD , & to containe in quantity one third part of the whole plot. The question is how long is YZ Ha and likewise Eb , and Nc .

M 4

First,



First, divide the length AB into such parts as the whole plot is to be divided into, as in this into three, divide the breadth into 4 parts as $AGHI$, make CK equall to AE , of the length AB , draw then the *Semicircle* ILK , whose Center is one AC , draw the arch ML upon C , then is LC a meane proportionall betweene IC and CK . divide CD into two equall parts, *viz.* N . unto which adde LC and it will come to Q . then let CQ be the *Diameter* of the halfe Circle CPQ . draw the line MP parallel to CD untill it touch the *Semicircle* CPQ , then is MP the length of Ea . H a . YZ . and c N . as was required

How to lay out severall quantities in common Fields unto severall Tenants.

YOU must (according to the direction before given) plot the whole Field, common, or other severall, with his particular bounds as you observe them in the *Survey* of the whole Mannor, or if you onely *Survey* that paticular, you must take speciall notice of all the bounds thereof: then provide a particular booke or paper, which must be ruled or divided into ten columns; in the first whereof, towards the left hand is to be written the Tenants Names and the Tenour by which they hold the same; the next three columns are to containe the breadth of every mans parcell of Land, noted over the head of every column with these three *Characters* 0.1.2. answering unto the severall divisions of your Chain, 0 signifying unites, 1. Signifying *Primes*, and 2 signifying seconds. In the next three columns is expressed the length of every mans parcell of Land, having the like Characters of Unites, Primes, and Seconds, over the head of each column as that of the breadth had. In the three last columns is to be expressed the quantity of each tenants parcell.

In the laying out of severall parcels in this kind, you will have use onely of the Chaine: then when you begin your worke, you must first write the name of the Field, and in the first column of your booke or paper, you must write the Tenants name, and

and the tenour by which he holds the same, from what place you begin to measure, and upon what point of the Compasse you passe from thence, and observing this direction in all the rest, you may (if you will) bound every parcell. This being noted in your booke, observe the species or shape of the furlong; whether it be all of one length or not, if all of one length, then you neede take the length but once for all: but if it be irregular, that is, in some places shorter and in others longer; then you must take the length thereof at every second or third breadth, and expresse the same in your booke under the title of lengths. As for the expressing of the severall breadths, you need but to crosse over the whole furlong, taking every mans breadth by the middle thereof, and entring the same as you passe along: but in case there be a considerable difference at either end, then I would advise you to take the breadth at either end, and adde them together into one sum; then take halfe of that sum for your meane or true breadth, and enter it in your book or paper under the title of breadth.

After this manner may you proceede from one furlong to another till you have gone through the whole Field; which when you have done and noted downe the severall lengths and breadths in your booke, you may multiply the length into the breadth of every parcell, as is taught in the next Chapter: & so shall you have the quantity of every parcell by it selfe; which quantity must be noted down in the three last columns of your book, as in the following example appeares.

Lepham

Lepham Field.

Tenants Names	Breadth.	Length.	Quantity.
<i>William Smith from the backlane Eastward, free.</i>	0 1 2	0 1 2	A R P
<i>John Esom for two Lives.</i>	6 8 2	16 2 0	0 2 30
<i>James Milson by Copy.</i>	1 3 2	16 2 0	0 0 21
<i>Nicholas Wilde at will.</i>	5 6 3	15 4 2	0 2 7
	8 4 1	14 2 3	0 3 0

CHAP.

CHAP. XLVII:

Shewing how to adde and substract, to multiply and divide the severall fractions of your Chaine, as if they were whole numbers.

Suppose you were to multiply 16 Unites, two Primes (which is the length of your first parcell in the foregoing Table,) by 1 Unite, 3 Primes, 2 Seconds, which is the breadth of the same parcell; you must place your numbers in all respects as if they were whole numbers: but over every fraction of your multiplicand you must place a prick, or point, as in this Example. The multiplicand contains onely one Fraction, which is two, over which two place a prick, or point, and at the end of your multiplier place as many points as there are fractions contained in that number, which in our Example are two, viz. 3. and 2. behind which figures I place two pricks, and the numbers will stand thus, under which draw a line, and multiply these two numbers together in all respects as if they were whole numbers, and then the worke will stand thus, the product of your multiplication being 21384. Now because in your numbers, viz. your multiplicand, and your multiplier, there are three fractions, namely, one in your multiplicand, and two in your multiplier; you must therefore with a dash of your pen cut off the three last Figures of your Product towards your right hand, and then will your product stand thus. 21 | 384.

$$\begin{array}{r}
 162 \\
 132.. \\
 \hline
 324 \\
 486 \\
 162 \\
 \hline
 21384. \\
 \text{The}
 \end{array}$$

The three last Figures whereof are the numerator of a fraction, whose denominator is 1000. and the other two Figures towards your left-hand are integers of your multiplication; so that the sum of this multiplication is 21 Perches, $\frac{384}{1000}$ parts of a Perch, which is something more then a third part of a Perch.

But for your better practice take another Example, which let be the third in the foregoing table, when the breadth is 5 Unites, 6 Primes, 3 Seconds, and the length 15 Unites, 4 Primes, and 2 Seconds; which being placed according to the former directions they will stand thus.

$$\begin{array}{r}
 1542 \\
 563.. \\
 \hline
 4626 \\
 9252 \\
 7710 \\
 \hline
 868146
 \end{array}$$

Now if you multiply these one by another as if they were whole numbers, then they would stand thus, the Product being 868146 from whence taking the foure last figures, (because there are foure fractions in your two numbers, there remains 86 Perches, and $\frac{8146}{10000}$ parts of a Perch.

In like manner, suppose you were to finde the quantity according to the second row in the foregoing Table, the breadth being 1 Unite, 3 Primes, 2 Seconds, and the length, 16 Unites, 2 Primes, which must be placed thus, and being multiplied as whole numbers will stand thus, and produce this Product, 21384. from whence cut off the three last figures (because there were three fractions in your numbers multiplied) and there will remaine 21 Perches, and $\frac{384}{1000}$ parts of

$$\begin{array}{r}
 132 \\
 162. \\
 \hline
 132 \\
 162. \\
 \hline
 264 \\
 792 \\
 132 \\
 \hline
 21384
 \end{array}$$

You may in like manner divide Integers, and Fractions, by Integers, and Fractions, as if they were whole numbers; and then cut off so many Figures as you have points in your Divisor, and dividend; but you will not have so frequent use of division, as multiplication; and therefore I forbear an Example.

When you adde severall parcels together, you must set the last Figures of the Integers, (of all of them) directly under each other, and then adde as in whole numbers, and so in subtraction: Bee sure the prime line, or line that seperates the Integers, from the Fractions, be placed in one ranke. For example, the three quantities in the foregoing rule being to be added together, must stand thus, and after you have added them together, you will have 139 *Perches*, and $\frac{5826}{15550}$ parts of a *Perch*. So likewise in subtracting the two last one from another; the remainder will be 65 *Perches*, and $\frac{4346}{10000}$ parts of a *Perch*; but if you are onely to expresse the quantity of one single piece, and regard not more exactnesse, than *Perches*; if the Figures to the right hand be lesse than 500, &c. you may neglect them; and if they be more than 500, &c. you must adde one more Integer to the number of *Perches*.

CHAP.

CHAP. XLVIII.

Shewing how to reduce Perches into Acres, and the contrary.

According to the Statute of 33 *Edm. I.* an *Acre* of ground ought containe 160 square *Perches*, and in every *Rood* of Land 40 square *Perches*: Therefore if any number of *Perches* be given to be turned into *Acres*, you must divide the number given, by 160 (the number of *Perches* contained in an *Acre*.) and the quotient shall shew you how many *Acres* are in that number of *Perches*: but if any thing remaine (if it be under 40) it must be *Perches*; but if the remainder exceeds 40, then you must divide it by 40 (the number of *Perches* contained in one *Rood*.) and the quotient shall be *Roods*, and the remainder shall be *Perches*.

Example.

Let 5267 *Perches* be given to be reduced into *Acres*, first divide 5267 by 160. and the quotient will be 32. and 147 remaining, which divide by 40. the quotient will be 3. and 27 remaining, so that the whole amounteth to 32 *Acres*, 3 *Roods*, and 27 *Perches*.

In like manner, let 5496 *Perches* be given to be turned into *Acres*; First divide 5496 by 160, the quotient will be 34. and 56 remaining, which 56. being divided by 40. the quotient will be 1. and 16 remaining, so that the whole will be 34. *Acres*, 1 *Rood*, and 16 *Perches*.

Hor

How to reduce Arches and Perches.

This is but the converse of the former; for whereas before, to bring *Perches* into *Acres*, you divided by 160. you must now, to turne *Acres* into *Perches*, multiply by 160.

Example.

Let 32 *Acres*, 3 *Roods*, 27 *Perches*, be given to be reduced into *Perches*; first multiply the 32 *Acres* by 160, and the product will be 5120, then multiply the 3 *Roods* by 40. the Product is 120. these two products, and the 27 *Perches* being added together, the sum will be 5267, and so many *Perches* are contained in the fore-said number of *Acres*, *Roods*, and *Perches*.

5120
120
27
5267

CHAP. XLIX.

How to reduce Statute measure, to customary measure, and the contrary.

According to the forenamed Statute of 33 Ed. I. an *Acre* of ground was to containe 160 square *Perches*, measured by the *Pole* or *Perch* of 16 foot and halfe, but in many places of this *Nation*, through long custome, there have been received other quantities called customary, as namely 18. 20. 24. and 28 foot to the *Pole*, or *Perch*.

It

It is therefore of extraordinary use for a *Surveyor* to know, how readily to reduce customary measure to Statute measure, and the contrary.

Which to performe, it is requisite, first that you reduce your given quantity into *Perches*; as is before taught. Then, when you would reduce cu-

statutory measure, as	18	foot to the <i>Perch</i> , or <i>Pole</i> , into statute measure of sixteene foot, and a halfe to the <i>Pole</i> , multiply the given quantity of <i>Perches</i> by	11901
	20		1692
	21		16198
	24		21154
	28		28802

And from the product cut off 4 figures to the right-hand and those to the left-hand are *Perches*, at sixteene foot, and a halfe, and those to the right-hand are parts of a *Perch*, the whole being 10000.

N

And

And contrarily.

When you would reduce Statute measure into customary, of

18
20
21
24

28

foot to the *Perch*, multiply the given quantity in *Perches*, by

8403
6806
6173
4619

3472

and from the product cut off foure figures to the right hand, which are a Fraction lesse then a *Perch*, (as in the other,) and those figures to the left hand, are the number of *Perches* according to

18
20
21
24

28

foote to the *Pole*.

Or by the *Logarithm's*, thus.

When you would reduce customa- ry, as of

18
20
21
24

28

foot to the *Pole*, into Statute measure of sixteen foot, and a halfe, adde the *Logarithme*

0,075578
0,167092
0,209471
0,325400

0,459348

Unto the *Logarithme* of the given quantity, and you have the *Logarithme* of the quantity in Statute measure.

On

On the contrary.

When you would reduce Statute measure into customary, of

18
20
21
24

28

Foote to the *Pole*, adde the *Logarithme*

0,924422
0,832908
0,790529
0,674546

0,540652

Unto the *Logarithme* of the given quantity, and you have casting away 1000000. the *Logarithme* of the quantity in customary measure of,

18
20
21
24

28

Foot to the *Pole*.

Example.

Let 5 Acres, 2 Roods, 20 *Perches*, according to 18 foot to the *Pole*, or *Perch* be given, and the quantity thereof in statute measure at 16 foot and a halfe required.

Reduce the given quantity into *Perches*, which are 900. then in the first part of the foregoing Table, you have over against 18, 11901, which multiplied by 900, is 10711900; the 1071, to the left-hand, are so many *Perches*, and the 0900.

to the right-hand, are parts of a *Perch*, the whole being 10000. which being reduced into *Acres*, giveth 6 *Acres*, 2 *Roods*, 31 *Perches*, and $\frac{2}{100}$ parts of a *Perch*, for the quantity according to Statute measure.

Example the second.

Let the same quantity 5 *Acres*, 2 *Roods*, 20 *Perches*, be given in Statute measure, which is in *Perches* 900, as before, and let it be required to find the quantity thereof at 18 foote to the *Pole*; In the second part of the Table over against 18. you have 8403, which multiplied by 900, amounteth to 7562700, which reduced into *Acres*, giveth 4 *Acres*, 2 *Roods*, 36 *Perches*, and $\frac{27}{100}$ of a *Perch*; for the quantity at 18 foot in the *Pole*.

And likewise, if you will worke by the *Logarithmes*; the *Logarithme* of 900, (the quantity of *Perches*, in the first *Example*) is, 2,954242, to which adde 0,075578, the *Logarithme* in the first part of the Table over against 18. and it makes, 3,029821, the *Logarithme* of the quantity 1071; &c.

Againe, unto 2,954242 adde, 0,924422, the *Logarithme* over against 18, in the second part of the Table; and it makes casting away 1000000. 2,878665, the *Logarithme* of the quantity in the second example. Thus may you reduce all the other measures, unto Statute measure, and the contrary, as 20,24. &c.

Shewing the use of a Table to reduce Irish Acres of 21 foote to the Pole, into English Statute Acres of 16 foot and a half to the Pole, and the contrary.

When you would reduce Irish Acres, into English Statute Acres, seeke your number of Acres, in the first part of the following Table, toward the right hand in the lesser column intituled Irish Acres, and over against the same in the greater columns, you have the same reduced into English Statute Acres, Roods, Perches, and 100 parts of Perches.

If you would reduce English Statute Acres, into Irish Acres, seeke your number of Acres, in the column intituled English Acres, toward the left hand, and over against the same you have Acres, Roods, Perches and parts, in Irish measure.

The Table proceedeth decimally; wherefore if your number of Acres to be reduced, consist of 1000. 100. 10. &c. Take the Acres, Roods, Perches &c. against each: and adde them together.

Example.

If it be required to reduce 986 Irish Acres, into English Statute measure. In the lesser column to the right hand, for Irish Acres, seeke for 900. and against the same you finde 1457 Acres, 3 Roods, 16 Perches and 20 hundredth parts of a Perch; Againe, seek 80. in that column, over against which,

you will finde 129 Acres, 2 Roods, 13 Perches; and 88 hundreths: also, seeke for 6 in the same columnne; and you have against it 9 Acres, 2 Roods, 35 Perches and 04 hundreths. These added together, (remembering that the Fractions of Perches, are hundreths, and that 40 Perches is a Rood, and 4 Roods an Acre) make 1597 Acres, 25 Perches and 12 hundred parts of a perch, and so much is 986 Irish Acres, at 21 foot to the Pole, in English Statute Acres, of 16 foot and a halfe to the Pole.

	A.	R.	P.	Par.	
Acres	{	900	1457	—3—	16—20.
		80	129	—2—	13—88.
		6	9	—2—	35—04.
		986	1597	—0—	25—12.

When you have a quantity to reduce, that consisteth of Acres, Roods, and Perches, you must take out of the second, and third parts of the table, the answerable quantities, and adde all together: and note that in that part for Perches, the small columnne for equall Perches, serveth unto both the other, as occasion shall serve.

Example 2.

If it be required to know how many Acres, &c. of Irish measure, is contained in 488 Acres, 2 Roods, and 23 Perches, of English Statute measure; first, overagainst 400. in the columnne for English Acres you have 246 Acres, 3 Roods, 30 Perches, 20 hundereth parts of a Perch: overagainst 80. in the same

same columnne, you have 49 Acres, 1 Rood, 22 Perches, and 04 hundreth parts: And against 8. you have 4 Acres, 3 Roods, 30 Perches and 20 parts: and then in the second part of the Table under English Roods, against two, you have 00 Acres, 1 Rood, 9 Perch, 39 parts. And in the third part of the Table for Perches, against 23. Perches, you have 14 Perches, and 20 parts. These all added together, make 301 Acres, 2 Roods, 26 Perches and 30 parts of a Perch.

	A.	R.	P.	Par.	
Acres	{	400	246	—3—	30—20.
		80	49	—1—	22—04.
		8	4	—3—	30—20.
Roods, 2.		—1—	09—39		
Perch 23.			—14—	20.	
<hr/>					
	301	—2—	26—	30	

N 4

A Table to reduce Irish Acres of 21 foot to the Pole, into English, Statute Acres of 16 foot to the Pole, and the contrary

Eng. Acr.	Irish at 21.0				Iri. Acr.	English at 16 1/2			
	A.	R.	P.	par.		A.	R.	P.	par.
2000	1237	2	31	0	2000	1237	2	17	10
1000	617	1	15	51	1000	1619	3	13	55
900	555	2	17	96	900	147	3	16	20
800	493	3	20	41	800	1295	3	18	84
700	432	0	22	86	700	1123	3	21	49
600	370	1	25	31	600	971	3	24	13
500	308	2	27	76	500	809	3	26	78
400	246	3	30	20	400	647	3	29	42
300	185	0	32	65	300	485	3	32	07
200	123	1	5	10	200	323	2	34	71
100	61	2	37	55	100	161	3	37	36
90	55	2	09	80	90	145	3	05	62
80	49	1	22	04	80	129	2	13	88
70	42	0	34	29	70	113	1	22	15
60	37	0	06	53	60	79	0	30	41
50	30	3	18	78	50	80	3	38	68
40	24	2	31	02	40	64	3	06	94
30	18	2	03	27	30	48	2	15	21
20	11	1	5	11	20	32	1	23	47
10	6	0	27	76	10	16	0	31	74
9	5	2	00	98	9	14	2	12	56
8	4	3	30	10	8	12	3	33	39
7	4	1	11	43	7	11	1	14	21
6	3	2	32	65	6	9	2	35	04
5	3	0	13	88	5	8	0	15	87
4	2	1	35	10	4	6	1	36	69
3	1	3	16	33	3	4	3	17	52
2	1	0	37	55	2	3	0	38	35
1	0	2	18	78	1	1	2	19	17

The Second Table for Roods.

En. Ro.	Irish at 21				Iri. Ro.	English at 16 1/2			
	A.	R.	P.	par.		A.	R.	P.	par.
1	00	0	14	6	1	00	1	14	79
2	00	1	09	2	2	00	3	09	59
3	00	1	34	0	3	01	0	34	38
4	00	2	18	78	4	01	2	19	17

The third part of the Table for Perches.

Irish. Per.	Irish. Per. par.	English. Per. par.	English. Per. par.	Irish. Per.	English. Ro. Pe. pa.	
1	00	62	01	61	21	12 96 0 34 02
2	01	23	03	24	22	13 58 0 35 6
3	02	85	04	86	23	14 20 0 37 26
4	02	47	06	48	24	14 82 0 38 88
5	03	09	08	10	25	15 43 1 00 50
6	03	70	09	72	26	16 05 1 02 12
7	04	32	11	34	27	16 67 1 03 74
8	04	94	12	96	28	17 28 1 05 36
9	05	56	14	58	29	17 90 1 06 98
10	06	17	16	20	30	18 52 1 08 60
11	06	79	17	82	31	19 14 1 10 21
12	07	41	19	44	32	19 76 1 11 83
13	08	03	21	06	33	20 37 1 13 45
14	08	64	22	68	34	20 99 1 15 07
15	09	26	24	30	35	21 61 1 16 69
16	09	88	25	92	36	22 22 1 18 31
17	10	49	27	54	37	22 84 1 19 93
18	11	11	29	16	38	23 56 1 21 55
19	11	73	30	78	39	24 08 1 23 17
20	12	35	32	40	40	24 69 1 24 79

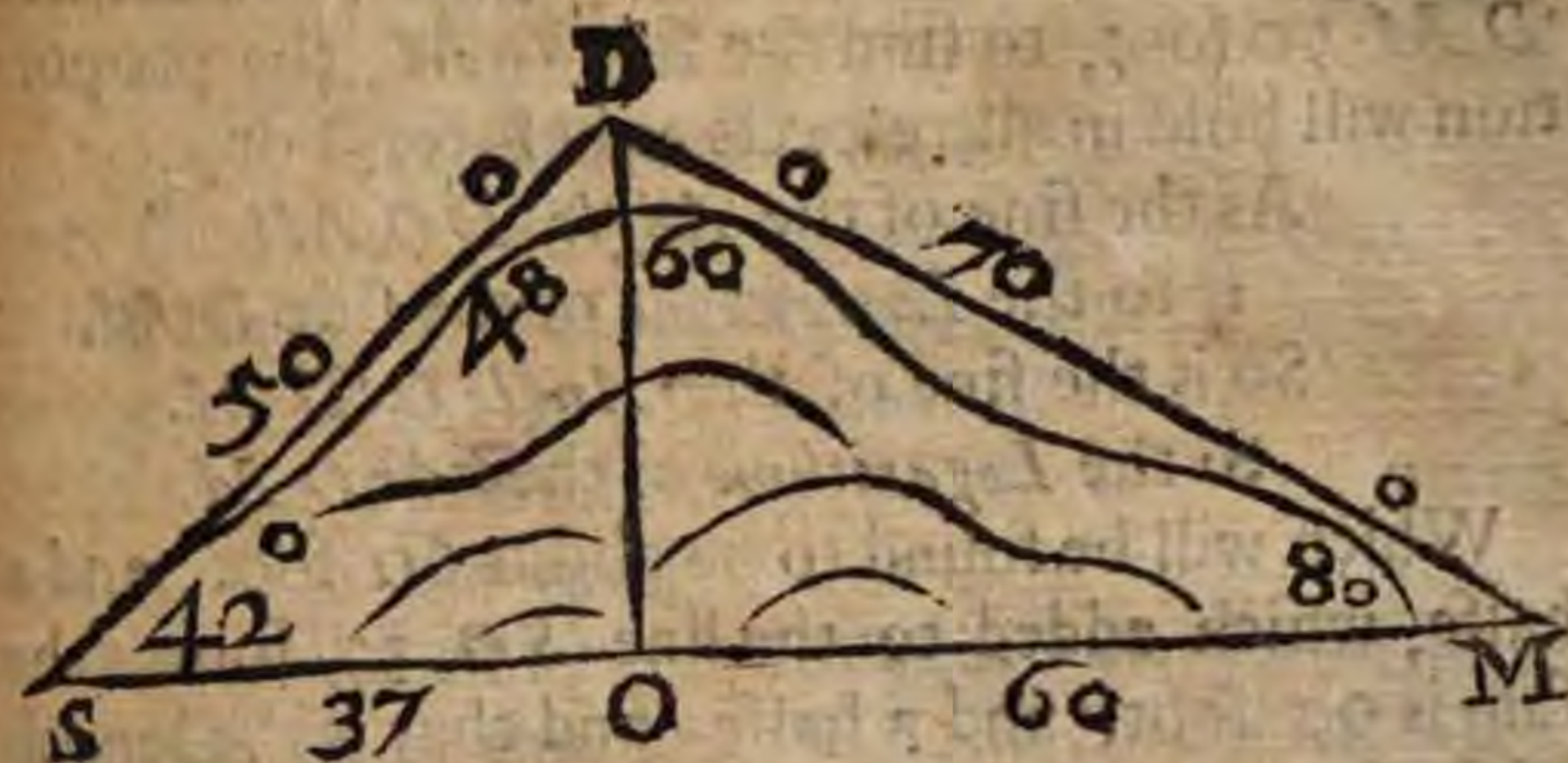
CHAP. LI.

How to finde the Horizontall line of any
Hill, or Mountaine.

This proposition differeth nothing, from those
before shew'd in the taking of
Altitudes.

Wherefore suppose you should meete with
the Hill, or Mountaine $S D M$. the thing
required is to finde the length of the line $S M$.
on which the Mountaine standeth. First, place your
Instrument at S . exactly levell; then let one go to
the top of the Hill at D . and there place a marke,
which must be so much above the top of the Hill,
as the top of the Instrument is from the ground
on which it standeth, then the *Quadrant* being
placed upon the *Index* of the *Table*, move it up
and downe till through the sights thereof you see
the top of the marke at D . then note the degrees
cut by the *Index* of the *Quadrant*, and that is the
quantity of the *Angle*

$D S O$.



$D S O$. which suppose 42 degrees, then by
consequence the Angle $S D O$, must be 48 degrees,
the complement of the former to 90 degrees;
then measure the side of the hill $S D$. which suppose
50 foot; Then in the Triangle $D S O$. you have
given, First; the side $D S$. 50. foot. Secondly,
the Angle $D S O$ 42 degrees. Thirdly, the Angle
 $S D O$ 48 degrees, together with the right Angle
 $D O S$ 90 degrees, and you are to finde the side
 $S O$ which to performe say; As the sine of the
Angle $D O S$. or the sine of 90 degrees, is to the
Logarithme of the side $S D$.

So is the sine of the Angle $S D O$. to the *Logar-*
ithme of the side $S O$. which will be found to be
about 37 foot.

Then because the Hill descends on the other side,
you must place your instrument at M . and make
like

like observation as before, observing the *Angle DMO* to be 30 degrees, and then by consequence the *Angle ODM* must be 60 degrees, and the side *DM* 70 foot, to find the side *OM*, the proportion will hold in all respects as before. For,

As the sine of the *Angle DOM*.

is to the *Logarithme* of the side *DM*.

So is the sine of the *Angle ODM*.

to the *Logarithme* of the side *OM*.

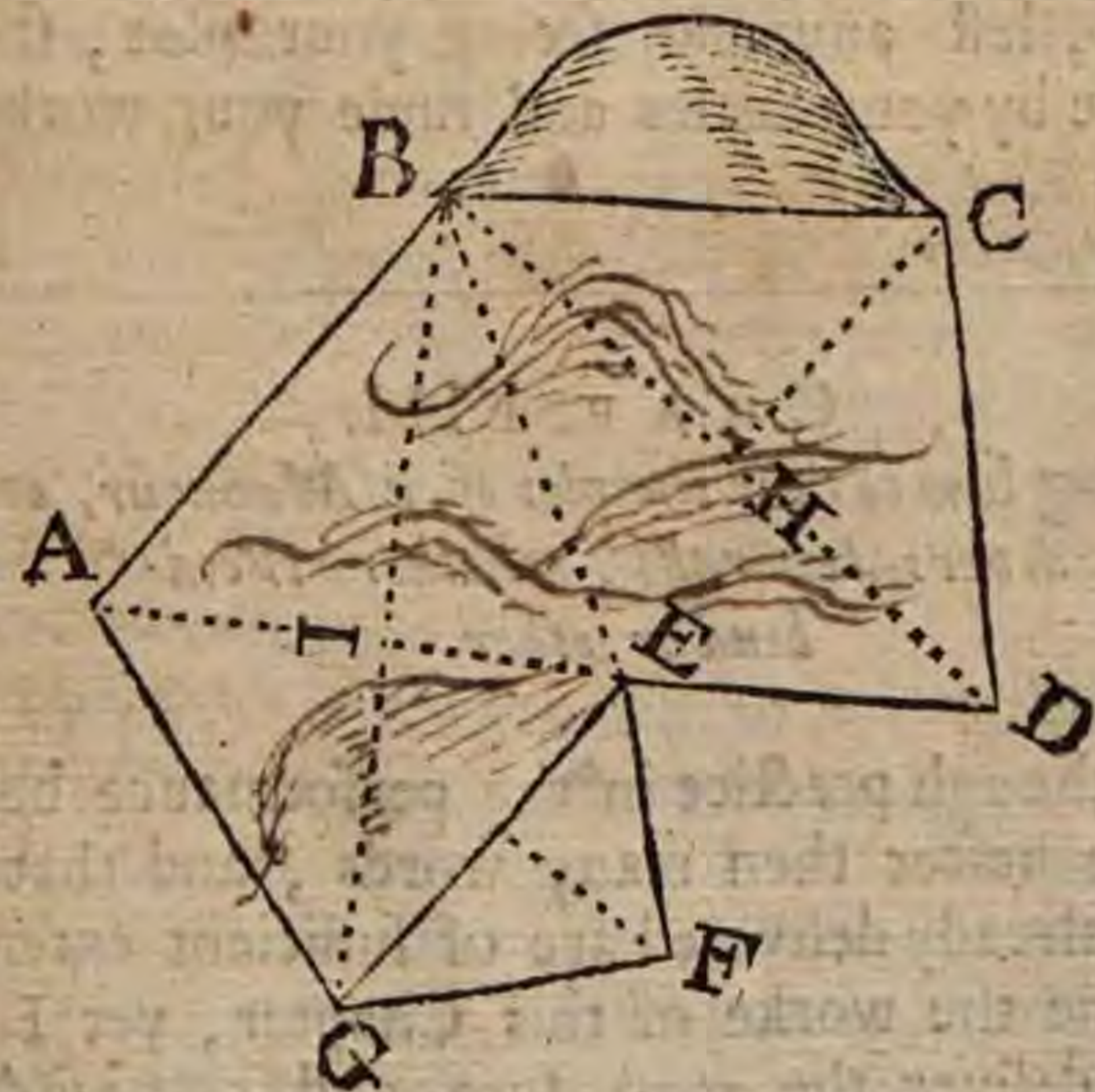
Which will be found to be about 60 foot, and a halfe, which added to the line *SO* 37 foot, the sum is 97 foot, and a halfe; and that is the length of the line *SM*, which line is to be protracted instead of the hypothenusall lines, *SD* and *DM*.

CHAP. LII.

How to protract, or lay down Montanous and uneven grounds, with the best way to finde the Area, or content of such irregulars.

Let *ABCDEFG* be a Montanous piece of ground to be measured. First, place your Instrument at *A*. and direct your sights to *B*. then measure the line *AB*. draw the same by the side of the Ruler upon the Table; then in regard that from *B* to *C* there is an ascent or Hill, you must finde the horizontall line thereof, and draw that line upon your Table, accounting thereon the length of the Hypothenusall line; Then measure round the Field, according to former directions, and

having the figure thereof upon your Table, reduce it into Trapeziums, as *ABEG*, and *BCDE*, and the Triangle *GEF*. then from the Angles *ACE*. and *F*. let fall the Perpendiculars. Now in respect there are many Hills, and Vallies all over the Field, you must measure with your chaine in the Field, over Hill and Dale, from *B*. to *D*. and to the line *BD*. set the number of *Perches* as you finde them by measuring, which will be much longer then the streight line *BD* measured on your Scale; then by helpe of your Instrument, finde the point *H* in the line *BD*. and measure with your Chaine from *C*. to *H*. over Hill, and Dale, as before, and to the Perpendicular *CH*. set the number as you finde it by the Chaine; then likewise



finde

finde the Perpendicular $I E$. and measure that with your chaine likewise, all which Lines (in respect of the Hills and valleys) will be found much longer then if they were measured by your Scale: Then by the measured Lines $B D$, $C H$, and $I E$, cast up the content of the *Trapezium* $B C D E$, and in this manner you must cast up the *Trapezium* $A B E G$, and the *Triangle* $G E F$, and this is the exactest way I can prescribe for the mensuration of uneven grounds, which being well, and carefully performed, will not vary much of the true content. For you must needs thinke that any hilly ground being pressed into a flat, would swell out about the bounds, and force the adjoining grounds out of their places, therefore to distinguish these from your other grounds, you must shadow them off in your plot with Hills and valleys, lest any man seeing your plot, should measure by your Scales and finde your worke to differ.

CHAP. LIII.

Shewing how to take the plot of a Mannour, or of divers severalls, whether Wood-land or other.

Although practice in the performance hereof be better then many words, and that the Rules already delivered are of sufficient extent to performe the worke of this Chapter, yet I will herein deliver the most sure and compendious way

way I can imagine. Suppose therefore that the following figure were part of a Mannour, as the Mannour of Red-ferne, you must first write the title thereof in your Field-booke, thus.

Mannour de Red-ferne in Com.

War. pro Custo. Liber. Ang.

Incip. 15. April. 1649.

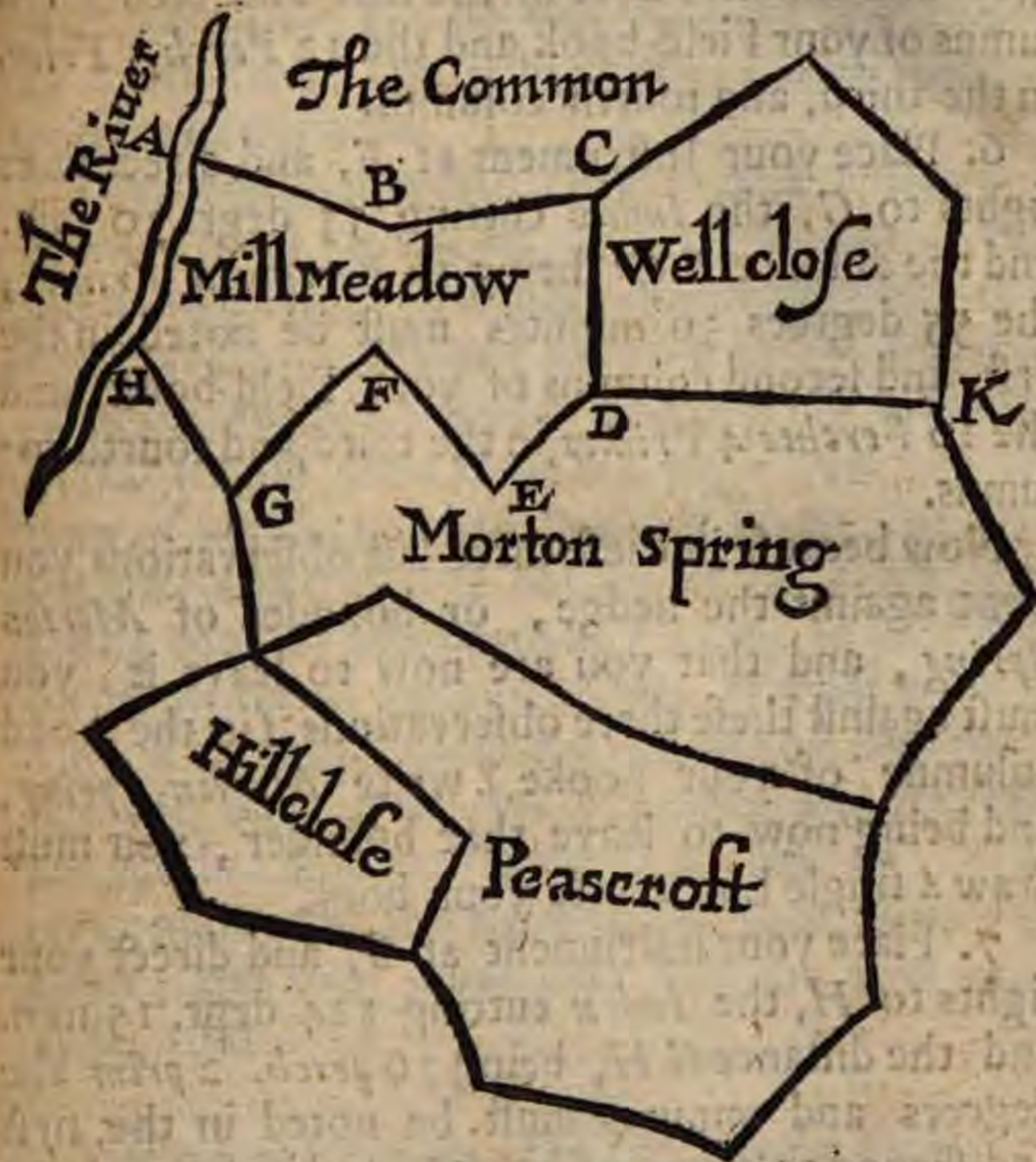
Then having your Field-book in a readinesse, ruled and fitted, as is taught in Chap 8. write over every close as you survey, the *Tennants* name, the name of the Close, and the tenure by which he holds the same: As in the following *Examp.* for the first close, *Thomas Jennings*, Mill-meadow pasture free. Then beginning to survey this parcell, which is Mill-meadow, first, place your Instrument at A , and direct your sights to B . noting the degrees there cut, which let be 195, which 195, degrees, must be noted in the first colunne of your Field-book; then measure with your Chaine the distance from A , to B , and you shall find it to containe 30 *Perches*, 4 *Primes*, which place in the third, and fourth columns.

2 Remove your Instrument to B , and direct your sights to C . the *Index* cutting 205 degrees 30 min. which note in the first, and second columns of your Field-book; then measure the distance $C B$. 26 *Perches*, 7 *Primes*, which note in the third, and fourth columns. Then in regard you are to leave the

the hedge, or bounder ABC , adjoining to the Common, (which is appertaining to another Manour, and therefore only the name inserted, for your remembrance when you come to protraction) you must draw a Line quite crosse your Field-book, and in the last colunne thereof, (which is very broad,) you must write the name of the bounder which you went against, as in the *Example*: these two observations being made, by the hedge or bounder of the Common, you must against these observations write the Common, and being you are now to leave that bounder, you must therefore draw a Line quite through your Field book, which denotes unto you that you now leave the bounder of the Common.

3 Place your Instrument at C . and direct your sights to D , the degrees cut being 120 . degr. 45 . min. and the distance CD , being 27 Perch. 8 Prim. These 120 degr. 45 . min. must be noted in the first, and second columns of your Field-book, and the 27 Per. 8 Prim. in the third, and fourth. Now because at these three observations, you went against the hedge, or bounder of Well-close, you must against them, (in the broad colunne of your Field-book,) write Well-close, and because at your next observation you are to leave that bounder, you must therefore draw a Line crosse your booke, denoting that you have done with that bounder.

4. Place



4. Place your Instrument at D , and direct your sights to E , the *Index* cutting 86 degr. 15 . min. and the distance DE . being 10 Perches, 4 Primes, the degrees and minutes must be noted in the first, and second columns of your Field-booke, and the 10 . Perches 4 . Primes, in the third, and fourth colunnes.

5. Remove your Instrument to E , and direct your sights to F , the *Index* cutting 300 degr. and the distance EF , being 12 , Perches 3 Primes, the de-
gree

degrees and minutes note in the first and second columns of your Field-book, and the 12 *Perch*, 3 *Prim.* in the third, and fourth columns.

6. Place your Instrument at *F*, and direct your sights to *G*, the *Index* cutting 55 degr. 30 min. and the distance *F G*. being 16 *Perches* 4 *Primes*; the 55 degrees 30 minutes must be noted in the first, and second columns of your Field-book, and the 16 *Perches* 4 *Primes*, in the third, and fourth columns.

Now because in these three last observations, you went against the hedge, or bounder of *Morton Spring*, and that you are now to leave it, you must against these three observations, (in the broad column of your booke,) write *Morton-Spring*, and being now to leave that bounder, you must draw a single Line crosse your book.

7. Place your instrument at *G*, and direct your sights to *H*, the *Index* cutting 324 degr. 15 min. and the distance *G H*, being 36 *perch.* 2 *prim.* the degrees and minutes must be noted in the first and second columns of your Field-book, and the *perches* and *primes*, in the third, and fourth columns.

8. Remove your instrument to *H*, and direct your sights to *A*, (where you began) the *Index* cutting 107 degrees, 15 min. and the distance *H A*, being 34 *per.* 6 *pri.* the degrees and minutes must be noted in the first and second, and the *perches* and *primes*, in the third and fourth columns of your Field-booke, as before. Now because in these two last observations, you went by
th
e

the River-side, you must therefore against them, write the *River*, and because you have now finished your first close, you must draw a double Line for your remembrance.

Then consider which close is next fitting to be taken in hand, which let be *Well-close*; and with-all, at what angle it is most meet to begin, which let be at *C*; and here (for your helpe, when you come to protraction) you must expresse in the title of this second close at what *Angle* you begin the same, (unlesse you had begun it where you ended the last, and then it is not materiall,) wherefore seeing you had best begin at *C*, look in your book on the worke of your last close, at what place the Line *B C* ended, as at the end of 205 degrees, 30 minutes, and 26 *perches*, 7 *primes*, and therefore against that number, make this signe \odot , or any other marke on the right-side of your down-right Lines, and then write your title for your second close, thus

Robert Roe. Well-close free.

Begin at \odot .

By this meanes you shall readily know when you come to protraction, where to begin with this close, and in the Margin place (2) for the number of your second close, and then proceede in your work, as before is taught for the last close, till you come to *K*, where noting that you want but one Line, as *K D*, to inclose this second close, and
O 2 also

also that this *Angle K*, is the fittest place to begin your third close at, placing there your instrument, and directing your sights to *D*, where you are to inclose, and then write in the margin of your book, 21, 30, 40, 2. against the degree here taken draw a short Line thus—which serves to put you in minde when you come to protraction, that you are to begin your third Field, where now you are at the *Angle K*, where you took your last sight: and then having inclosed this second close, proceed to the third from *K*, in the title whereof you need not make mention at what place you begin for the former reason, but working in that, and all the rest as before is taught, and if there were never so many inclosures, you may (without confusion) easily distinguish the worke of the one from the other, and be able (remembering the premises) to draw a plot thereof at any time, remembering alwayes that the numbers in the margin of your booke are to be placed severally in your plot, in those closes they represent: and by this meanes you are eased of much trouble, that you must by the other way be put to in protracting upon the Table it selfe, for then in every plot you must write the Name of the Tenants, or the close, or the tenour, or the quality thereof, which breedeth confusion, and occasioneth much trouble in casting up the contents.

These instructions being sufficient for the application and use of the Field-book, I shall desire the *Surveyor* often to make practice thereof, and compare his book with the plot, & protracting the same

according to the directions hereafter given, he shall find it to be most exact, and easie.

Here by the way, I might give the *Surveyor* some directions, whereby to take in divers severalls at once, when their bounds are regular, by only noting the ends or extremes thereof, which will much ease him both in *surveying*, and protracting, as by a little practice hee will quickly find.

Here followeth the figure of one lease of your Field-booke, as it ought to be ruled, which take for an example, it being the collections of the preceding example.

Thomas Jennings, Mill-meadow, Parsher, free.

Deg. m. p. | pr. |

(1)	195	00	30	4	.	The Common.
	205	30	26	7	.	○
	120	45	27	8	.	Well-close.
	86	15	10	4	.	
	300	00	12	3	.	Morton-spring.
	55	30	16	4	.	
	324	15	36	2	.	
	106	15	34	6	.	The River.

De.	m.	p.	pr.		
Robert Roe, Well-close free from \odot .					
(2)	160	00	123.	Cow-pasture.	
	180	45	162.		
	95	15	147.		
<hr/>					
	21	30	40	2.	Morton-spring.
<hr/>					
Richard Hall, Morton-spring for life.					
<hr/>					
(3)					

And here I will adde one abreviation in the precedent work, which is this.

Having placed your Instrument at *A*, direct your sights to *B*, and measure the distance *AB*, then remove your Instrument to *C*, and by your back sights looke towards *B*, and measure the distance *BC*, then direct your sights to *D*, and measure the distance *CD*; then remove your Instrument to *E*, and by your back-sights look towards *D*, and measure the distance *DE*, and so proceed round the Field, placing your Instrument at every other *Angle*, and here you must note, that in taking your back sights, you must alwayes number your degrees, cut by one, and the same end of the *Index*.

How to protract, or lay downe any observations taken according to the direction of the last Chapter.

PROvide a Skin of Velome, or Parchment, or divers sheets of paper, neatly fastned together with Starch, or Mouth-glew, (according to the magnitude, or greatnesse you intend to have your plot,) which paper, or parchment, let be ruled all over with occult parallel Lines, representing *Meridians*, the distance of which Lines, must not exceed the breadth of the *Scale* of your *Protractor*.

Then suppose you were to protract the observations of the last *Chapter*, laying your Field-book before you, consider which way your plot will extend, and accordingly begin your work, which let be at the point *A*, upon which point, place the *Center* of your *Protractor*, turning it about till the correspondent divisions at each end of the *Scale* thereof, lie directly upon one, and the same parallel *Meridian*: and staying your *Protractor* there, look in your Field-book for the *degrees* cut by the *Index* at your first observation, and against that division of your *Protractor*, place your *Protracting-pinne*, holding it there till you bring the *Scale* of your *Protractor* to lie directly thereupon, the beginning (or first number of your *Scale* lying upon the point *A*,) and then by the edge of the *Scale*, draw a Line of the length of your first measured

Line, as you finde in your Field-book 30 perches, 4 primes, which let be *A B*.

* Then, place the *Center* of your *Protractor* upon the point *B*, in all respects as before, and finding your next degrees, and length in your Field-book to be 205 degrees, 30 minutes, 26 Perches, 7 Primes; against 205 degr. 30 min. of your *Protractor*, place your *protracting-pinne*, & apply the *Scale* of your *protractor* thereunto, the beginning of the divisions lying on the point *B*, and by the side thereof, draw a Line of the length of 26 perches, 7 primes, which is the Line *B C*.

Now perceiving by your book that you are to leave the bounder that you went against, and find this marke \odot there placed, (you must with black-lead, or such like) make the same marke at the point *C*, and likewise a small dash with the pen, thus to signifie that you leave the bounder you last went against; Then place the *Center* of your *Protractor* on the point *C*, as before, and finding your next degrees, and lengths to be 120 degrees, 45 minutes, 27 perches, and 8 primes, against these

* And here you must note, that the Lines belonging unto any number of degrees under 180, are to be drawn from the *Center-point* downwards, or towards you, and those Lines that belong to any degree above 180, are to be drawne from the *Center-point* upwards, or from you, as the last Line *B A*, from the *Center-point* *B* to *A*.

these degrees of the *Protractor*, place the *protracting-pin*, and bring the edge of the *Scale* of the *protractor* from this point to *C*, the beginning lying upon *C*, and from the point *C*, draw the Line *C D*, of the length of 27 perches, 8 primes, which because it belongeth to a number of degrees under 180, is to be drawn downwards.

In this manner you must proceed with all the other Lines, and *Angles*, as you find them noted in your Field-book; till you come to inclose at *A*, where you began.

Having thus finished your first inclosure, you must in all respects, with your second, and third, and so on, were there never so many. And to know where to begin to *Protract* your second inclosure, you must have recourse to your Field-book, where you shall find this marke \odot at the beginning of your second close, and the like marke on your paper at the point *C*, which is your remembrancer to put you in minde, that at the point *C* you must begin your second close, which you must *protract* in all respects as you did the other.

Here note that you may take the plot of a *Mannour* upon your plaine Table, by helpe of the rules delivered in *Chapter* the 39, and those preceding, which will performe it with great facility and certainty, the practice whereof will be worth your time, and therefore I could wish you would make frequent use thereof.

CHAP.

CHAP. LV.

Shewing how to reduce a plot to a greater or lesser quantity, according to any proportion.

HAVING protracted your plot according to the former directions of the last *Chapter*, and if you find it to be greater, or lesser then your intended, or confined limits, you may reduce it into a smaller, or greater proportion, according to the following Doctrine.

For the effecting hereof you must provide a Ruler of what length you please, which must be divided into 100 equall parts, and numbred as in the figure *AB*, and through the *Center A*, is a hole made to put in a small pin, to fasten it to a Table, so that it may be turned round about upon the *Center A*.

Now suppose you were to reduce the figure of the plot in *Chapter 51*. into halfe the bignesse it is now of. First, you must fasten the plot into a Table at the foure corners, with Mouth-glew, or past, the right side of the plot lying upermost, then lay another paper, or parchment thereupon of your intended bignesse, fastned likewise at the foure corners unto the other plot, so



so that the *Center*, or middle of the lesser plot may lie upon the *Center* of the greater plot, about the middest of your paper, or plot, place the *Center* of your *Ruler*, through the *Center* of which, put a pin to fasten your two plots, and your *Ruler* to the Table, so will your papers lie fast, and your *Ruler* will turne about according as you please.

Now to reduce your plot begin at *A*, unto which point bring your *Ruler*, and suppose that the point *A*, meets with 98 degrees of the *Ruler*, now (because the plot is to be reduced into halfe the bignesse) you must therefore take the halfe of 98 degrees, which is 49, and against that division of the *Ruler* make a mark upon your paper with your *protracting-pin*.

Then turne your *Ruler* about to *B*, which cutteth 90 degrees of the *Ruler*, the halfe whereof being 45, you must make a mark upon your paper, against 45 degrees of the *Ruler*.

Then turne your *Ruler* about to *C*, where it cutteth 92 degrees, the halfe whereof being 46, you must make a mark upon your paper, against 46 degrees of your *Ruler*.

Then bring your *Ruler* to *D*, where it cutteth 40 degrees, the halfe whereof being 20, make a marke upon your paper against 20 degrees of your *Ruler*.

In this manner must you bring your *Ruler* to *E*, *F*, *G*, and *H*, and to all the other *Angles* in the whole plot.

By these new markes you must draw Lines upon your paper, as the Lines *AB*, *BC*, *CD*, *DE*, *EF*,

E F, *FG*, *GH*, and *HA*, so you shall have upon your new plot, the exact figure of the Field *ABCD EFGH*, according to a *Semi-proportion*, and thus must you do with all the other closes.

And when you come towards the middle of your great plot, you must then unpaste two of the corners of your lesser plot, and folde it backwards (the face of the new plot,) towards the face of the old, and by this meanes going over all the plot, you shall have the exact symmetry and proportion thereof upon your lesser paper.

In like manner if you were to reduce a plot from a smaller to a greater proportion, you must work according to the former directions, by doubling, or trebling your numbers, *Mutatis mutandis*, and by this meanes you may most speedily, and exactly performe the same.

CHAP. LVI.

How to deck, and beautify your plot after Protraction.

Your plot being Protracted according to your intended bigness, and having written the content of each close about the midst of the same, you may about the bounds of every field or inclosure, with a fine pensill and sap-green, neatly go over your black Lines, so shall you have a transparent stroke of green on either side of your black Line, which will add a great luster, and beauty to your plot.

Then

Then in your Wood-land grounds draw diverse little *Trees* in the most materiall places, and shadow your mountainous & uneven grounds with *Hills*, and *Dales*, expressing all high-ways and *Rivers*, distinguish them by colours, according to their similitudes.

Then in some convenient place of the plot without the inclosure, draw a *circle*, and therein describe the 32 points of the *Marriners* compasse, according to the scituation of the grounds, with a *Flowerdeluce* at the North-part thereof, and you may draw Lines with Red-ink from every point of the Compasse thorough the wast places of your plot.

Then in some other convenient place of your plot draw a *Scale* of the same bigness with that by which your plot was made, with a paire of Compasses opened upon the same, if your plot will permit.

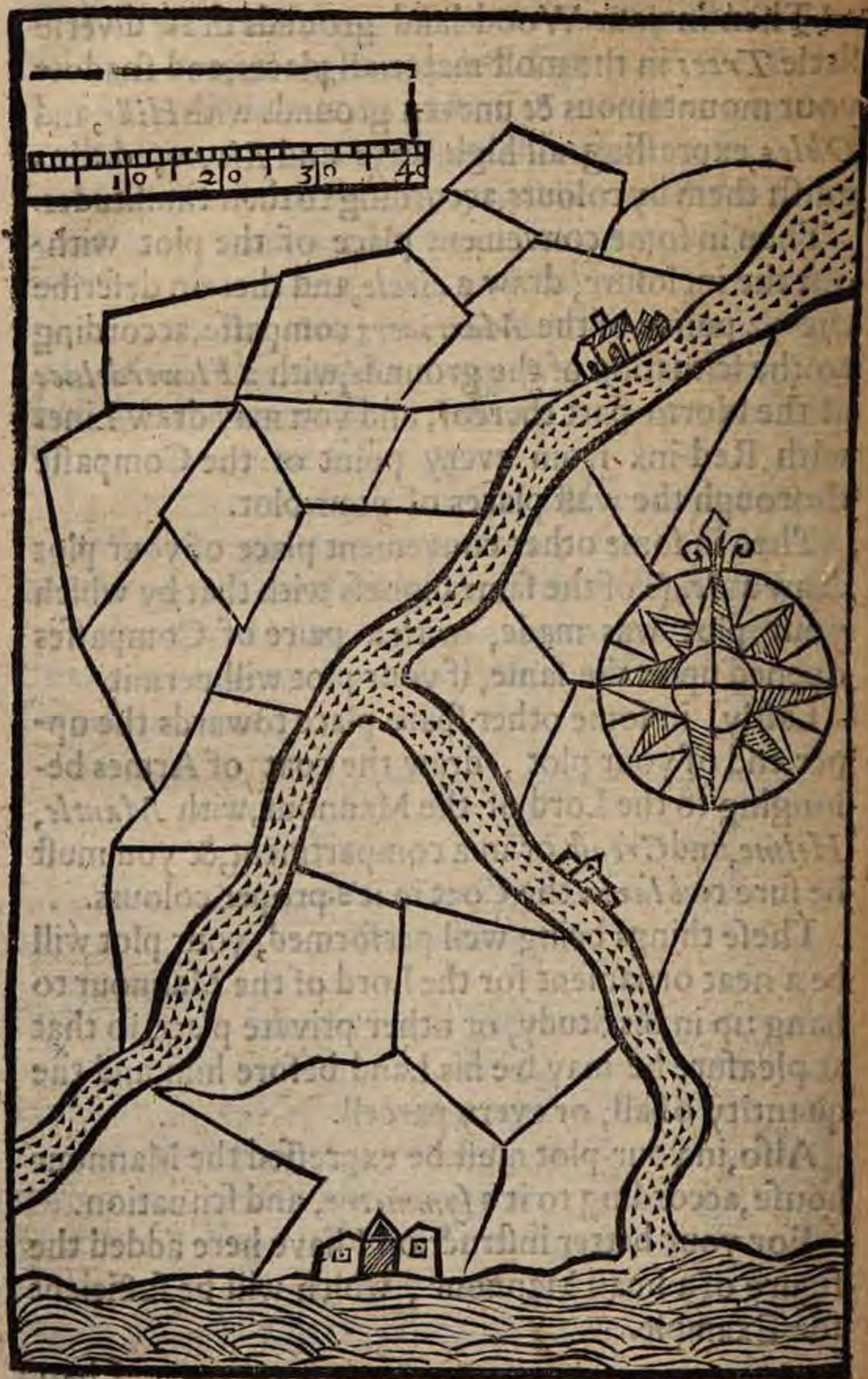
Lastly, in some other spare place towards the upper end of your plot, draw the coat of Armes belonging to the Lord of the Mannour, with *Mantle*, *Helme*, and *Creast*, or in a compartment, & you must be sure to *blazen* the Coat in it's proper colours.

These things being well performed, your plot will be a neat ornament for the Lord of the Mannour to hang up in his Study, or other private place, so that at pleasure he may see his Land before him, and the quantity of all, or every parcell.

Also, in your plot must be expressed the Mannour house, according to it's *symmetry*, and scituation.

For your better instruction I have here added the figure of a small Mannour, which will be sufficient for Example.

Chap.



CHAP. LVII.

How to finde whether water may be conveyed from a spring-head to any appointed place.

There is an instrument called a *Water-level*, for the performance hereof, the making whereof is sufficiently known. Now if it were required to know whether water may be conveyed in *Pipes* or *Trenches* from a spring-head to any determinate place, observe the following directions.

Place your *Water-level* at some convenient distance from the spring-head, in a right-line towards the place to which the water is to be conveyed, as at 30, 40, 60, or 100 yards distant from the *Spring-head*. Then having in a readiness two long streight poles, (which you may call your *Station-staves*) divided into feet, inches and part of inches from the bottom upwards: being thus provided, cause one (whom you may call your first *Assistant*) to set up one of the said staves at the *Spring-head*, and require another (whom you may call your second *Assistant*) to erect the other staffe beyond your Instrument, at 30, 40, 60, or 100 yards forwards, towards the place to which the water should be conveyed. These *Station-staves* being erected *Perpendicular*, and your *Water-level* in the midway precisely *Horizontall*, go to the end of the *Level*, and looking through the sights, cause your first *Assistant* to move a Leaf of paper up and down your *Station-staffe*, till through the sights you see the very edge thereof, and then by some known-signe or sound, intimate to him, that

that the paper is then in it's true position, then let this first *assistant* note against what number of feet, inches, and parts of an inch the edge of the paper resteth, which he must note down in a paper. Then your *Water-level* remaining immoveable, go to the other end thereof, and looking through the sights towards your other *Station-staffe*, cause your second *assistant* to move a Leaf of paper along the *Staffe*, till you see the very edge thereof through the sights, and then (by some known signe or sound) cause him to take notice what number of feet, inches, and parts of an inch, are cut by the said paper, which will him also to keep in minde, or note in a paper, as your first *Assistant* did.

This done, require your *first assistant* to bring his *Station-staffe* from the *Spring-head*, and cause your *second assistant* to take that *Staffe* and carry it forward towards the place, to which the water is to be conveyed, 30, 40, 60, or 100 yards, & there to erect it perpendicular as before, letting your *first assistant* stand at that *Staffe* where your *second assistant* before stood; then in the mid-way between your two *assistants*, place your *Water-level* exactly *Horizontall*, and looking through the sights thereof, cause your *first assistant* to move a paper up & down, and when you give him a signe to note what number of feet, inches, and parts of an inch are cut by the paper, and note them down, then going to the other end of your *Water-level*, look through the sights, and cause your *second assistant* to move a paper along the *Staffe*, and to note the feet, inches, and parts of an inch as before.

Then

Then cause your *first assistant* to bring away his *Station-staffe*, and cause your *second assistant* to take it and carry it 30, 40, 60, or 100 yards forwarder towards the place to which the water is to be conveyed, and leaving your *first assistant*, at the place where your *second assistant* last stood, place your *Water-level* againe in the mid-way between your two *assistants*, and looking through the sights as before, cause each of them to move a Leaf of paper up and down their *Station-staves*, and note down in their severall papers the number of feet, inches, and parts of an inch cut, when you looked through the sights of your *Water-level*.

In this manner you must go along from the *Spring-head*, to the place unto which you would have the water conveyed, and if there be never so many severall stations, you must in all of them observe this manner of work precisely; so, by comparing the notes of your two *assistants* together, you may easily know whether the water may be conveyed from the *Spring-head* to the desired place, or not.

¶ Here note, that in your passage between the *Spring-head*, and the appointed place; from station, to station, you must observe this order, (otherwise great error will ensue) *viz.* that your *first assistant* must at every station, stand between the *Spring-head*, and your *Water-level*; & your *second assistant* must always stand between your *Water-level*, and the place to which the water is to be conveyed: thus by observing this order in your work, you shall have no confusion, neither

P

shall

shall one of your *assistants* take more paines than the other.

Having thus orderly proceeded from the *Spring-head*, to the place appointed, call both your *assistants* together, and cause them to give in their notes of the observations at each station, and add them together severally: then if the note of the *second assistant* exceed (or be greater than) the note of the *first assistant*, take the lesser out of the greater, and the remainder will shew you how much the appointed place, to which the water is to be brought, is lower than the *Spring-head*.

The first Assistants note.

Stati.	Feet.	Inch.	Parts.
1	15	3	$\frac{1}{5}$
2	2	1	$\frac{1}{4}$
3	1	6	0
Sum.	18	10	$\frac{3}{4}$

The second Assistants note.

Station	Feet.	Inch.	Parts.
1	3	2	$\frac{3}{4}$
2	14	0	$\frac{1}{4}$
3	3	11	0
Sum.	21	2	0

By

By this Table you may perceive that the notes of the *first assistant* collected at his severall stations, being added together, amount to 18 Feet, 10 Inches and $\frac{3}{4}$ of an Inch, & the notes of your *second assistant* at his severall stations being added together amount to 21 Feet, 2 Inches, so the number of the *first assistants* observations, being taken from the number of the second, there will remaine 2 Feet, 3 Inches, and $\frac{1}{4}$ of an Inch, and so much is the place, to which the water is to be brought, lower than the *Spring-head*, according to the streight *Water-level*, and therefore the Water may easily be conveyed thither.

¶ Here note, that when you have called your *two assistants* together, and examined their severall notes, and added them together, if then you shall find the sum of your *first assistants* note to be greater than the sum of your *second assistants* note, that then it is impossible to bring the water from that *Spring-head* to the intended place: but if the sums of the notes of your *two assistants* do exactly concur; there is then a possibility of effecting it, if the distance be but short; though with more charge and difficulty.

¶ Note 2. that the most approved Authours, concerning this particular do averr, that at every miles end there ought to be allowed $4\frac{1}{4}$ Inches, more than the streight Levell, for the current of the water.

¶ Note 3. If there be any hill lying in the way between the *Spring-head* and the place to which the water is to be conveyed, you must then cut

a trench by the side of the Hill, in which you must lay your Pipes equall with the streight *Water-Levell*, with the former allowance. And in case there be a valley, you must then make a Trunck of strong wood well underpro ped with strong pieces of Timber, and well pitched, or leaded, as is done in divers places between *Ware* and *London*.

Note 4. That in your conveying of water to an appointed place, it is not convenient to bring it from the *Spring-head* by the nearest distance, or in a streight Line, but by a crooked or winding way; and you ought also to lay the Pipes one up and another down, but this is to be observed but in some cases only, where the water will have too violent a current.

A N

AN APPENDIX.

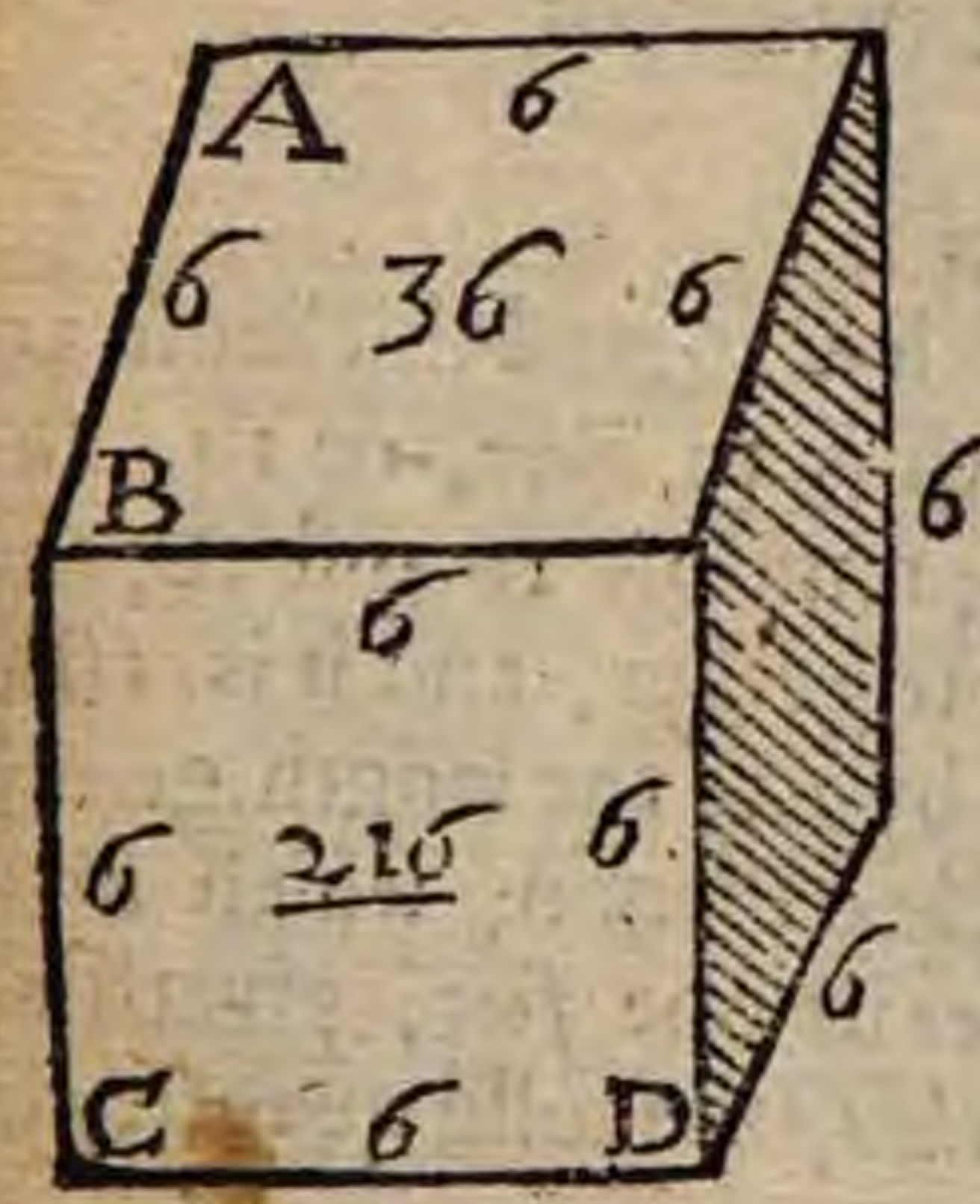
Shewing how the Content of most regular Figures may be attained: Also how to find the Crassitude; or Solid content of any Timber; and how to reduce a Wine or Beer-vessell unto a Cylinder, and find the content thereof, in Wine or Beer Galons.

Prop. I.

To measure the solidity of a Cube.

A *Cube* is a figure comprehended under six equall sides, every side being a *Geometricall Square*, to find the solidity whereof, do thus, measure one of the sides, which multiply in it self, then that summe being again multiplied by the side, shall give you the solid content thereof.

Example.



Let the figure *ABCD* be a *Cube*, whose side *AB* let be six foot, this 6 being multiplied into it self, produceth 36. then multiply 36 by 6. and the product will be 216. and so many solid feet of Timber or Stone, are contained within the *Cube ABCD*.

Prop. II.

To measure the solidity of a long Cube.



Let $MNO P Q$ be the figure of a long Cube, or oblong, the side whereof OP is four foot, which being multiplied into it self, giveth 16 foot for the Square $MNO P$, this 16 being multiplied by 8, the length of the side OQ giveth 128, and so many solid feet of Stone, or Timber are contained in the whole figure $MNO P Q$.

If a flat piece of Stone, or Timber be to be measured, that is more in breadth than thickness; multiply the breadth and thickness together, and the product multiply again by the length, and you have the solid quantity thereof.

Example.

If a piece whose breadth is 16, and thickens 10 Inches, and whose length is 12 Foot, or 144 Inches, is to be measured; multiply 10 and 16, the breadth and thickness together, and it is 160, which multiplied again by 144 the length, giveth 23040, the Square Inches therein, which divided by 1728, the Inches in one foot, giveth 13300, and 576 square Inches, the solid quantity of the piece.

When

When a piece of square Timber is to be measured, that is bigger at one end than at the other; multiply each end squarely, and add the Products together, and taking half thereof, multiply the same by the length of the piece, and the Product thereof is the solid content of the piece.

Example.

A piece being to be measured, that at one end is 15 Inches square, and at the other end 18 Inches square, and 11 foot or 132 Inches in length; multiply 15 and 18 square, and the Product for 15 is 225, and for 18 324, which added together, make 549, half is 274½ Inches, which multiplied by the length 132 Inches, is 36234, this divided by 1728, the square Inches in a foot, the quotient is 25 $\frac{720}{1728}$, viz. 25 foot, and almost a half, the solid content of the piece.

Example 2.

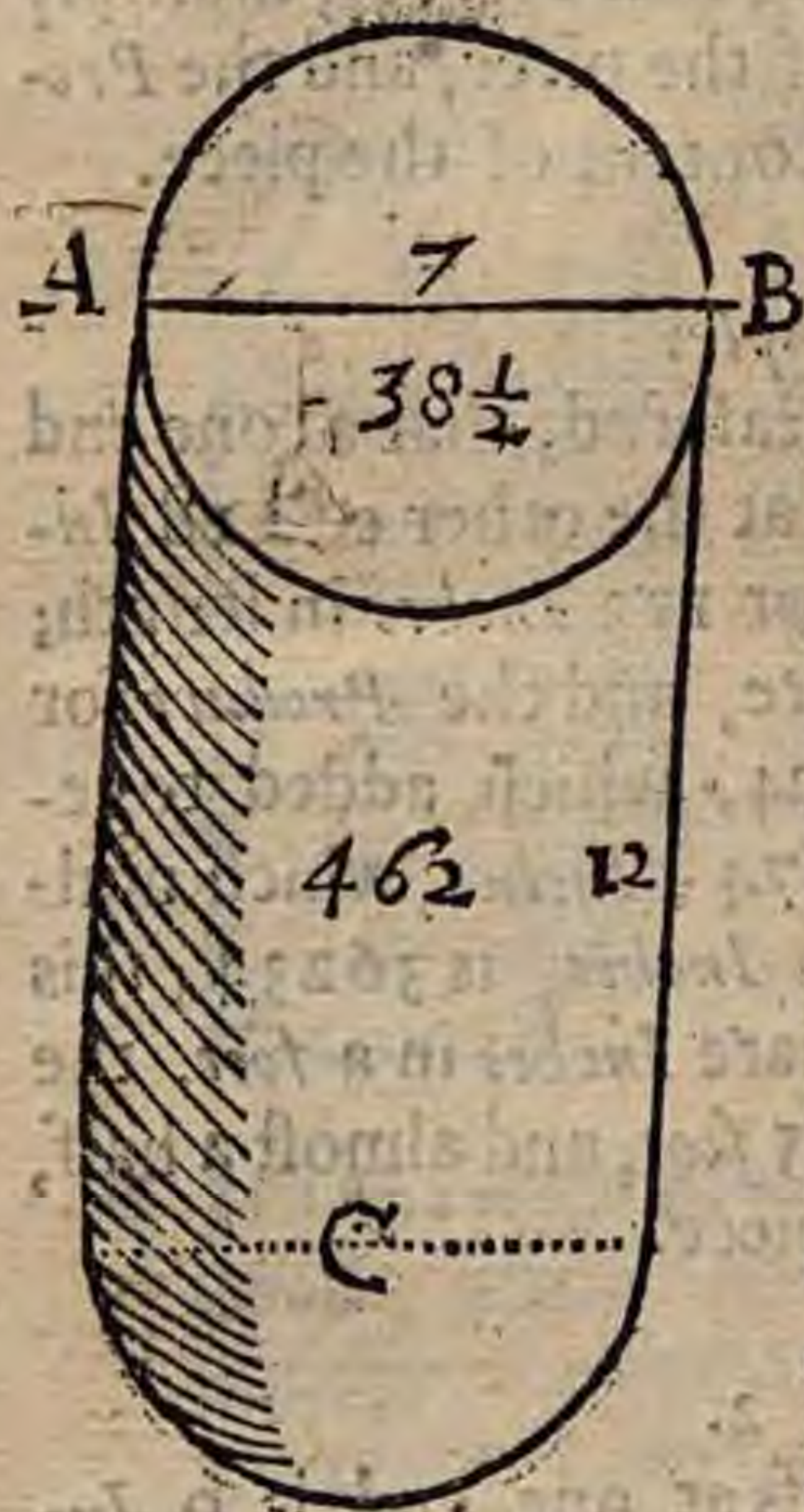
A piece whose thickness at one end is 9 Inches, and whose breadth is 12 Inches, and at the other end 12 Inches in thickness, and 16 Inches in breadth, and 10 Foot or 120 Inches long, is to be measured; multiply 9 and 12, and it makes 108, and also multiply 12 and 16, and the Product is 192, add 108 and 192 together, and it makes 300, half whereof, viz. 150, multiplied by 120 the length; makes 18000, this divided by 1728, giveth in the quotient 10 $\frac{720}{1728}$, so that the solid quantity of the piece is 10 Foot, 720 square Inches.

P 4

Prop

Prop. 3.

How to measure the solidity of a Cylinder, or Pillar.



Let the *Cylinder* given be $A B C$, the crassitude whereof is required. Let the *Diameter* of the *Circle* at the end $A B$ be 7 foot, then is the superficial content thereof (by Chapter 43) 38 Foot, and a half.

This number being multiplied by 12 . the length of the *Cylinder*, giveth 462 , for the *Crassitude* of the whole *Cylinder*.

¶ When a round *Pillar*, or piece of *Timber*, is to be

measured that is taper, or bigger at one end, then the other, seek the *Area*, or superficial content of each end, which add together, and multiply half thereof by the length, and you have the *solidity*.

Example.

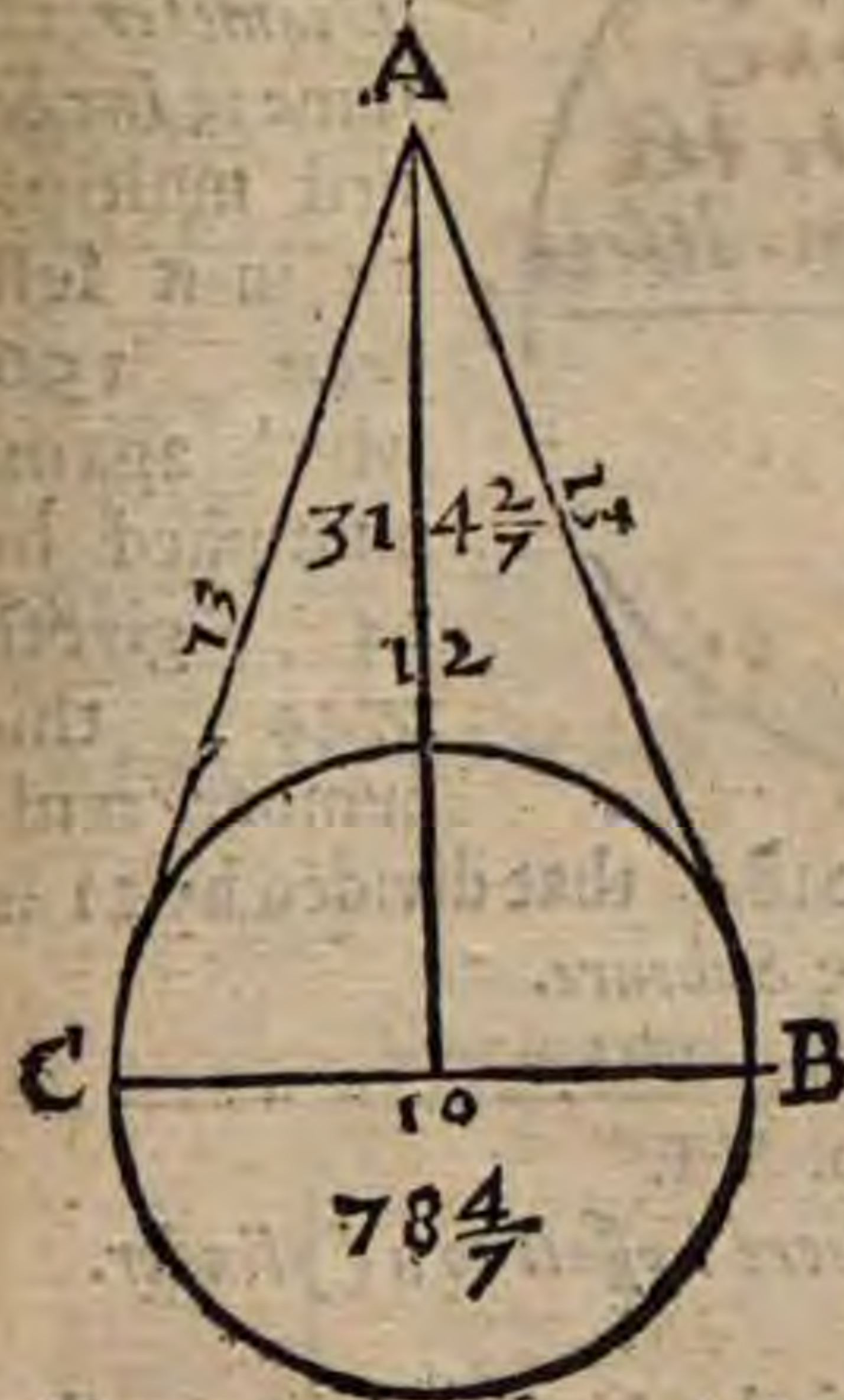
A round *Pillar* is to be measured, whose *Diameter* at one end, is 20 Inches, & at the other end, the *Diameter* is 32 Inches, and in length 16 foot, or 192 Inches, the *Area* of the lesser end is

$314\frac{1}{4}$, and the *Area* of the greater end is $773\frac{1}{4}$, which added together, make $1087\frac{1}{2}$, half this

this, viz. $543\frac{1}{2}$, multiplied by 192 the length gives $104393\frac{1}{2}$ square Inches, which reduced is 60 foot, and 713 cubical Inches, for the solid content of the *Pillar*.

Prop. I V.

To measure the content of a Cone:



Let the *Cone* given be $A B C$. the height whereof $A C$ is 12 foot, and the *Diameter* of the base $C B$ is 10 . by which the superficial content of the *Circle* will be found to be $78\frac{4}{7}$, which multiplied by 4 the third part of the *Perpendicular*, giveth $314\frac{2}{7}$ for the content required.

But by reason it is not easie to measure the altitude of a *Cone*,

without the true knowledge of the *Perpendicular*, I will therefore shew how that may be found: first, take half the *Diameter* $C B$, which is 5 . and multiply it in it self, it makes 25 . which number keep; then measure the side $C A$ 13 . which multiplied in it self makes 169 . from which take the square of half the base, which is 25 (your number before found) and there remains 144 , the square root whereof is 12 . and that is the length of the *Perpendicular*.

Prop.

For Example.

Suppose the Lines DA, DE , or DB to be 10000 and the *Angle* at D . 45 degrees; The *Area* of the *Circle* (whereof AEB is a segment) is, 31415926536
 Then, as 360 degrees unto 31415926536, so is 45 degrees unto 3926390817, the *Area* of $AEBDA$.
 The side CD will be the *Cosine* of the *Angle* EDB . *viz.* 67 degrees, 30 minutes, and is 92388, The line AC , or CB is the *sine* of the *Angle* ADC , or DCB . 22 degrees, 30 minuts, and is 38268. These sides multiplied,

306144
 306144
 114804
 76536
 344412

The product is—3535503984
 Which subtracted from $AEBD$ —3926990817
 Leaveth—391486833

For the *Area* of the *Segment* $AEBCA$: half which, divided by AC , or CB 38268.

195743417
 5, 191340
 4403417
 1, 38268
 576617
 1, 38268
 193937
 5, 191340
 2597.

The *quotient* is 5116 for HA, EG , or IB , if you subtract DC 92388, from DE 10000, there will remaine for EC 7612. Then

Then as EC 7612 unto EG 5116, so 1000 to 672; and this is the proportion between the difference of the *Diameters* and the part thereof to be added unto the lesser *Diameter*, to reduce it unto a *Cylinder*, when the Segment is 45 degrees, *vi* 1000 to 672.

But because this is too hard a task to performe before the gaugeing of every vessell, I have by the foremention'd method, calculated the proportions between the *Diameters* at the heads and bongue; for substance, 90, 45, 22, and 11 degrees; Therefore

If the vessel be a segment of	90	45	22	11	
	} Degr. }				
	multiply the difference of the Diameters by				
	} 689 }	} 672 }	} 668 }	} 666 }	
	and from the product, cut off three figures to the right-hand, and those to the left-hand, add to the Diameter at the head, and you have the meane Diameter.				

Or by the Logarithmes.

If the vessel be a segment of	90	45	22	11	
	} deg }				
	unto the Logarithme of the difference of the Diameters, add the Logarithme				
	} 2,8382 }	} 2,8273 }	} 2,8247 }	} 2,8233 }	
	and from the aggregate, subtract 30000, the remainder is the Logar. of the sum to be added to the Diameter at the head; to finde the meane Diameter.				

Exam.

Example.

A Vessell whose length between the heads is Inches, and whose Diameter at the heads is 22 Inches, and a half, and the Diameter at the bosome Inches; is given to be reduced to a Cylinder: The difference of the Diameters is 9 Inches and a half; we suppose ACB in the figure to be 48, and C about 5; viz. half the difference of the Diameters. the Angle at D will be about 45 degrees, the difference of the Diameters is decimally 9.50. which multiply by 672, over against 45 degrees in the foregoing Table; The Product is 6.38|400. then cutting off three figures to the right-hand, the other are 6 Inches, and $\frac{38}{100}$ parts of an Inch, which added to 22, 50. the lesser Diameter; giveth the meane or Equated Diameter 28.88; so that a Cylinder whose Diameter is 28 Inches & $\frac{88}{100}$ parts of an Inch, and whose length is 48 Inches (the length of the vessell) is equall in content to that vessell. Or if you add 2, 8273, the Logarithme over against 5 in the Table, unto 2, 9777. the Logarithme of the difference of the Diameters, you have (casting away 30000) 2, 8050 the Logar. of 6038, as before.

The meane or Equated Diameter of a Wine or Beer-vessell, and the length being given; to find the content in Wine or Beer-gallons.

Concerning the Cubicall dimension of the Wine, and Beer-gallon; Authours are of diverse opinions: But I suppose none have made more accurate observations therein than M. Wibrand, unto whose proportions

portions in his *Tachometria* sold by Nath. Brookes at the Signe of the Angell in Cornehill London. I shall adhere. Therefore multiply the Equated Diameter in it self, and that product multiply again by the length of the Vessell, which divide by 286.5. and you have the content in Wine-gallons, but if you divide the same by 343.8. you have the content in Beer-gallons.

Or by the Logarithmes, thus,

Unto the double Logarithme of the meane, or Equated Diameter, and the Logarithme of the length; add the Logar. 7, 5429, and cancell one figure to the left-hand, and you have the Logarithme of the content in Wine-gallons. And unto the double Logarithme of the meane Diameter, and the Logarithme of the length; add the Logar. 7, 4637, and you have the Logarithme of the content in Beer-gallons.

Example.

In the fore-mentioned vessell whose length is 48 Inches, and whose meane Diameter is 28 Inches, and $\frac{88}{100}$ parts of an Inch; multiply 2888 in it self, and it makes 834.0544: This multiplied again by 48, the length of the vessell, the Product is 40034.6, &c. which divided by 286.5. the quotient is 139 $\frac{111}{286.5}$, shewing the content to be in Wine-gallons 139, and somewhat above two thirds of a Gallon; and divide this 40034.6. by 3438, and the quotient is 116 $\frac{158}{3438}$, shewing the content of the vessell in Beer-gallons; 116, and almost a half.

By the Logarithmes.

The *Logarithme* of the length— 48. 1, 6812The double *Logar.* of the meane }
Diameter— 28. 88, } — 2, 9212The proportionall *Logar.* for Wine gal. 7, 5429The *Logar.* of 139 ¹/₁₀₀, the content in }
Wine-gallons as before. } 2, 1453The *Logarithme* of the length 48. 1, 6812The double *Logarithme* of the meane }
Diameter— 28. 88, } 2, 9212The proportionall *Logar.* for Beer-gal 7, 4637The *Logar.* of 116 ¹/₁₀₀, the content in }
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Peany (from the songs sung to
 Pean or Apollo beginning with
 a song of triumph
 So Pean.) a song of triumph
 Pean (from the songs sung to Pean or
 Apollo beginning with a
 song of triumph)

L.	C.	L.	L.	C.	L.
20	= 50	= 00.	45	: 22.	23
21	= 47	= 67	46	: 21.	72
22	= 45	= 46	47	: 21.	28
23	= 43	= 48	48	: 20.	84
24	= 41	= 67	49	: 20.	41
25	= 40	= 00.	50	: 20.	00.
26	= 38	= 47	51	: 19.	61
27	= 37	= 04	52	: 19.	12
28	= 35	= 72	53	: 18.	87
29	= 34	= 49	54	: 18.	52
30	= 33	= 34	55	: 18.	19
31	= 32	= 26	56	: 17.	86
32	= 31	= 25	57	: 17.	55
33	= 30	= 31	58	: 17.	23
34	= 29	= 42	59	: 16.	95
35	= 28	= 58	60	: 16.	67
36	= 27	= 78	61	: 16.	40
37	= 27	= 08	62	: 16.	13
38	= 26	= 32	63	: 15.	86
39	= 25	= 67	64	: 15.	63
40	= 25	= 00.	65	: 15.	24
41	= 24	= 40	66	: 15.	12
42	= 23	= 82	67	: 14.	93
43	= 23	= 26	68	: 14.	71
44	= 22	= 73	69	: 14.	40
			70	: 14.	20

71-14-29	93-10-78
72-13-87	94-10-64
73-13-70	95-10-53
74-13-52	96-10-42
75-13-32	97-10-31
76-13-16	98-10-21
77-12-99	99-10-12
78-12-88	100-10-00
79-12-66	
80-12-50	

81-12-35
82-12-20
83-12-05
84-11-91
85-11-77
86-11-36
87-11-50
88-11-37
89-11-24
90-11-12
91-10-99
92-10-87

This table
 shows the length
 of an acre the
 breadth being
 given in
 links



