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TO THE

Lord PAISLEY.

My Lord,

ALL who are acquainted with the Subjects of the following Treatiſe will acknowledge my Judgment in the Choice I have made of your Lordſhip's Name, which can not fail to recommend it to the peruſal of the Public; And though an Author is very unwilling to beleive his Works deſtitute of real Merit and Uſefulneſs, yet if this Book ſhall meet with Approbation, I am ſenſible how much will be owing to your Lordſhip's Patronage, whoſe known Skill in theſe Sciences is the Foundation of this Trouble.

Permit me to add, that I have a particular Pleaſure in doing myſelf this Honour at a Time when your

Lordſhip's great Merit has placed you at the Head of a moſt Ancient and moſt Honourable SOCIETY, whoſe profound Knowledge, in theſe Affairs, is their Pride and Diſtinction. I am,

My LORD,

Your Lordſhip's moſt Obedient,

Moſt Humble,

And moſt Devoted Servant,

B. Langley.

A

T A B L E

OF THE

C O N T E N T S.

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PREFACE.

THE ſubjects of the preſent treatiſe, on account of their antiquity, uſefulneſs and entertaining variety, having been the delight of the greateſt maſters in knowledge, thro' various ages, are, it muſt be acknowledged, tranſmitted to us in a ſuitable degree of perfection. They have indeed been largely treated of by various hands, but generally in a theoretical, rather than in a practical manner, ſo as to appear ſomewhat intricate and obſcure to ſuch as were not acquainted with the principles of mathematics, or have not applied themſelves in earneſt thereto. My deſign therefore is to treat of architecture, gardening, menſuration and Land-ſurveying, in a method as eaſy and intelligible as it is new and generally uſeful. I ſhall begin with the fundamental, or firſt principles of theſe ſeveral arts, and gradually conduct my reader from the eaſier parts of 'em up to the hardeſt, taking particular care all along to let him ſee the *utile* as well as the *dulce* thereof; the fruitful practice, and not the barren theory only. From a failure of authors in this point, I apprehend it is that theſe arts are at preſent much leſs cultivated than they merit. An author cannot do them greater juſtice, than to paint them as they are, moſt uſeful and delightful employments; of great importance in human life. To convince the world of this truth, as it is the deſign, ſo it wou'd be the higheſt recommendation of the preſent treatiſe. And this I can ſincerely ſay, that I have had a view thereto thro' the execution of the whole deſign. I ſhall not therefore offer at any recommendation of the arts themſelves, which want no able hand to ſet them off with colours, and the winning charms of rhetorick; but leave my reader, from the plain, naked, artleſs facts and obſervations he will meet with in the work, to determine of their merit. And I am greatly miſtaken if to all true judges this does not appear a more equitable, and more unexceptionable procedure than to write, as the uſual manner is, an encomium of the arts I treat of, in order to recommend the work. For if the book cannot be ſupported by its own merit, I am ſure a panegyrick upon its ſubject will but render it the more ridiculous and contemptible. All that I requeſt is a fair and candid peruſal. I deſire only that my reader wou'd come with a mind prepared not to be ſtartled, or prejudiced againſt the author, by the appearance of novelty back'd with reaſon; tho' it at firſt ſight ſhou'd ſeem to thwart ſome current and prevailing opinions. This were a temper that wou'd for ever exclude the light, and droniſhly remain content with whatever doctrine happens to have its run. But we of late have seen such successful inrodes made into opinions once thought just, that we cannot be too suspicious of our entertaining establish'd errors for truth, and shutting our eyes against plain fact and obvious reason. 'Tis not that I pretend to a faculty beyond that of others in discovering the truth in the particulnr subjects I have here treated; but my genius leading me to such kind of studies, I hope I may be allowed to have observed the common things, and to make my own use of them. If what I alledge be true, (for which I always give my reasons) the world will have the advantage; but if it shall prove to be false, I shall willingly bear the blame: Only I make this request, that I may be censured by the proper judges, and such as have been conversant in the same kind of studies with my self; otherwise the world, I hope, will agree with me, that I am condemn'd unjustly. That the reader may form the better judgment of the performance, he may be pleased to take the following account thereof.

Geometry being the basis of architecture, gardening, mensuration and land surveying, (which are the subjects of this treatise) I have in the first part, laid down all the most useful and necessary geometrical definitions, problems, theorems, and axioms, that are absolutely necessary to be well understood by every one who desires to be a complete artisan, and those in a most concise and familiar manner. The second part contains the application of the first to practise in the geometrical construction of all kind of scales for the delineating, and mensuration of all sorts of plans and uprights, and of the *Tuscan*, *Dorick*, *Ionick*, *Corinthian*, *Composite*, *French* and *Spanish* Orders of architecture, with their derivation, proportion, *&c.* in general. And seeing that neither ancient or modern architects have yet agreed on the measures of the principal parts of entire columns: I shall therefore before I proceed any further, demonstrate the same particularly.

The principal parts of entire columns are three, *viz.* The pedestal, the column, and the entablature; all which are severally divided into three other parts. As first, the pedestal by its base, die, and cornice; the column by its base, shaft and capital, and the entablature by its architrave. Freeze and cornish, whose several heights and projectures are measured by modules and minutes. (*Vide* prob. the 9th sect. 1. part 2d.)

(1.) Pedestals, (called by the ancients *Stylobatæ*) are of two kinds, *viz.* The one broken, and the other continued. Broken pedestals, are parts of a continued pedestal, which project or break out, right under each column, as in the Theatre of *Marcellus*, the arches of *Titus*, *Septimius*, and *Constantine* in the *Coliseum*, and in the altars of the *Pantheon*. Continued pedestals are such as range throughout, without projectures or breaks under each column, as in the Goldsmith's arch, the temple of *Vesta* at *Tivoli*, and that of *Fortuna Virilis*.

Both ancient and modern architects have delivered rules for the heights of entire pedestals, but all different, whereby the young architect is at a loss to know, among the several, which is the best.

Palladio makes the height of the *Tuscan* pedestal three modules; the *Dorick* four modules and five minutes; the *Ionick* five modules four minutes; the *Corinthian* five modules one minute, and the *Composite* six modules seven minutes.

Scammozzi makes the height of the *Tuscan* pedestal three modules twelve minutes; the *Dorick* four modules eight minutes; the *Ionick* five modules; the *Corinthian* six modules eleven minutes, and the *Composite* six modules two minutes.

Vignola

Vignola makes the height of the *Tuscan* pedestal five modules; the *Dorick* five modules four minutes; the *Ionick* six modules, and the *Corinthian* and *Composite* seven modules each.

Serlio makes the height of the *Tuscan* pedestal four modules fifteen minutes; the *Dorick* six modules; the *Ionick* six modules; the *Corinthian* six modules fifteen minutes, and the *Composite* seven modules four minutes. The height of the *Ionick* pedestals at the temple of *Fortuna Virilis*, is seven modules twelve minutes; those of the theatre of *Marcellus* three modules eight minutes, and at the *Coliseum* four modules twenty two minutes.

The height of the *Corinthian* pedestals, at the altars of the *Pantheon*, are seven modules twenty eight minutes; the *Coliseum* four modules two minutes, and the *Composite* pedestals of the Goldsmiths-arch, seven modules eight minutes.

Now since 'tis absolutely necessary, that these diversities should be reduced to a mean proportion, for a standard measure, therefore I have done it, and is as following, *viz.* Make the entire height of the *Tuscan* pedestal equal to two diameters or modules. The *Dorick* to two modules twenty minutes; the *Ionick* to two modules forty minutes; the *Corinthian* to three modules, and the *Composite* to three modules twenty minutes, the progression being of forty minutes.

N. B. That a module is a length equal to the diameter of the base of the column, divided into sixty equal parts called minutes.

The difference in the proportions of the parts of pedestals, are as great as those of their heights, and therefore I have also established this one general proportion for the parts of all pedestals, *viz.* Divide the height of any pedestal (be it *Tuscan*, *Dorick*, *Ionick*, *Corinthian* or *Composite*) into one hundred and twenty equal parts, and of those parts give to the socle twenty, to the mouldings of the base ten; to the die or trunk seventy five, and to the cornice fifteen.

The proportions assigned for the projecture of the base and cornish of pedestals, by both ancient and modern architects, are as various as their other parts, and therefore in this point also, I have reduced the diversities to a mean proportion, that thereby a general rule may be observed throughout the five orders, *viz.* In any order, be it *Tuscan*, *Dorick*, *Ionick*, *Corinthian*, or *Composite*, make the bases of pedestals, (exclusive of their zocolo or plinth) with a projecture equal to their altitude, which being different in every order, will therefore cause the projecture of the base to be different in each order. In the projecture of cornices of pedestals, made by either ancients or moderns, there is but little difference, for they usually make their projecture equal to (or very little more, than) that of the base, of which the last is to be preferr'd; and therefore, for a standard rule, I give the following proportions, for the projecture of both base and cornice, as follows, *viz.* To the *Dorick* pedestal, I give to the projecture of the base twelve minutes, and to the cornice fourteen. To the *Ionick* pedestal I give to the projecture of the base fourteen minutes, and to the cornice seventeen. To the *Corinthian* pedestal, I give to the projecture of the base fifteen minutes, and to the cornice nineteen. And lastly, to the *Composite* pedestal, I give to the projecture of the base sixteen minutes, and to the cornice twenty two.

I shall now mention another particular belonging to pedestals, as is common in all the orders, (and then proceed to the proportions belonging to columns) which is as follows: That the breadth of the die of every pedestal be always equal to the projecture of the base of its column.

The

The projecture of the bases of columns, is also an unsettled part of architecture. For to the *Tuscan* base *Palladio* and *Scammozzi* allow each forty minutes, as also hath the *Trajan*'s column, but *Vignola* allows forty one, and *Serlio* forty two minutes. To the projecture of the *Dorick* base, *Palladio* allows forty minutes, *Scammozzi* forty two, *Vignola* forty one, *Serlio* forty four, and at the *Coliseum* forty minutes.

To the projecture of the *Ionick* base, *Palladio*, *Scammozzi*, and *Serlio* allow forty one minutes; *Vignola* forty two; the temple of *Manly Fortune* forty three; and the *Coliseum* forty minutes. To the projecture of the *Corinthian* base, *Scammozzi*, *Serlio*, and the *Coliseum* allow forty minutes; the portico of the *Pantheon* forty one; the three columns of *Campo Vaccino*, the baths of *Dioclesian*, *Palladio*, and *Vignola* allow each forty two, and the pilasters of the portico of the *Pantheon* forty three.

And lastly, to the projecture of the *Composite* base, the temple of *Bacchus*, the arch of *Septimius*, *Scammozzi*, and *Serlio*, allow each forty one minutes, *Palladio* and *Vignola* forty two; the baths of *Dioclesian* forty three, and the arch of *Titus* forty four minutes. Hence it appears, that forty two minutes is a mean proportion, between the extremes, and is what I recommend for the projecture of the bases of columns in general.

The great diversity of the lengths of columns of the same order assign'd by architects, is a very difficult point to account for: To the length of the *Tuscan* column *Vitruvius Palladio*, and *Vignola*, give seven diameters or modules. *Scammozzi* seven and an half. The *Trajans* column eight, and *Serlio* but six diameters.

To the length of the *Dorick* column, *Vitruvius* in temples, allowed seven diameters; but in *Portico*'s of temples seven diameters and an half; at the *Coliseum* they consist of nine diameters and an half; and at the theatre of *Marcellus* seven modules and fifty minutes; *Scammozzi* gives eight and an half; and *Vignola* eight diameters only.

To the length of the *Ionick* column, *Vitruvius*, *Palladio*, and *Serlio*, give eight diameters forty minutes, as also is the *Coliseum*, and theatre of *Marcellus* at *Rome*.

To the length of the *Corinthian* column, *Vitruvius* gives nine diameters thirty minutes, and *Serlio* nine diameters only; at the porch of the *Pantheon* they are nine diameters thirty six minutes.

The temple of *Pantheon* they are nine diameters, thirty six minutes. The temple of *Vesta* nine modules thirty nine minutes. The temple of the *Sibil* eight modules sixteen minutes. The *Coliseum* eight modules thirty seven minutes.

The temple of *Peace* nine modules thirty two minutes: The arch of *Constantine* eight modules thirty seven minutes: The three columns of the *Campo Vaccino*, ten modules six minutes; the porch of *Septimius* nine modules thirty eight minutes; the temple of *Faustina* nine modules thirty minutes, and the *Basilic* of *Antoninus* ten modules exactly.

To the length of the *Composite* columns, *Scammozzi* gives nine modules forty minutes, and the same is at the temple of *Bacchus*; the arch of *Septimius* nine modules thirty minutes, and the arch of *Titus* ten modules precisely.

Now

Now, becauſe 'tis reaſonable, that a proportionable length ſhould be eſtabliſhed for the length of columns in general, I have therefore reduced the extremes of their diverſities to a mean proportion as following, *viz.* Make the height of the *Tuſcan* column equal to ſeven diameters or modules, and twenty minutes; the *Dorick* to eight modules; the *Ionick* to eight modules forty minutes; the *Corinthian* to nine modules twenty minutes, and the *Compoſite* equal to ten modules only. So will their progreſſion be proportionable, conſiſting of forty minutes in each column.

The diminiſhing of columns being firſt aſſign'd for that beautiful appearance, as flows therefrom, is made in three different manners. As firſt, to begin the diminution at the baſe of the column, and continue it to the capital. The ſecond is to make the column thicker towards the middle, than at its baſe, diminiſhing of it towards the baſe and capital, which kind of diminution is called the ſwelling. The third and laſt way is according to the antique manner: Beginning the diminution at one third of the height above the baſe of the column, as is ſhewn in folio 63 hereof, and is the moſt beautiful kind of diminution.

The difference and quantity of diminution in each of the orders, is exhibited in ſect. 2. Part 2. hereof.

There being yet no certain determin'd proportion for the height of the aſtragal and cincture, which terminate the ſhaft of a column. I therefore have alſo reduced thoſe members, to ſuch a proportion, as may be applied throughout the orders in general. As firſt to the cincture, I give three minutes, and to the aſtragal three minutes and one third. In the *Pantheon,* the temples of *Veſta* and *Manly Fortune,* and arch of *Titus*, the cinctures are very near three minutes. And in the temple of *Antoninus* and *Fauſtina* ſomething more, as alſo the temple of *Bacchus*, the arch of *Septimius,* and in the bath of *Diocleſian*, from which I have extracted my mean proportions.

The received proportion for the height of the baſes of each order is, to make them equal to the ſemidiameter of the column at its baſe, the *Tuſcan* excepted, in which the cincture is included, which in other orders is not.

In the five orders of architecture, there are three different heights of Capitals. The *Tuſcan* and *Dorick* capitals are always equal to the height of their baſe. The *Ionick* capital, from the top of the abacus to the point of interſection, where the cathetus and voluta interſect each other, at the bottom of the volute; to the ſemidiameter and an eighteenth part thereof. And laſtly, the *Corinthian* and *Compoſite* capitals to one module and ten minutes.

But, notwithſtanding that theſe meaſures are aſſigned for the height of capials, yet 'tis to be obſerved, that the ancients did not obſerve them ſtrictly. For the capital of *Trajan*'s column (which is of the *Tuſcan* order) is leſs than the ſemidiameter of the column's baſe, by a full third; and in the *Dorick* capital of the theatre of *Marcellus*, its height is almoſt thirty three minutes, and that of the *Coliſeum* near thirty eight minutes: Nay, in the *Corinthian* capital of *Vitruvius* (the father of architects) he makes its height but fifty minutes: And therefore I finding that its height was not ſufficient, have introduced a modern capital in its ſtead. At the temple of the *Sibyl* at *Tivoli*, the height of the *Corinthian* capitals are but forty ſeven minutes. In the frontiſpiece of *Nero* ſixty ſix minutes, and in the temple of *Veſta* at *Rome* almoſt ſixty eight minutes. And laſtly, the height of the *Compoſite* capitals of the arches of *Septimius* and the Goldſmiths, are but fifty eight minutes and an half, and the temple of

Bacchus ſixty ſix. Hence appears the oppoſite diverſities, from which are eſtabliſh'd the mean proportions before delivered.

And altho' the proportions of the aforeſaid capitals are very different from each other, yet there is a far greater difference in the height and projecture of entablatures, which they with their columns ſupport.

To the height of the *Tuſcan* entablature, *Vitruvius* allows one hundred and five minutes, *Palladio* one hundred and four minutes, *Scamozzi* one hundred and twelve, *Vignola* one hundred and five, and *Serlio* ninety minutes.

To the height of the *Dorick* entablature, *Vitruvius* allows one hundred and twenty minutes (equal to two modules) *Palladio* one hundred and thirteen minutes: *Scamozzi* one hundred and twenty ſeven minutes; *Vignola* one hundred and twenty; *Serlio* one hundred and twelve; and the like of all other Maſters, as are ſet forth in the 19, 21, 22, 24, 25, 26, 27, 28, and 29th plates hereof, to which I refer.

Now ſeeing that the beauty of an order doth conſiſt in a proportionable entablature; therefore to prevent the deſtruction thereof, by having entablatures either of ſuch a ſize: that they ſeem utterly inſupportable, as thoſe of *Campo Vaccino*, and the frontiſpiece of *Nero*, or on the contrary, too mean and pitiful as the entablatures of *Bullant* and *Delorme*; I adviſe that the height of all entablatures be always equal to two diameters, or one hundred and twenty minutes, and their projecture of the cornice, equal to the height thereof in the *Tuſcan*, *Ionick*, *Corinthian* and *Compoſite* entablatures, and the *Dorick* entablature alſo, when the cornice is made without mutules, (as in that famous ſtructure the *Coliſeum*). But when the *Dorick* entablature hath mutules introduced, their length requires the entire cornice to have more projecture than height.

Having thus demonſtrated the proportions of the principal parts of columns, I ſhall now proceed to the remaining part of my preface.

The third ſection of part 2. contains many excellent architectonical axioms and analogies, collected from moſt grand maſters.

The fourth ſection of part 2. contains the uſe of an inſpectional plain ſcale, which furniſhes the young ſtudent not only with all kind of ſcales, but readily divides the ſeveral parts of a building inſtantly.

The fifth ſection of part 2. contains trigonometrical definitions, with the conſtruction of chords, ſines, tangents, half tangents, ſecants and verſed ſines, applied to practice in the ſolution of the twelve caſes of plain trigonometry, which is performed geometrically alſo, by the help of a plain ſcale and pair of compaſſes, in a very conciſe and familiar manner.

The ſixth ſection of part 2. contains the geometrical conſtruction of draughts, plans, maps of gardens, farms, *&c.* Wherein is ſhewn how to perform ſuch works, much more expeditious and exact than any author yet extant.

The third part contains all the moſt uſeful geometrical axioms and analogies for the menſuration of any ſuperficial figure or ſolid body.

The fourth ſection of part 3. contains the meaſures, and manner of taking the dimenſions of all kinds of work relating to building, as Carpenters, Glaziers, Joiners, Painters, Plaſterers, Maſons, Bricklayers, Paviors, *&c.*

The

The fourth part contains divers inſpection tables of menſuration, whereby any dimenſion may inſtantly be caſt up, without the aſſiſtance of multiplication, or even ſuch capacities as are not maſters of croſs multiplication, are hereby enabled to meaſure any work with as great accuracy, as the beſt accomptant.

The firſt, ſecond, third, fourth, fifth, ſixth, ſeventh, eighth, ninth, tenth, eleventh, twelfth, fifteenth, ſixteenth and ſeventeenth plates, being thoſe which the ſeveral ſubjects hereof have recourſe to, need not in this place ſay any thing thereof.

The thirteenth and fourteenth plates contain a new ſyſtem of gardening, wherein 'tis ſhewn what great improvements may be made, even in the ſmalleſt of gardens; for by the method there obſerved, a ſmall garden may be made to appear as a very large one; and ſuch as are very large, to become the moſt noble and delightful.

And becauſe no gardener can well underſtand the true manner of laying out a garden, even in any manner as bears any proportion, without well underſtanding the elements of geometry; therefore for his ſake, in the firſt part hereof, I have laid down all as is neceſſary to be known in a moſt conciſe and eaſy manner, and applied to practice in the geometrical conſtruction of all kind of lines and figures, as are requiſite for his purpoſe in the practice of gardening. Perhaps that ſome may expect that I ſhould herein treat of the culture of lands, the management of fruit trees, *&c.* which are parts as doth not relate to the mathematical part of gardening, as in deſigning, drawing, laying out, *&c.* But if God permits, I ſhall ſpeedily communicate a treatiſe thereof, wherein I ſhall diſcover many curious experiments, as will prove both pleaſant and advantagious to all lovers of gardening.

The eighteenth, nineteenth, twentieth, twenty firſt, twenty ſecond, twenty third, twenty fourth, twenty fifth, twenty ſixth, twenty ſeventh, twenty eighth and twenty ninth plates, contain the geometrical profiles and elevations of the five orders of architecture, as laid down by all the grand maſters, both ancient, antique, and modern.

The thirty and thirty firſt plates are deſigns for the entrance into ſhady walks; the firſt into a right lined walk, and the other into a curved, or artinatural walk, and thoſe are delineated according to the truth of perſpective.

The thirty third plate contains two deſigns for the enterances into *Grottos* according to the grand manner.

The thirty fourth plate contains divers capitals of the *Corinthian* and *Compoſite* orders, taken from the works of *Vitruvius*, and *Andrew Boſſe*, with an elegant elevation of a noble ſtructure after *Palladio*.

The thirty fifth, thirty ſixth, thirty ſeventh, and thirty eighth plates contain divers geometrical elevations of doors, neathes, *&c.* of the *Tuſcan*, *Dorick*, *Ionick*, *Corinthian* and *Compoſite* orders, adorned with His moſt Sacred Majeſty King GEORGE; their Royal Highneſſes the Prince and Princeſs, whom God preſerve.

The thirty ninth plate contains divers excellent deſigns for chimney-pieces, collected from the beſt of maſters.

And

And the fortieth plate, the geometrical elevation of the portico of *St. Mary* the *Egyptian,* with a *Corinthian* frontifpiece from the Ancients, and the impofts of the *Tufcan, Dorick, Ionick, Corinthian* and *Compofite* orders.

Having thus, by way of preface, explain'd the feveral parts of the work, I now recommend you to the practice, defiring that you wou'd read and examine it, without critical envy, free from pre-occupation that may obfcure your Judgment, and hinder your acknowledging the truth of what I have here prefented for your improvement.

Therefore be not advifed by fuch as condemn a conception when they underftand it not; and believe it falfe becaufe 'tis new; neither imitate thofe, who feeking only to carp at words, neglect the fenfe of the fubject.

B. Langley.

THE

THE

PRACTICE

OF

Architecture, *Gardening*, *Mensuration*, and *Land-Surveying*, Geometrically demonstrated.

PART I.

Of such Geometrical Elements as are absolutely necessary to be well understood by every Person who desires to well understand the TRUTH of Lineal ARCHITECTURE, GARDENING, and MENSURATION universally.

SECT. I.

Of Geometrical Definitions and Rudiments.

PLATE I.

(1.) A Point in the practice of geometry, is the least superficial appearance as can be made by the point of a pen, pencil, pin, *&c.* as the point A, and is to be divided by the mind, tho' not by the hand, into any number of parts, as is conceived, Fig. I.
notwithstanding that *Euclid*, and many other famous geometricians, has defin'd a point to be neither quantity or part of quantity, and therefore not to

be

be divided into parts: but how 'tis demonſtrated, neither he or any other has ſet forth.

(2.) A line in the practice of Geometry, is a length, with ſuch a breadth, as is given thereunto by the point of the pen, pencil, *&c.* as deſcribes the ſame, which is quite contrary to all other authors, who define a line to be a length without breadth or thickneſs, but without any ſort of demonſtration whatſoever to prove the ſame.

(3.) Of lines there be divers kinds, as right, circular, elliptical, parabolical, hyperbolical, *&c.*

(4.) A right line is generated by the point of a pen, pencil, *&c.* moving from one point to another, the neareſt
Fig. II. way; therefore a right line is the neareſt diſtance contain'd between two points, as the diſtance between the points A, B. The end or limits of all right lines are points, as the points A B.

(5.) A circular line is generated by the motion of one end of a right line. Suppoſe A C to be a right line, fix'd at C as on a center; then by moving it out of the poſition A C to C B, the point A will deſcribe or generate the arch,
Fig. III. or circular line, A B; and if you move it forward to its former poſition A C, the point A will deſcribe or generate the circumference of a circle.

(6.) An elliptical line, or ellipſis, is generated by an ob-
Fig. IV. lique ſection of a cylinder.

(7.) A parabolical line is generated by a parallel ſection
Fig. V. of a cone. As alſo a hyperbolical curve, the former to the ſide, and the latter to the axis.

(8.) As points terminate lines, ſo do lines ſuperficial figures.

(9.) A ſuperficial figure hath length and breadth only, and is contain'd under one termination or many. So
Fig. VII. A is contain'd under one line or termination, B under two, C under three, D under four, E under five, *&c.*

(10.) A circle is a plain geometrical figure, contain'd under one line, called the periferie or circumference.

(11.) Every circumference of a circle is deſcribed according to the 5th hereof, and the point on which the deſcribent reſts, is the center. So in *Fig.* III. the point C is the center thereof. Therefore, as the center of a circle is
Fig. VII. the exact midſt of the ſame, all right lines drawn from thence to the circumference, are equal one to the other, as in *Fig.* VII. A B is equal to B C, and that to B D, *&c.*

Fig. VIII. (12.) The diameter of a circle is a right line drawn through the center, and ending at the circumference, as the line A B C.

(13.) The radius, or ſemidiameter of a circle, is half the diameter.

(14.) A ſection, ſegment, portion, or part of a circle, is a figure contain'd under one right line, and part of the circumference. So the right line A B divideth the circle into two unequal parts, and are the ſections, ſegments, portions, or part of that circle. Fig. IX.

(15.) A ſemicircle is one half of a whole circle, as the figure A.

(16.) A quadrant is one half of a ſemicircle, as the figure B. Fig. X.

(17.) The radius of a quadrant, is either of the ſtreight ſides, as *n m*, or *m o*, and the circular ſide *n o* is called the limb, which is always divided into degrees and min. as will hereafter be fully ſhewn in its proper place.

(18.) An ellipſis is alſo a plain geometrical figure, contain'd under one line, called the circumference, and is generated according to the 6th hereof; and as the diameters of a circle are equal to each other, ſo likewiſe are the diameters of one ellipſis to another, when both are of the ſame dimenſion, but at no other time. Therefore in ellipſis's there is a great variety contain'd.

(19.) Every ellipſis hath two diameters, the one longer than the other; the longeſt diameter is called the conjugate diameter, and the ſhorteſt the tranſverſe diameter; the point of interſection of both diameters as A, is the center of the ellipſis. Fig. XI.

(20.) A triangle is a geometrical figure contain'd under three ſides, and is either right lined as the triangle A, or circular as C, or mix'd as B. Fig. XII.

(21.) When a geometrical figure conſiſts of four ſides and angles, and all equal as the figure B, ſuch a figure is called a quadrat, or geometrical ſquare; but if of the four ſides, two be longer than the other, each to its correſpondent, and the angles equal as the figure C, 'tis called an oblong, long-ſquare, or parallelogram; alſo when the ſides be all equal, and the angles unequal, as the figure D, ſuch a figure is called a rhombus or diamond form; but if ſuch a figure ſhould have two ſides longer and two ſhorter, each to his oppoſite correſponding, as the figure E, 'tis called a rhomboyades; and when the ſides are all unequal, and the angles the ſame as the figure F, ſuch a figure is called a trapezium. Fig. XIII.

(22.) When any figure contains more than four unequal ſides, and angles, ſuch are in general called irregular figures.

(23.) When a geometrical figure contains five equal ſides and angles, as the figure A, ſuch a figure is called a
Fig. XIV. pentagon; and if ſix as B, a hexagon; if ſeven as C, a heptagon; if eight as D, an octagon; if nine as E, a nonagon; and if ten as F, a decagon.

(24.) The diagonal lines of a geometrical ſquare, are two right lines, drawn from one angle to the other, as the lines
Fig. XV. A B and C D.

(25.) The diameters of a geometrical ſquare, are two right lines drawn through the interſection of the diagonals, parallel to the ſides of the ſquare, as the lines E F and I K.

(26.) The center of a geometrical ſquare, is a point of interſection of the diagonals, or diameters, or both, it
Fig. XV. being the ſame as the point L. And what is here ſaid of a geometrical ſquare, the ſame is to be underſtood of an oblong, or parallelogram, rhombus, rhomboyades and trapezium.

(27.) As lines terminate ſuperficial figures, ſo do ſuperficial figures ſolid bodies.

(28.) A ſolid body hath three dimenſions, *viz.* length, breadth, and (thickneſs or) depth.

(29.) Geometrical ſolid bodies, are the ſphere, ſpheriod, cone, fruſtum of a cone, cylinder, pyramis, fruſtum of a pyramis, priſm, tetraedron, fruſtum of a tetraedron, cube, fruſtum of a cube, parallelepipedon, octaedron, dodecaedron, and icoſaedron.

(30.) A ſphere, globe, or ball, is generated by the revolution of a ſemicircle, about its own diameter. So alſo is a ſpheriod, by the revolution of a ſemi-ellipſis on its longeſt diameter, as figure A and B.

(31.) A cone, is generated by the revolution of a right angled plain triangle about one of its legs, as the figure D. So alſo is a cylinder by the revolution of a paralle-
Fig. XVI. logram about one of its ſides, as the figure E.

(32.) The fruſtum of a cone, is the remains of a cone, when a part thereof is taken away from the upper part, as F L G, taken away from H L I, leaves the fruſtum F G H I; and what is here ſaid of the fruſtum of a cone, the ſame is to be underſtood in the fruſtum of a pyramis or pyrament.

(33.) A pyramis, or pyrament, is a ſolid, which hath a triangle, ſquare, polygon, &c. for its baſe, and hath as many reclining faces as are ſides contain'd in the baſe, which all terminate in a point like a cone, which point, or termination, is called the vertex, or vertical point of the

pyrament

pyrament or cone. See figure K, which is a pyrament, whoſe baſe is a geometrical ſquare.

(32.) A priſm is a ſolid body of five faces, three of which are parallelograms, and two equilateral triangles, as the figure M.

(33.) A tetraedron is a ſolid, containing four faces, each an equilateral triangle, and is one of thoſe five bodies, as are called, the regular, or platonick bodies, as the figure N.

(34.) The fruſtum of a tetraedron is a tetraedron with the angles or vertexes cut off, or a ſmall tetraedron cut from every angle. This body thus cut, is compoſed of eight faces, *viz.* four hexagons, and four equilateral triangles, and is as agreeable a body as any herein contained. See figure O.

(35.) A cube is a ſolid body containing ſix faces, each a geometrical ſquare, as figure P.

(36.) The fruſtum of a cube, is a cube with the angles cut off, or 'tis a cube, that has had a pyramis cut from each angle, this ſolid contains fourteen faces, of which ſix are octagons, and eight equilateral triangles, which being taken together is a very handſome body. See figure Q. There is alſo another body, as is not a great deal different from the preceding, which by workmen is called the canted cube, and is no other than the greateſt pyrament, as can be taken from each angle, (which in the former was not.) This body thus cut, contains the ſame number of faces as the preceding; but inſtead of having ſix octagons and eight ſmall triangles, it hath ſix geometrical ſquares, and eight very large equilateral triangles. See figure U. Fig. XVI.

(37.) A parallepipedon is a ſolid body, containing ſix faces (as the cube) whereof but two are geometrical ſquares, and the other four, parallelograms; but a parallepipedon may have all its faces parallelograms, when its ends are parallelograms, inſtead of geometrical ſquares. See the figures R and S.

(38.) An octaedron is a ſolid body, containing eight faces, each an equilateral triangle.

(39.) A dodecaedron is a ſolid body, containing twelve faces, and each a pentagon.

(40.) An Icoſaedron is a ſolid body, containing twenty faces, and each an equilateral triangle.

(41.) The baſis of a ſphere, or ſpheriod, is but a point.

(42.) The baſis of a cylinder is a right line.

(43.) The basis of a cone is a circle.

(44.) Besides the preceeding solids there be two others, *viz.* one of twelve faces, and another of thirty, and every one a rhombus or diamond form. And as these definitions are full sufficient for any surveyor, I shall now proceed to the second section.

SECT. II.

Of *Geometrical Problems.*

PROBLEM I.

TO divide the right line A B, *into two equal parts, by the perpendicular* d d.

Open your compasses to any distance, that is more than half the line A B. Place one foot or point in A, and with the other describe an arch as *e e*, then with the same opening on B, describe the arch *c c*, which will intersect the first arch *e e*, in *d d*; draw a right line from *d* to *d*, the two intersections, and it shall divide the given line A B, into two equal parts, in the point E, and shall be perpendicular thereunto.

Fig. XVII. A perpendicular is a right line, erected upon a right line, making the angles equal on each side, as E *d*, on either side A B.

Use.

This problem is of great use in the setting out of buildings and gardens, as well as in drawing or designing the same on paper. In the practice of which, a ten foot rod, or a garden line, supplies the place of compasses, for to describe the arches of intersection.

PROBLEM II.

Upon any point as E, *given in the right line* A B, *to erect the perpendicular* I E.

1. Open your compasses to any small distance, and placing one foot in the given point E, with the other foot intersect the given line on each side, as at *c* and *d*.

2. Open your compasses to any greater distance, and placing one point in *d*, with the other describe the arch *b b*;

b b; alſo with the ſame opening on the point *e*, deſcribe the arch *a a*, interſecting the firſt arch *b b*, in the point I. Fig. XVIII.

3. Draw the line I E, and it ſhall be the perpendicular required.

Uſe.

This is alſo a very uſeful problem, as alſo are all the enſuing, both in building and gardening, in dividing of the parts thereof, which are too numerous to be inſerted here, and therefore are omitted till a more convenient time, when I ſhall preſent the world with a particular diſcourſe on that ſubject for the inſtruction of ſuch youth, whoſe natural genius tends either to architecture or gardening.

Problem III.

From the end of the right line A C, *at* C, *to erect the perpendicular* C D.

1. Open your compaſſes to any diſtance, and ſet one foot in C, deſcribe the arch B, *n*, *m*, and upon it ſet the ſame opening from B to *n*, and from *n* to *m*. Fig. XIX.

2. With the ſame diſtance, or opening of your compaſſes, deſcribe the arch *n f*, on the point *m*, and alſo the arch *e m*, on the point *n*, interſecting the arch *n f*, in the point D.

3. Draw the right line C D, and it ſhall be the perpendicular required. This problem may be performed many other ways; but none better or eaſier than the preceding and the following.

Problem IV.

How to erect a perpendicular upon the end of a line, after another manner.

1. With any opening of the compaſſes, deſcribe the arch B *g*, on the point C, and ſet that opening from B to *g*.

2. Deſcribe the arch B D E F, on the point *g*, with the ſame opening as before; and upon this arch ſet up the ſame opening three times, *viz.* from B to D, from D to E, and from E to F. Fig. XX.

3. Draw a right line from F to C, and it ſhall be the perpendicular required.

Problem

PROBLEM V.

To let fall a perpendicular line, from a point to a right line given.

☞ In the performance of this problem, there is two cafes. The firft, is when the given point is over or near the middle of the line. And the fecond, when near or over the end of the line.

Cafe I.

Let N O, be the right line given, and from the point P to let fall the perpendicular P Q.

1. Open your compaffes to any diftance greater than P Q, and on the point P defcribe the arch R S, interfecting the given line in the points R and S.

Fig. XXI.

2. With any opening on the point R defcribe the arch *v v*, and with the fame opening on the point S defcribe the arch *m m*, interfecting the firft arch, in the point I.

3. Lay a ruler from I to P, and draw the right line P Q, and it will be the perpendicular required.

Cafe II.

Let T, O, be the right line given, and from the point V to let fall the perpendicular V M.

1. From the given point V, to any part of the given line T O, draw a right line as V N, and by the firft hereof divide it into two equal parts in the point X.

Fig. XXII.

2. On the point X with the diftance V X or X N, defcribe the arch or femicircle V M N, interfecting the given line in the point M.

3. From the point given, to M the interfected point, draw the right line V M, and it fhall be the perpendicular required.

PROBLEM VI.

To defcribe a right line, parallel to a right line at any diftance affigned.

Definition.

Parallel right lines are fuch, that being infinitely continued would never meet.

Of parallel lines there be principally two kinds, *viz.* right lined parallels and circular parallels, as in the following problems.

In deſcribing of right lined parallels, there are two caſes; the firſt, to draw a right line parallel to a right line at any diſtance given; the other, thro' a point aſſign'd, which point may be over, under, or oblique to the given line.

Caſe I.

Let E F be a right line given, and let it be required to draw another right line parallel thereunto, at the diſtance of G H. Fig. XXIII.

1. Take in your compaſſes the given line G H, and on any part of the given line E F, as at E, deſcribe the arch *i k*, as alſo towards the other end, as at F, with the ſame diſtance, deſcribe the arch *c m*.

2. A line drawn by the convexity of thoſe two arches, ſhall be the parallel required, at the parallel diſtance of G H.

Caſe II.

Let A B be a right line given, and let it be required to draw another right line parallel thereunto; that ſhall paſs thro' the point E.

1. Take with your compaſſes the neareſt diſtance from the given point E, to the given line A B, and with that Fig. XXIV. diſtance, at the end A, deſcribe the arch *n n*.

2. A right line drawn through the given point E, by the convexity of the arch *n n*, ſhall be the parallel deſired, at the parallel diſtance of the given point E.

Problem VII.

To make the angle M C B, *equal to the given angle* E A N.

1. Upon the angular point A, with any opening of the compaſſes, deſcribe the arch *o o*, and with the ſame open- Fig. XXV. ing ſet one point, or foot of the compaſſes, on the point C, and deſcribe the arch *n n*.

2. Take the diſtance *o o*, and ſet it from *n* to *n*.

3. A line being drawn from C to *n*, ſhall make the angle M C B, equal to the angle E A N, as required. This problem is of great uſe in taking the plan of buildings, gardens, &c.

PROBLEM VIII.

To divide an angle, as A B C, *into two equal parts.*

1. Upon the angular point B, with any opening, describe the arch *r r*, interfecting the fides of the angle in the points *r r*.

Fig. XXVI. 2. With any opening, on the points *r r*, defcribe the arches *m m* and *v v*, interfecting each other in the point L.

3. A right line drawn from L to B, fhall divide the angle A B C, into two equal parts as required.

PROBLEM IX.

To divide a right line into any number of equal parts.

Let it be required to divide M N into fix equal parts.

1. From the end M or N, draw a right line at pleafure, as A M.

Fig. XXVII. 2. Make the angle N M E equal to M N A, by Prob. VII. or by the fecond cafe of Prob. VI. make M E parallel to A N.

3. Open your compaffes to any fmall diftance at pleafure, and fet off that diftance five times from N towards A, and from M towards E, as at the points 1, 2, 3, 4, 5.

4. Draw right lines from 5 to 1, from 4 to 2, from 3 to 3, from 2 to 4, and from 1 to 5; and their interfections will divide the given line M N, into fix equal parts, as required.

PROBLEM X.

To find a mean proportion between two right lines given. Let it be required to find a mean proportion, between the given lines N *and* O.

1. Make A D, equal in length to both the lines O and N, and by Problem I. divide it into two equal parts, in the point C.

2. On the point C, defcribe the femicircle, making the F. XXVIII. diameter equal to A D.

3. At E (the joining of both lines) erect the perpendicular E I, and continue it till it meet the curve in the point I.

4. The line E I is the mean proportion required.

PROBLEM XI.

To find the center of a circle as ſhall paſs through any three points given, as are not in a right line.

Let the three given points be D B A.

1. Draw a right line from any one of the points, as A, to either of the other points, as to B, and alſo draw another right line from B to D.

2. By problem I. divide thoſe two equal parts by two perpendiculars, as the perpendicular lines H F and C E, which perpendicular lines do always interſect each other, and the point of interſection is the center of a circle as will paſs through the points aſſigned. Fig. XXIX.

PROBLEM XII.

To inſcribe a triangle geometrical ſquare, pentagon, hexagon, heptagon, octagon, nonagon, or decagon, within a circle.

1. Deſcribe the circle A F C G, and draw the diameter A C and F G, interſecting each other at right angles, in the center E.

2. Make A B and A D, equal to the ſemidiameter E C, and draw the right line B D, which is the ſide of an equilateral triangle, as may be inſcribed in that circle.

3. Draw the right line A F, and it ſhall be the ſide of a geometrical ſquare.

4. Upon H, with the diſtance H F, deſcribe the arch F I, and draw the right line F I, which is the ſide of a pentagon as may be inſcribed therein. The diameter A C, or F G, is the ſide of a hexagon, and half B D; as H B, or H D, is the ſide of a heptagon or ſeptagon. Fig. XXX.

5. From E, the center through M, draw the right line E M K, ſo ſhall the diſtance, or right line A K, be the ſide of an octagon.

6. Divide the arch B A D, into three equal parts, each of which is the ſide of a nonagon, as D S.

7. The diſtance E I is the ſide of a decagon. Every ſide in the figure is number'd with its proper number, as

as the ſide of a pentagon with number 5, a hexagon with the number 6, &c.

This figure, thus made, is a very uſeful inſtrument to inſcribe any poligon in a circle, when required; as for example:

Let it be required to inſcribe a nonagon in the circle A B C D.

Fig. XXXI. 1. On the center E, deſcribe the circle F, G, H, I, equal in diameter to the circle A F C G, fig. XXX.

2. From thence take the diſtance S D, and ſet that diſtance from F to V, from V to Q, from Q to P, &c. to the point F, where you began.

3. Lay a ruler from the center E, to the ſeveral points F V Q P, &c. and 'twill cut the outer circle in the points *x x x*, &c.

4. Draw lines from *x* to *x*, &c. and thoſe lines ſhall form the nonagon required. And what is here ſaid of a nonagon, the ſame rule is to be underſtood of any other figure, as before deſcribed.

Problem XIII.

To make an equilateral triangle, as A, B, O, *whoſe ſides ſhall be equal to any given line, as the right line* N M.

1. Make A B equal to the given line N M, and with the diſtance A B, on the point A, deſcribe the arch *v v*, and with the ſame diſtance on the point B, deſcribe the arch *a a*, interſecting the arch *v v*, in the point O.

F. XXXII. 2. Draw from the interſection O, the right lines A O, and B O, and they will complete the equilateral triangle whoſe ſides are each equal to the given line N M, as required.

Problem XIV.

Three unequal right lines, as R S T, *being given to make a right lined triangle, whoſe ſides ſhall be equal thereunto.*

1. Make A B, equal to R.

2. Take the line S in your compaſſes, and on A deſcribe the arch *a a*.

3. Take the line T in your compaſſes, and on B deſcribe the arch *m m*, interſecting the firſt arch in the point C. Fig.

4. Draw from the interſection C, the right lines C A and C B, and they will complete the triangle, whoſe ſides are reſpectively equal to the given lines R S T, as required.

$$\left.\begin{array}{l}A\,B\\A\,C\\C\,B\end{array}\right\}\text{ equal to the given line }\left\{\begin{array}{l}R\\S\\T\end{array}\right.$$

Problem XV.

To deſcribe a geometrical ſquare, whoſe ſides ſhall be equal to a right line given.

Let it be required to make the geometrical ſquare M N O P, whoſe ſides ſhall be reſpectively equal to the given line A B.

1. Make O P equal to A B.

2. On the point P erect the perpendicular P N, (by problem III, or IV, hereof) and make it equal in length to the given line A B. Fig. XXXIV.

3. With the diſtance A B, on the point N, deſcribe the arch *n n*, and with the ſame diſtance, on the point O, deſcribe the arch *a a*, interſecting the former in the point M.

4. From M the point of interſection, draw the right lines M N and M O, and they will complete the geometrical ſquare, as required.

Problem XVI.

To make an oblong parallelogram, or long ſquare, as A B C D, *whoſe length and breadth ſhall be equal to two given lines, as* N O.

1. Make the line C D, equal to the given line O, and on D, (by the IIId problem hereof) erect the perpendicular B D, and make it equal to the given line N. Fig. XXXV.

2. On B, with the diſtance C D, deſcribe the arch *o o*, and on the point C, with the diſtance B D, deſcribe the arch *r r*, interſecting the former in the point A.

3. From A the point of interſection, draw the right lines A B and A C, and they will complete the oblong, as required

The ſide A B and C D } is equal to the right line { O
The ſide A C and B D } { D

PROBLEM XVII.

To make a rhombus, or diamond form, whoſe ſides ſhall be equal to a right line given.

Let it be required to deſcribe the rhombus A, M, N, O, whoſe ſides ſhall be each equal to the given line V, R.

Fig. XXXVI. 1. Make A O equal to V R, and on the point O, with the diſtance O A, deſcribe the arch A M N.

2. With the ſame diſtance ſet up the opening of the compaſſes from A to M, and from M to N.

3. From the point A to the point M, draw the right line A M, and from the point M, draw the right line M N to the point N; and laſtly, draw the line N O, and you will complete the rhombus as required, with its reſpective ſides equal to the given line V R.

PROBLEM XVIII.

To make a rhomboyades, whoſe ſides ſhall be equal to two given right lines, as L *and* Q; *and the acute angles at* M *and* O, *equal to the given angle* Z.

1. Make P M equal to the given line L, and by problem VII, make the angle E M P, equal to the angle Z, and make M E equal to the given line Q.

Fig. XXXVII. 2. Take in your compaſſes the given line L, and on E, deſcribe the arch *n n*.

3. Take the length of the other given line Q, and on the point P, deſcribe the arch *a a*, interſecting the former in the point O.

4. From O the point of interſection, draw the lines O E and O P, and they will conſtitute the rhomboyades as required, whoſe ſides O E and P M, ſhall be equal to the given line L, and the ſides O P and E M, equal to the given line Q, as alſo the angles at O and M, equal to the given angle Z.

PROBLEM

Problem XIX.

To make a trapezium (*as the ſigure* R N O M) *whoſe ſides ſhall be equal to four right lines given, as the lines* D, E, V, T, *and one angle, as the angle* N, *equal to an angle given, as the angle* Z.

1. Make N M equal to the given line D, and by problem VII. make the angle at N, equal to the given angle Z, and make N, R, equal to the given line E.

2. Take the given line V in your compaſſes, and on M deſcribe the arch *n n*, then take the given line T, and on R deſcribe the arch *a a*, interſecting the former arch in the point O. Fig. XXXVIII.

3. From the point of interſection O, draw the right lines O M and O P, and they ſhall complete the trapezium, as required, with its reſpective ſides equal to the lines given.

Problem XX.

How to deſcribe an ellipſis to any length and breadth given, as the ſigure A B C M, *whoſe longeſt diameter is equal to the given line* D V, *and the ſhorteſt to the line* E P.

1. Make the right line A C equal to the given line D V, and (by problem I.) divide it into two equal parts, by the perpendicular B M, which make equal to the given line E P.

2. Take half the longeſt diameter, as A F or C F, and on B deſcribe the arches *a a*, and *a a*, interſecting the longeſt diameter in the points O and N, which are the two centers by which the ellipſis may be deſcribed. Fig. XXXIX.

3. Faſten two pins, or tacks, (if on the ground, as in a garden, two ſtakes) at O and N, and putting a line about them, faſten the ends together, at the length of the line O C, or N A, ſo that the ſtring may move about both the pins, tacks, *&c.* at pleaſure.

4. Take a black-lead pencil, tracer, *&c.* and extending the line therewith, it will, by its motion about thoſe two centers, deſcribe an ellipſis, as ſhall be equal in length and breadth to the given lines D V and E P, as required.

Problem XXI.

How to deſcribe an ellipſis to any length and breadth, as the figure A B C D, *whoſe longeſt diameter is equal to the given line* M, *and the ſhorteſt to the line* N, *by the help of a pair of compaſſes, without the aſſiſtance of a line and tracer, as in the preceding problem.*

1. Deſcribe the longeſt and ſhorteſt diameters, equal to the given lines, interſecting each other, at right angles in the point E (as in the preceding).

2. Take half the ſhorteſt diameter, as B E, and place that diſtance from A to F on the longeſt diameter.

Fig. XL. 3. Divide the ſpace between F and E the center, into three equal parts, and place one of thoſe parts backward from F to I.

4. Make E K equal to E I, and on K, with the diſtance K I, deſcribe the arches *n n* on the one ſide, and *n n* on the other.

5. With the ſame diſtance, on the point I, deſcribe the arches *o*, *o*, and *o*, *o*, interſecting the other two in the points L and M.

6. Lay a ruler from L to I, and draw the line I V; alſo from L to K, and draw the K P; alſo from M to K, and draw the line K Q; and alſo from M to I, and draw the line I R.

7. On I, with the diſtance, I A deſcribe the arch *z* A *z*, and on K, with the ſame opening, deſcribe the arch *x* C *x*.

8. On M, with the diſtance M *z*, deſcribe the arch *z* B *x*; and on L, with the ſame opening, deſcribe the arch *x* D *z*, and thus is the ellipſis completed, as required.

Problem XXII.

To inſcribe a circle within a ſquare.

Fig. XLI. 1 Draw the diagonals N S and V M, interſecting each other in the point O.

2. From the point O, let fall the perpendicular O C, and with the opening O C on O, deſcribe the circle as required.

PROBLEM XXIII.

To inſcribe a ſquare within a circle, and to circumſcribe a circle about a ſquare.

1. By the third of problem XII. inſcribe the ſquare A E I O, and draw the diagonals A O and E I, interſecting each other in the point N. Fig. XLII.

2. On N, with the diſtance N A, N E, N I, or N O, (they being all equal to each other, by definition 11. fig. VII.) deſcribe the circumſcribing circle, as required.

PROBLEM XXIV.

To inſcribe a circle within a triangle, as the circle M, o, e, *within the equilateral triangle* A E N.

1. Divide any two of the angles of the given triangle, as the angle N and A, into two equal parts, by the lines N *o* and A *e*, interſecting each other in the point M, (as by problem VIII. hereof). Fig. XLIII.

2. From M let fall the perpendicular M P; and on M, with the diſtance M P, deſcribe the inſcribed circle, as required.

PROBLEM XXV.

To circumſcribe a circle about a triangle.

The ſolution of this problem is exactly the ſame as problem XI. For if you ſuppoſe the three angular points B C A, to be three given points, *&c.* as in that problem, the operation hereof is exactly the ſame, and therefore needs no further demonſtration. Fig. XLIV.

PROBLEM XXVI.

To find the center of a circle, that ſhall paſs through any two given points within a circle, and divide the circumference into two equal parts.

Let M N be the given points.

 1. From

1. From any one of the points as M, draw a right line through the center O, extending it infinitely to Æ. Upon this line, at the center O, erect the perpendicular
Fig. XLV. O W, and from W through M, draw the line W R; and from R, through O the center, draw the diameter R, O, *a*.

2. Draw the right line W *a*, and extend it till it interfect the line M O Æ, in the point V; through which, and the given points M and N, you may defcribe the arch of a circle (by problem XI.) as will divide the circumference given into two equal parts, and pafs through the two given points, as required.

Problem XXVII.

To make a geometrical fquare, as A E M N, *equal in area to any right lined triangle, as the triangle* I O M, *given.*

1. Let fall the perpendicular O R, and make M S equal to half the perpendicular O R.

Fig. XLVI. 2. Divide I S into two equal parts at R, and on R, with the diftance I R, or R S, defcribe the femicircle I A S.

3. At M erect the perpendicular M A, and extend it till it interfect the femicircle in A.

4. The line A M is the fide of a geometrical fquare, whofe area is equal to the area of the triangle given, as required.

Problem XXVIII.

To make a geometrical fquare, equal to a parallelogram given.

Let it be required to make a geometrical fquare equal in area to the oblong, or parallelogram, A B C D.

Fig. XLVII. 1. Continue the fide C D to F, making D F equal to BD, and divide C F into two equal parts at G, and thereon, with the diftance G C, or G F, defcribe the arch C E F.

2. Continue DB to E, and then will D E be a mean proportional, and the fide of a geometrical fquare, whofe area is equal to the oblong, or parallelogram, A B C D given, as required.

Problem XXIX.

To divide a line given, in ſuch proportion as another is before divided.

Let it be required to divide the right line M, in ſuch proportion as the line A E.

1. By problem XIII. hereof, make the equilateral triangle G H I, with its ſides equal to the line A E, and divide any one ſide thereof, as H I, in the ſame proportion, as A E (the length being equal).

2. Take the length of the line M, and ſet it from G (the angle oppoſite to the ſide divided) to V, on one ſide, and to O, on the other ſide, and draw the right line V O. Fig. XLVIII.

3. Lines being drawn from G, thro' the points 1, 2, 3, 4, 5, and 6, ſhall interſect the line V O, in the points o o o, &c. and divide that line in the very ſame proportion as the given line H I, as was required.

Problem XXX.

To divide the circumference of any circle into 360 equal parts, as the circle A B C D, *fig.* XLIX.

1. Draw the diameter A C, and by problem I. divide it into two equal parts by the perpendicular B D, then will the circle be divided into four equal parts, and conſequently the circumference alſo.

2. Open your compaſſes to half the diameter, as P A, &c. and ſet that diſtance, *firſt*, from A to *e*, and from A to *f*; *ſecondly*, from B to *m*, and from B to *l*; *thirdly*, from C to *k*, and from C to *i*; *laſtly*, from D to *h*, and from D to *g*; and thus you have divided the circumference into 12 equal parts, each repreſenting 30 degrees.

3. Divide each of thoſe diviſions into three equal parts, and each of thoſe parts into ten, and then will the circle be divided into 360 equal parts, which are called degrees. It is to be obſerved herein, that the ſemi-diameter, which is generally called the radius, is always equal in length to 60 degrees, or equal parts of the circumference. Every equal part (or degree) of the circumference, is always ſuppoſed to be divided into 60 leſſer e- Fig. XLIX.

qual parts, and thoſe are term'd or called minutes. Therefore when we mention two degrees and a half, we ſay two degrees 30 minutes; or one deg. and $\frac{1}{3}$, we ſay one degree and 20 min. and when we write down any number of degrees and min. as thirty degrees fifty ſeven minutes, we write them thus 30° : 57′, &c. And what is here ſaid in the diviſion of the circumference of this circle, the ſame is to be underſtood in the diviſion of the circumference of every circle, for in the circumference of every circle, there is always the ſame number of degrees therein, although ſome circles may be ſmaller, and others larger than the given circle A B C D.

Demonſtration.

1. Draw right lines from the center P, through every tenth degree of the circumference, and extend them infinitely.

2. On P the center, deſcribe the inward circle, and the lines before drawn through every tenth degree, will interſect that circle in the points *n n n*, &c. and will divide that circumference into thirty ſix equal parts, each repreſenting 10 degrees. Alſo on P deſcribe the outward circle *o o o o*, &c. wherein you may obſerve the aforeſaid lines of every tenth degree, to divide that circumference
Fig. XLIX. in the very ſame proportion, as the inward circle *n n n n*, &c. and the given circle A B C D. Therefore let any circle be as ſmall as may be conceived, or as large as the greateſt circle as can be ſuppoſed to bound the univerſe, the number of degrees in each are both equal, and conſequently the minutes the ſame, though greater or leſſer each, in ſuch proportion as the circumference of one circle hath to another, which is what was to be demonſtrated.

N. B. Before the young ſtudent proceeds any further, let him well underſtand this problem, for hereon the whole body of mathematicks depends, as alſo the ſeveral operations following; but if he finds any difficulty upon the firſt or ſecond reading, either of this or any other problem, let him not be diſcouraged, 'twill by often contemplating be made eaſy; for mathematicks, is not to be underſtood at once reading over, like plays, hiſtory, or romances.

PROBLEM XXXI.

To inſcribe an ellipſis within an oblong, or parallelogram, as A B C D.

1. Draw the two diameters of the parallelogram, as E G and F H, which ſuppoſe to be the length and breadth of an ellipſis given, to deſcribe the ſame as if they had not been the diameters of the oblong. Fig. L.

2. By problem XX, or XXI, deſcribe the ellipſis E F G H, and it will be the ellipſis inſcribed, as required.

PROBLEM XXXII.

To erect a perpendicular line by the help of a ten foot rod (or other meaſure equally divided) on the ground, in the ſetting out of a building, garden, &c.

The proportional numbers contained in a ſquare, or right angle, is 3, 4, and 5; or 6, 8, and 10; therefore if you would raiſe the perpendicular D F, from the point D, on the line H D; ſet off ſix foot from D to E, and with eight foot of your rod at D, deſcribe the arch *a a*; and alſo with ten foot, deſcribe the arch B B, on the point E, and the interſection F is the perpendicular point required: or, from E lay a ten foot rod, and from D an eight foot rod, and cloſe their ends together, and that ſhall be the perpendicular point alſo; and a right line drawn from thence to D, ſhall be the perpendicular required.

This problem may be applied to practice on paper, if you uſe a ſcale of equal parts, and a pair of compaſſes inſtead of the ten foot rod.

SECT. III.

Of *Geometrical* Axioms *and* Theorems.

PLATE IV.

AXIOM I.

IF to, or from, equal quantities, be added or ſubtract-ed equal quantities, the ſums or remainders will be equal.

Demonſtration.

Fig. I. 1. Draw the two diameters A F and L B, interſecting each other in the center N, and then will the angle A N L be equal to the angle B N F, for the arches A B and B F completes a ſemicircle, as alſo do the arches B A and A L. Therefore the arch B F muſt be equal to the arch A L, becauſe the arch A B continues the ſame; and by the ſame reaſon the angle A N B, is equal to the angle L N F.

AXIOM II.

Quantities equal to a third, are equal to one a-nother.

Demonſtration.

Fig. II. The alternate angles C and F, are equal to each other, as alſo E and D; for the angle C is equal to the an-gle B, and the angle B to the angle F, by the preceding axiom. Wherefore C and F being both equal to B, muſt be equal to one another, and the like of E and D, which are both equal to the angles A and G.

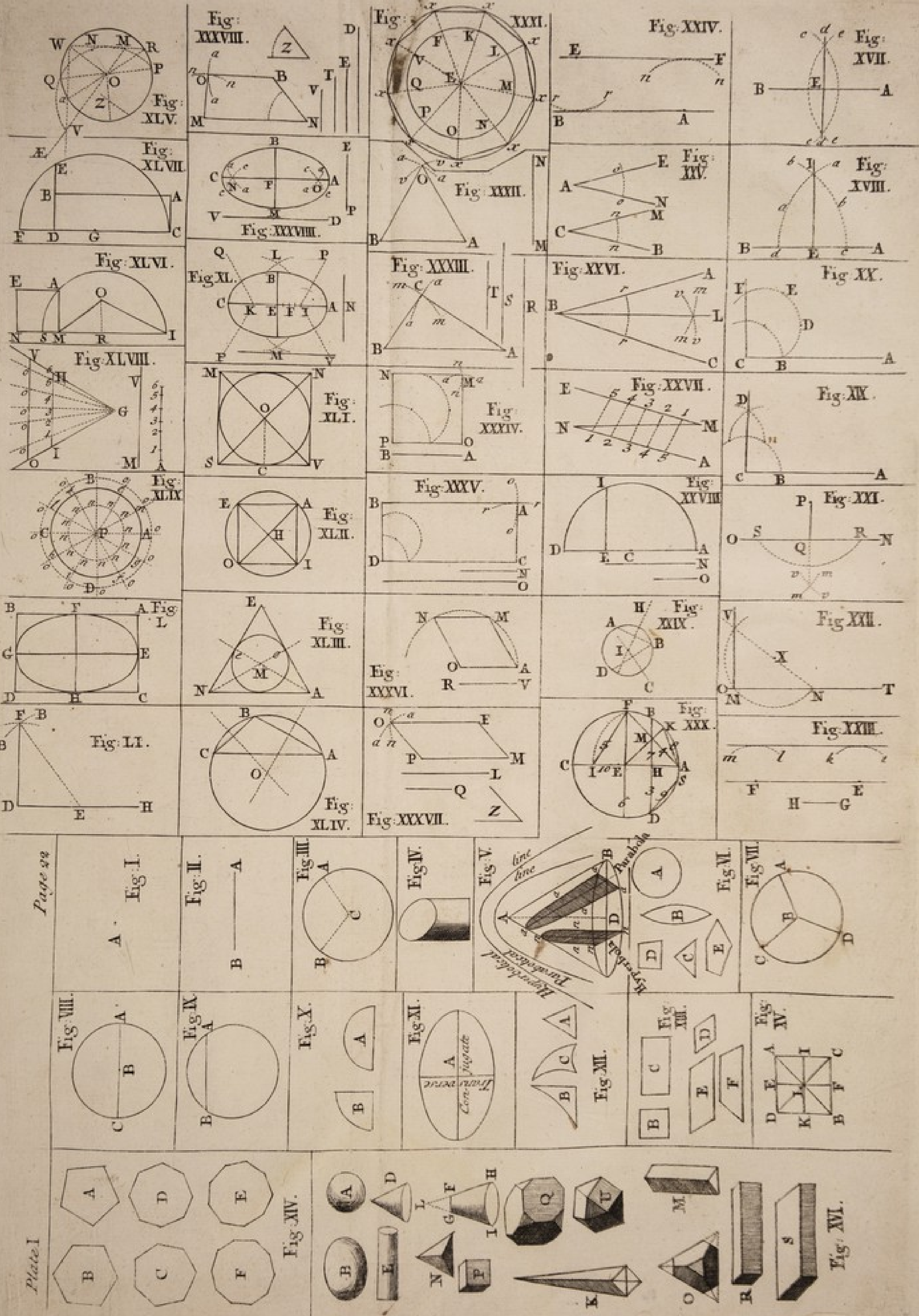
Fig: XLV.
Fig: XXXVIII.
Fig: XXXI.
Fig: XXIV.
Fig: XVII.
Fig: XLVII.
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Fig: XXXII.
Fig: XXV.
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Theorem I.

If a right line do fall on two parallel right lines, it maketh the opposite angles equal, and the internal angles on the same side, equal to two right angles, or 180 *degrees.* Fig. II.

1. The right line P Q, falling upon the two parallel right lines R T and S V, do make the angle D equal to A, and C to B, also the angle G equal to E, and H to F.

2. the angle D with F is equal to two right angles, because F is equal to C (by axiom II.) and C and D together are equal to two right angles, or a semicircle; and since the angle F is equal to the angle C, therefore F D or E C, are equal to two right angles, or 180 deg. which was to be proved.

Theorem II.

If multifarious right lines be intersected by multifarious right lines, which are parallel one to the other, the segments are proportional one to the other. Fig. III.

Demonstration.

Let the right lines N O and N M, be intersected by the six parallel right lines T T, V V, X X, Y Y, Z Z, and W W; then will the intersegments be proportional one to the other. For if N A be one fifth part of N O, N B is likewise one fifth part of N M, and the like of all others.

Theorem III.

If four right lines be proportional, that is, as the first is to the second, so is the third to the fourth; the parallelogram made of the two means (or middle terms) will be equal to the parallelogram made of the extreams. Fig. IV.

Demonstration.

Let the four proportionals be A 24, B 16, C 12, and D 8; I say, the parallelogram made of the two mean terms,

terms, *viz.* 16 and 12 is equal to the parallelogram made of the two extreams, *viz.* 24 and 8. Therefore multiply 16 by 12, and the product is equal to 192, and alſo 24 by 8, and the product is equal to 192, as before. Therefore 'tis apparent, that the parallelogram made of the means, is equal in power to the parallelogram made of the extreams, which was to be demonſtrated.

Theorem IV.

If three right lines be proportional, viz. *as the firſt is to the ſecond, ſo ſhall the ſecond be to a fourth. The ſquare made of the means ſhall be equal to the oblong made of the extreams.*

Demonſtration.

Fig. V. Let the proportional lines or numbers be 4, 8, 8, then will it be as 4 is to 8, ſo is 8 to 16, and the ſquare A E I O of the means, will be equal to the parallelogram, made by the extreams. For multiplying the means 8 by 8, the product is 64, and multiplying the extreams 4 and 16 by each other, the product is 64, and is equal to the product of the means which was to be demonſtrated.

Theorem V.

In every right angled plain triangle, the ſquare made of the hypothenuſe, or ſide which is oppoſite to the right angle, is always equal to the ſum of the ſquares made of the legs or ſides.

Demonſtration.

Fig. VI. Let N O M be a right angled plain triangle, whoſe ſides are as follows, *viz.* the ſide N M equal to 6, and the ſide M O equal to 8, then will the hypothenuſe be equal to 10.

2. If you multiply the ſide N M into itſelf, its product will be equal to 36, the ſquare N D M I.

3. Multiply the ſide M O into itſelf, and its product will be equal to 64, the ſquare M O V C.

4. Add

4. Add the area of both squares together, *viz.* 36 and 64, and their sum will be equal to 100.

5. Multiply the hypothenuse NO into itself, and its product is 100, which is equal to the sum of the squares made of the legs before added together, as was to be demonstrated

Sect. IV.

Plate. II.

Of the *Construction* of *Compound Geometrical FIGURES.*

1. *General AXIOMS for the proportions of figures.*

Axiom I.

THat the length of a proportionable parallelogram be to the breadth, as three is to two; therefore if the length be three foot, the breadth must be two foot.

Axiom II.

When a geometrical square hath its sides intercepted with semicircles externally, as A, the diameter of every such semicircle must contain $\frac{5}{7}$ of the side, on which 'tis described; and the same proportion also, when at the end of a parallelogram, as B. Fig. IX.

Axiom III.

When the angles of a geometrical square, or oblong, is cut off by the arch of a circle, the radius of those quadrants, or arches, must be $\frac{1}{7}$ the length of the side of a geometrical square, or end of the parallelogram, and the same proportion is to be observed when the angles are cut

cut off by a small geometrical square, as the fig. C cut by little squares, and D by quadrants or arches.

Axiom IV.

When the side of a geometrical square, or end of a parallelogram, hath its angles cut off by arches or little squares, and the $\frac{5}{7}$ remaining be intercepted by a semicircle, as E F; the arches, or little squares, must be first described, and the diameter of the semicircle must contain $\frac{5}{7}$ of the remainer, as the semicircle in axiom II. contains $\frac{5}{7}$ of the whole breadth.

Axiom V.

When the angle of a geometrical square, or oblong, is cut off by a part of a geometrical square, and the quadrant of a circle, as fig. G; the radius of those arches, or quadrants, must contain $\frac{3}{4}$ of the side of each little square.

Axiom VI.

Fig. IX. When a compound figure is circumscribed by a compound figure, those arches of the compound figure circumscribing, must contain $\frac{1}{3}$ of that side to which they belong, so *a*, *b*, contains $\frac{1}{3}$ of CD in figure H; but the center of all such arches must always be upon the internal fig. as at *m*.

Axiom VII.

When any side of a right line figure has a square break therein, as the figure T at V; the length of that break must be $\frac{1}{5}$ of AB, (*viz.* the length of the side wherein it stands) and the depth $\frac{1}{5}$; but when a break happens against an arch, as at O, in figure T T, those breaks must be made in proportion to the curve of the opposite arch.

Axiom VIII.

When an arch breaks into an oblong, as the arches *m m* in figure T T, it must not break in above $\frac{1}{5}$ of the breadth of the oblong at most, and the extreams of such an arch must ever be five times their depth. They are to be defcribed by problem XI. fect. I. having the depth, and both extreams given, as three given points.

AXIOM IX.

When the fides of a geometrical fquare is intercepted with femicircles internally, as figure Z; the diameters of thofe femicircles muft be no more than one half the fide of the fquare, wherein they are defcribed. Fig. IX.

Thefe axioms, and the preceding problems of fect. I. being well underftood, the young ftudent will find no fort of difficulty in defcribing the figures contain'd in the eight enfuing problems, to which we will proceed

A general Rule concerning Compound Figures.

THAT every compound (or plain) figure, that is encompafs'd with another figure, be not of the fame kind, *viz.* not to incompafs an octagon with an octagon, but with a circle, or fome other figure as is agreeable thereunto, and the like of all other figures in general.

PROBLEM I.

To defcribe the compound figure A B C D, *with its circumfcribing figure* E F G H.

1. By problem XV. fect. I. defcribe the geometrical fquare A B C D. Fig. I.

2. By axiom II. hereof, defcribe the quadrants of each angle, and thus will the interior figure be completed.

3. At the parallel diftance affign'd, draw the fquare E F G H, by problem VI. fect. I. and by axiom VI. hereof; defcribe the arches *o, o, o, o,* whofe centers are at *e, e, e, e,* and they will complete the figure required.

PROBLEM II.

To describe the compound figure A B C D, *with its circumscribing figure* E F G H.

1. By problem XV. sect. I. describe the square ABCD, in such proportion as is laid down in axiom I. hereof, and by axiom III. deduct the little squares from every angle.

Fig II. 2. Describe the outer parallelogram parallel to the first at the distance assign'd, and by axiom VI. describe the four arches H, G, F, E, whose centers are at *a a a a*, and they will complete the figure required.

PROBLEM III.

To describe the compound figure A B C D, *with its circumscribing figure.*

1. By problem XV. sect. I. describe the geometrical
Fig. III. square ABCD, and by axiom II. hereof, describe the semicircles, and then by drawing the circumscribing line parallel thereunto, at any distance assign'd, the figure is completed as required.

PROBLEM IV.

To describe the compound figure A B C D, *with its circumscribing figure.*

1. By problem XVI. sect. I. describe the parallelogram,
Fig. IV. according to the proportion of axiom I.

2. By axiom III. cut off the angles with the quadrant of a circle, and by axiom II. describe the semicircles at each end, whose centers are *e e*.

Lastly, Describe the circumscribing figure parallel thereunto, at any distance assign'd ; and the figure is completed, as required.

PROBLEM V.

To describe the compound figure A B C D, *with the circumscribing figure* E F.

1. By

1. By problem XVI. ſect. I. deſcribe the parallelogram A B C D, according to the proportion of axiom I. and deſcribe the ſemicircles at the ends, according to axiom II. Fig. V.

2. Deſcribe the outward line parallel thereunto at any diſtance aſſigned; and by axiom VII. deſcribe the breaks E F, and the figure is completed as required.

Problem VI.

To deſcribe the compound figure A B C D, *and its circumſcribing figure* E F G H.

1. By problem XV. ſect. I. deſcribe the geometrical ſquare A B C D, and by axiom V. deſcribe the angles. Fig. VI.

2. At any aſſigned diſtance deſcribe the outer ſquare E F G H; and by axiom VII. deſcribe the quadrants at every angle.

Laſtly, By axiom VI. deſcribe the arches K M N L, and the figure is completed as required.

Problem VII.

To deſcribe the compound figure A B C D, *and its circumſcribing figure* E F G H.

1. By problem XV. ſect. I. deſcribe the geometrical ſquare A B C D, and by axiom II. deſcribe the ſemicircles whoſe centers are *a a a a*; and by axiom III. deſcribe the arches at every angle. Fig. VII.

2. At any parallel diſtance aſſign'd, deſcribe the ſquare E F G H, and at the ſame parallel diſtance, deſcribe the arches I K L M, and the figures will be completed as required.

Problem VIII.

To deſcribe the compound figure A B C D, *with its circumſcribing figure* E K F L H M G I.

1. By problem XV. ſect. I. deſcribe the geometrical ſquare A B C D, and by axiom IX. deſcribe the ſemicircles *a a a a*. Fig. VIII.

2. At any parallel diſtance aſſigned, deſcribe the ſquare E F G H; and by axiom VII. deſcribe the breaks K L M I; and by axiom III. the arches at the angles E F G H, which will complete the figure as required.

Theſe foregoing eight inſcribed figures, are very beautiful forms for fountains, baſons, fiſh-ponds, graſs-plots, or ornaments of cockle-ſhells, ſand, borders, &c. about a ſtately tree of yew, holly, philerea, lauruſtinus, &c. or ſtatue. Provided that you have the advantage of a terrace-walk, or mount, to view the ſame, otherwiſe a plain plot of graſs is far preferable.

And to complete the idea and practice of ſuch figures in gardening, I have, for the exerciſe of the young ſtudent, and variety of choice, for all gentlemen as delight therein, inſerted the ſeveral forms in figure X. which are in general deſcribed by the preceding rules, and may not only prove a great help to invention, but alſo of uſe to many gentlemen in forming ſuch parts of their gardens (as they relate to) in the moſt elegant manner. Fig. X.

Thoſe figures marked A A, &c. are varieties of the interſections of gravel, ſand, and graſs walks with proper centeral plots, or figures, to place ſtatues on pedeſtals in, as alſo the forms of the ends of parterres, or graſs-plots, as circumſcribe the ſame.

Thoſe figures marked B B, &c, are niches, or breaks in hedges, walls, &c. for to place publick ſeats of delight in, at the termination of an elegant walk, avenue, &c. And,

Thoſe marked D D, &c. are the forms of cabinets, or private places of retirement, in the moſt private retired parts of a wilderneſs, labyrinth, grove, &c.

N. B. That although hitherto I have recommended theſe compound figures in gardening only; yet the ingenious ſtudent in architecture is to obſerve, that they are exceeding beautiful in building, as in cielings, parrquetting, painting, paving, &c.

SECT.

SECT. V.

Of the Conſtruction of the ſingle, double, &c. ſpiral Line, Scroll, Artinatural Line, &c. for Practice in Gardening.

PROBLEM I.

PLATE III.

TO deſcribe a ſingle ſpiral line at any aſſigned diſtance.

Let it be required to deſcribe the ſingle ſpirial line, at the diſtance of the given line *i k*. Fig. I.

1. Draw a right line, as A B, and on any convenient point of the ſame, as at *c*, deſcribe a circle of ſuch a diameter as is aſſigned.

2. Take half the given line *i k*, and place that diſtance from *c* the center, to *b* and *d* on each ſide hereof, which points, *b* and *d*, are the two centers, on which the double ſpiral line will be deſcribed.

3. Take the diſtance *db a*, and on *db*, deſcribe the ſemicircle *a f*.

4. Take the diſtance *b*, *f*, and on *b*, deſcribe the ſemicircle *f h*.

5. Take the diſtance *d h*, and on *d*, deſcribe the ſemicircle *h g* ; and ſo by moving your compaſſes firſt to the other center *b*, and afterwards to *d*, &c. you may continue the ſpiral line about infinitely, which is what was required to be performed.

PROBLEM II.

To deſcribe a double ſpiral line at any diſtance aſſigned.

Let it be required to deſcribe the double ſpiral line, at the diſtance of the given line *m*, *n*. Fig. II.

1. Draw a right line, as A B, and on any convenient point of the fame, as at *a*, defcribe a circle of fuch a diameter as is affign'd.

2. Take half the given line *m*, *n*, and place that diftance from *a* the center, to *b* and *c* on each fide thereof, which points, *b* and *c*, are two centers, on which the double fpiral line will be defcribed.

3. On *c*, with the diftance *c*, *e*, defcribe the femicircle *e*, *s*, *d*.

4. On *b*, with the fame diftance, defcribe the femicircle *m*, *n*, *f*.

5. On *c*, with the diftance *c f*, defcribe the femicircle *f r g*, and then you will have got the double line equal; therefore, if you remove your compaffes to the other center *b*, you may thereon, with the diftance *b d*, defcribe the femicircle *d*, *o*, *h*, and on the fame center, the femicircle *g* P *i*, and then by removing again, firft to *c*, may defcribe the femicircles *h*, *u*, *k*, and *i*, Q, *l*, &c. as in the preceding problem, which is what was to be demonftrated.

Problem III.

To defcribe the compound line, called the running worm.

This line may be defcribed in two manners, *viz.* on a right line, as A B, or on a fpiral line, as N K I G E.

I. *To defcribe the runing worm on a right line.*

Practice.

1. Draw the right line A B, and on *a*, with any convenient opening (that will not defcribe an arch with too fharp a turning to create giddinefs in walking) defcribe
Fig. III. the arch A *b*, and with the fame opening, turn your compaffes from *b* to *c*, and on *c*, defcribe the arch *b d*; and then turning them *d* to *e*, defcribe the arch *d f*, and in the like manner all the others contain'd in the line A B. When this line is applied to any ufe as requires breadth, as a walk through a wood, &c. that breadth may be defcribed upon the fame centers, as the line it felf, and in the very fame manner.

II. *To*

II. *To deſcribe the running worm on a ſpiral line.*

Practice.

1. By the preceding problem, deſcribe the double ſpiral line F G, H I, K L, M N; and on E *a*, deſcribe the ſemicircle, or rather arch *b c*, and on the ſame center, the arch *d, e, f*.

2. With the former opening *b a*, turn the compaſſes from *c* to *g*, and on *g*, deſcribe the arch *c h*, and alſo the arch *f i*; and with the ſame openings and manner of working the other arches, and their parallels, muſt be deſcribed. And as this running worm is deſcribed but on one Fig. IV. of the two ſpiral lines, therefore by giving the other the ſame parallel breadth as the running worm, and uniting them together at Z and F, 'twill create a variety in walking, and unexpectedly bring out the perſon, at his place of entrance, contrary to his expectation.

PROBLEM IV.

To deſcribe a treble ſpiral line at any diſtance aſſign'd.

Let it be required to deſcribe the treble ſpiral line at the diſtance of the given line *m, n,*

1. By problem XIII. ſect. I. deſcribe the equilateral triangle A B C, and make the ſides thereof each equal to the given line *m, n,* and from the center thereof, through every angle, draw the right lines B D, C D, and A D.

2. On A, with the diſtance A C, deſcribe the arch *c d e,* and with the ſame opening on B, deſcribe the arch A *f g*; and alſo on C, deſcribe the arch B *h i*. (And here you muſt note, that in this and all other figures of this kind, the ſeveral arches therein that compoſe the whole muſt not be continued in one arch of a circle any farther Fig. V. than from one line of direction to another, be there one, two, three, four, &c. *viz.* in this figure; for example, no arch muſt be deſcribed at one ſweep, no farther than from the line of direction A D to the line of direction C D, or from the line of direction C D to the line of direction B D;

and the like from the line of direction B D to the line of direction A D.

3. On A, with the distance A *i*, describe the arch *i k l*; and with the same opening on the point B, describe the arch *e m n*; and also on the point C, describe the arch *g*, *o*, *p*.

4. On the point A, with the distance A *p*, describe the arch *p*, *t*, *u*; and with the same distance on B, describe the arch *l*, *q*, *u*; and also on the point C, describe the arch *n r s*; and in the like manner on the three points A B and C, you may encrease the magnitude thereof, as much as desired, which is what was required to be done.

These treble spiral lines, are exceedingly beautiful, when planted with hedges of hornbeam, english-elm, &c. and the whole environ'd with a wood, wherein may be described divers other walks (as those marked F F, &c.) that be made to unite with the three several walks of the spiral line, as at D D D.

Those walks marked F F, are what I call artinatural walks by reason they are described by art, and represent the product of nature, which in all woods and wildernesses should be imitated as near as possible, which hitherto, by designers of gardens, as the late Mr. *London*, his followers, &c. has never been thought of, or practised, they always observing a stiff heavy regular form equal in all other parts alike; so that when any person had seen one quarter of any of their gardens, they had then, in effect, seen the whole, the remaining three parts being but the first repeated so many times, and those stuff'd up with their ever-greens at such a rate, that they ever had an aspect more like unto a nursery than a pleasant garden, as intended.

The beauty of a garden (in my humble opinion) consists in a regular, irregularity, that the parts may appear as equal, and at the same time be unequal among themselves, and thereby, at every step forward, a new scene, or fresh object appears, and the whole becomes an everlasting entertainment.

But since this treatise is not particularly design'd for gardening, I shall therefore forbear, and return to problem V.

PROBLEM

Problem V.

To describe a quadruple spiral line at any distance assign'd.

Let it be required to describe the quadruple spiral line at the distance of the given line H I.

1. By problem XV. sect. I. describe the geometrical square 1 2 3 4, and make each side thereof equal to the given line H I.

2. Divide each side thereof into two equal parts, and draw the diameters, extending them infinitely; as from A the center, to B C D and E.

3. On A the center, describe the circle *e b c d*, of such diameter as shall be assign'd.

4. The points 1 2 3 and 4, being the centers on which the whole is described; therefore, on the point 1, with the distance 1 *d*, describe the arch *d a*; and with the same distance on 2, describe the arch *b f*; and also on 3, describe the arch *e g*; and likewise on 4, describe the arch *c h*. Fig. VI.

5. Begin again, and on the point 1, with the distance 1 *h*, describe the arch *h i*; and with the same distance on the center 2, describe the arch *a k*; and also on 3, describe the arch *f l*; and likewise on 4, describe the arch *g m*; and then begining again at the center 1, with the distance 1, *m*, &c. you may describe the four lines to any magnitude required.

This kind of figure may at last be circumscribed in a circle (as in the figure) when 'tis applied to practice on the convexity of a mount, or concave, as that of the Honourable *Thomas Vernon*'s, in the gardens of his seat at *Twickenham Park* in the County of *Middlesex*, made by me in the year 1722. This concave was a large sand-pit, and then a perfect nusance, and supposed to be incapable of any improvement as would be agreeable to the circumjacent parts of the gardens, then new made: but when I deliver'd a draught of the same, the former supposition was destroy'd, and 'twas then demonstration sufficient, that instead of its being a nusance, 'twould be a very agreeable beautiful figure, as it now appears in.

And from hence it further appears, that the great expence that many noblemen and gentlemen have formerly been put to, by the indiscreet directions of Mr. *London*, and his emiſſaries, in removing hills to fill up ſuch concavities, to make the ground level and uniform (as they in their own terms call it) for the execution of their regular ſtuff'd up parterres, flower knots, &c. with fine finakin furbelow'd yews, hollies, &c. whereby the whole ever had the aſpect of a nurſery, more than a garden of delight, as I ſaid before; were not only an immenſe needleſs expence, but the garden it ſelf thereby totally ruin'd. And ſince I have here taken the liberty to mention that error, I will alſo enlarge a ſmall matter further, in relation to another, full as groſs as the preceding, *viz.* to fully execute their regular forms, cut down many a well grown ſturdy oak, elm, &c. and introduces a trifling flowering ſhrub, or ſmall tree of yew, holly, phylerea, lauruſtinus, &c. which, in my opinion, is a plain proof of their ignorance of the ſcience, as well as a crime almoſt unpardonable. But to return to problem VI.

Problem VI.

How to deſcribe an elliptical ſpiral line about an ellipſis given.

Let it be required to deſcribe about the ellipſis K M I L, the elliptical ſpiral line N O G P Q V R S T W E, at the diſtance of the given line X Y.

1. Deſcribe the ellipſis K M I L, according to problem XXI. ſect. I. and draw the lines of direction G F, G A, H C, and H E, infinitely.

2. Divide the given line X Y into nine equal parts, and take the diſtance of two of thoſe diviſions in your compaſſes, and ſet it on the line of direction G F, from D, the point of interſection, to 1, and on the ſame line from G to 2; as alſo from B to 3, and from H to 4, on

Fig. VII. the ſame line. Theſe four points 1, 2, 3 and 4, are four centers, as will deſcribe the elliptical ſpiral line, as following.

1. On the point 1, with the diſtance 1, N, deſcribe the arch N, O.

2. On 4, with the diſtance 4, O, deſcribe the arch O G P.

3. On 3, with the diſtance 3, P, deſcribe the arch P Q.

4. On 2, with the diſtance 2, Q, deſcribe the arch Q V.

5. On 1, with the diſtance 1, V, deſcribe the arch V R.

6. On 4, with the diſtance 4, R, deſcribe the arch R S.

7. On 3, with the diſtance 3, S, deſcribe the arch S T.

8. On 2, with the diſtance 2, T, deſcribe the arch T W.

Laſtly, On 1, with the diſtance 1, W, deſcribe the arch W E; and in the like manner may it be deſcribed to any magnitude deſired; where any perſon deſires to have this line double, treble, quadruple, &c. they muſt proceed according to the preceding rules of the foregoing problems, and their deſires will be anſwered.

Problem VII.

To deſcribe a volutus, or ſcroll, to any magnitude required.

As for example, Deſcribe the voluta, fig. VII. with the parallel diſtance of its lines equal to the given line X X.

1. Take the length X X, and on A, deſcribe the circle D 4 C 3; and through the center A, draw the right line of direction S P.

2. Divide the diameter of the circle into four parts, as at 1, A, 2; and ſet off as many of thoſe ſmall diviſions on the ſame line of direction, without the circle (as thoſe at 6, 8, 5, 7, &c.) as are convenient for your purpoſe.

3. That being done, on the point 2, with the diſtance , 3, deſcribe the ſemicircle 3 E 7; and on 1, with the 2 ſame diſtance, deſcribe the ſemicirce4 B 8.

4. On 2, with the diſtance 2, 8, deſcribe the arch 8 F G.

5. On the point 3, with the diſtance 3, 7, deſcribe the ſemicircle 7 H L, and on the ſame point, the ſemicircle K N P.

6. On the point 4, and at the diſtance 4 L, deſcribe the ſemicircle L M O; and on the ſame point the ſemicircle G I K. Fig. VIII.

7. On the point 6, with the diſtance 6 O, deſcribe the ſemicircle O Q T, and on the ſame center the ſemicircle P R S, &c. ſo that it now appears, that the oftner

'tis turn'd round, ſo many more centers muſt be added, as thoſe of 5, 7, 8, &c.

This figure has been very much uſed in parterres, flower knots, &c. but beſt for an entrance into a cabinet, or private place of repoſe in the quarter of a wood, wilderneſs, &c. And beſides all the foregoing lines of the ſix laſt problems, there is yet another, far ſuperior to any of them, when apply'd to practice in rural works, and is what (as I ſaid before) I call an artinatural line, and is to be deſcribed according to the following problem.

Problem VIII.

To deſcribe an artinatural line, in ſuch proportion as traced by hand.

It's to be obſerved, that there is no ſet form for this line, it being various according to the diſcretion of the hand that traces the ſame ; therefore what is to be underſtood by this problem is, how to find the centers of Fig. VIII. ſuch arches as will deſcribe the line traced, or very near thereunto. As for example,

Let it be required to find the centers of ſuch arches as will deſcribe the artinatural line B C D F G H K L M, &c.

1. By diſcretion, divide the ſeveral turnings, into ſuch parts as doth appear to be ſegments of circles.

2. In every ſuch diviſion make three points at pleaſure ; and by prolem XI. ſect. I. find the centers thereof, and deſcribe the ſeveral ſegments therein contained, and they will complete the line as required. And as the only uſe that this line can be applied to, is in pleaſant ſolitary walks of a wood, wilderneſſes, &c. therefore ſuch breadth as is aſſign'd them, may be deſcribed on the ſame centers parallel thereunto. See the diagram, wherein one view will give more inſtruction than many words.

Sect. VI.

Plate IV.

Of the Geometrical Contruncation of the Cube, Parallelepipedon, and the ſolid Bodies generated thereby.

And in conſideration, that the following operations wholly depends upon the diviſion of a right line into extream and mean proportion ; I will, therefore, firſt lay down

HOW to divide any right line (as the given right line A B) *in extream and mean proportion.* Fig. XV.

Practice.

1. Make the geometrical ſquare C D L N, with every one of its ſides equal to the given line A B.

2. On N, with the radius N D, deſcribe the arch, or quadrant, D I L.

3. Biſſect C L, C D, N L and N D, in the points O K G M, and draw the diameter K M and O G.

4. Draw the right line I M, and on M, deſcribe the arch I F, and make B P equal to M F.

5. The diſtance of B P, is the greater ſegment, and the point P, doth divide the line A B in extream and mean proportion, as required.

Of the Contruncation of ſolid Bodies.

1. The ſolid bodies generated by the ſeveral ways of cutting a cube, are the canted cube, the fruſtum of a cube, the tetraedron and its fruſtum ; the octaedron, dodecaedron, icoſaedron, twelve, and thirty rhombs, of which the

the tetraedron, octaedron, dodecaedron, and icoſaedron, (as likewiſe the cube) are called regular bodies, by reaſon they may be inſcribed within a ſphere. (*See 14th book of Euclid.*)

Cube. 2. A cube (by the 37th definition, ſect. I. part. I.) is a ſolid body containing ſix faces, each a geometrical ſquare, equal to each other, and every angle 90 degrees. This body is very eaſily made, provided every angle is an exact right angle, which in practice is very difficult to be perform'd. However, although workmen cannot be exactly mathematically true, yet they come ſo near to the truth, as not to occaſion any ſenſible difference in the operation.

Fig. VII. *Canted Cube.* 3. If every face of a cube be divided, as A B C D, by an inſcribed geometrical ſquare, as E F G H, whoſe angular points divide the ſides A B, B D, D C and C A, each into two equal parts; and the triangular parts, as E A F, F B G, G D H, H C E, &c. are cut off, the remaining body is what is called the canted cube, containing 14 faces, of which ſix are geometrical ſquares, and eight equilateral triangles.

Fruſtum of a Cube. *Fig. VIII.* 4. If within every face of a cube be inſcribed an octagon, whoſe diameters are equal with thoſe of the face of the cube, as the octagon F G H I K L M E, and the triangular parts G B H, I D K, L C M, E A F, &c. are cut off, the remaining body is what is called the fruſtum of a cube, containing 14 faces, of which ſix are octagons, and eight equilateral triangles.

Tetraedron. *Fig. IX.* 5. Suppoſe O S be $1\underline{0000}$, and O P the root of $\frac{2}{3}$ $8\underline{1649}$, and O Z the root of $\frac{3}{4}$ $8\underline{6602}$, divide Z Y into two equal parts, in the point X, and draw the triangle X S O; alſo draw the like on its oppoſite ſide, equal and oppoſite thereunto. Make O B equal to $\frac{1}{3}$ of O Z, and draw B V, parallel to O S, interſecting the perpendicular X Q, in the point R, which is the vertex of the tetraedron L M N; draw the right lines V W and V T from the point V to the angles T W, and the like from the point B, to the oppoſite angles of T and W. If the triangular portions V S T, B O P, G L C, &c. are cut off, the remaining body is a priſm; whoſe ſide T V W, and its oppoſite, are each triangles, and the other three V T P B, &c. are parallelograms. *Laſtly*, by the points T R X, and the ſide of the triangle T X, drawn on the baſe, as likewiſe by the points P R X, and the other ſide of the triangle P X; divide the priſm, and thoſe parts being cut off, leaves the

the trianglar body called a tetraedron, containing four faces, and each an equilateral triangle.

6. Divide every face of the tetraedron, as Z A, *viz.* divide every ſide into three equal parts, and draw the lines *b c*, *i g* and *f d*; then will the figure *b c i g f d*, be a hexagon, and if the triangular parts *b a c*, *i h g*, *f e d*, &c. are cut off, the remaining body is called the fruſtum of a tetraedron, containing eight faces, of which four are hexagons, and four equilateral triangles. Fig. IX. *Fruſtum of a Tetraedron.*

7. Suppoſe a long cube, or parallelopipedon, as S Y C F, be as follows, *viz.* Let Q S, or W X, be equal to $10\underline{0000}$, and X Y, or Q P, to the root of $\frac{2}{3}$ as aforeſaid, $8,\underline{1649}$, and S X to the root of $\frac{3}{4}$ more by $\frac{1}{3}$ thereof $11,\underline{5470}$, make X T, W V and O P, each equal to $2,\underline{8867}$, one fourth of X S, or Z P, and draw the right line V T, parallel to W X, and the like on its oppoſite ſide, or baſe. Fig. X.

Biſſect Q S, in R, and draw the equilateral triangle R V T, and the ſame in its oppoſite ſide, ſo that the point B, of the oppoſite triangle, be oppoſite to the point R. Draw the right lines V Z, V O and Q V, and the like on the oppoſite ſide, and cut off the triangular parts T V Z Y downwards, and its oppoſite O P Q S, upwards; then will there remain two equal parallelograms V T S R Q and O Z B Y. *Laſtly*, cut off O V R and T R above, and O V B and T B by the triangle beneath, and thereby, at ſix cuts, will be made a ſolid of eight equal faces, each an equilateral triangle, called an octaedron. Fig. X. *Octaedron.*

8. Divide each ſide of a cube into two equal parts, as D K by *q d*, H G by *g i*, &c. make D *q*, or H *g*, &c. the radius equal to $10\underline{0000}$, and divide them by extream and mean proportion. Then will D *a*, F *e*, &c. be equal to $6,\underline{1803}$ the greater ſegment, and *e i*, *m d*, &c. to $3,\underline{8197}$ the leſſer ſegment. From the greateſt ſegment of one ſide to the middle of the other, draw right lines, as from *m* to E, from *o* to *i*, from I to *g*, from *e* to *d*, &c. *Laſtly*, If you cut off each triangular priſm, as E B *m r*, I *o g i*, *a e q d*, &c. at 12 cuts, will be framed a ſolid, containing 12 equal faces, each a pentagon, called a dodecaedron. Fig. XI. *Dodecaedron.*

9. Divide each ſide of a cube into two equal parts, as B C, by the right line *p b e d*, &c. interſecting each other, at right angles, as the right lines *b d* and *a c*, in the point *e*, make *e p*, &c. the radius equal to $10,\underline{0000}$, and let *e b*, *c a*, *e d*, and *e c*, be each equal to $6,\underline{1803}$ and through the points *a b c d*, draw the four right lines *a b*, *b c*, *c d*, and Fig. XII.

d a, extending each of them to the exteriour lines of the face, A B, B C, C E, and E A. Divide every face in the same proportion, and thereby is constituted eight equilateral triangles marked in the diagram 2, 3, 4, 5, 6, 7, 8, &c. By which every angle being cut off, the body will then contain six geometrical squares, and eight hexagons. If you
Icosaedron. make *a c* the base, the point *f* of the other face shall be the vertex to cut out the triangle *a c f*, and *f h* shall be the base and *l* the vertex to cut out the triangle *f h l*, and *l n*, the base, and *c* the vertex to cut out the triangle *l n c*, and the like of all others, till every one be cut off, and the remaining solid will be a body containing 20 faces, each an equilateral triangle, called an icosaedron.

☞ This body may be cut by the aforesaid lines of the dodecaedron, by drawing the parallel lines upon the cube at the distance of the lesser segment instead of the greater.

10. Suppose a parallelopipedon be as follows, *viz* the length to the breadth as 1 is to the root of $\frac{1}{2}$, so shall D C
Fig. XIII. or P B be equal $10,\underline{0000}$ and B A or P G, to $7,\underline{0710}$ Bissect the lines G H, P B, and D C, in the points E L H, as also their opposites, and draw the right lines H B, H P, I G, I A, I D, I C, E B, E P, and their opposites; draw the diagonals D G, and F P, and their opposites, meeting the aforesaid lines of every angle, and thereby constitute tri-
12 *Rhombs.* angles, such as D I G, &c. Lastly cut away the angle P, by the triangle D I G, and the like of others, and thereby, at eight such operations, will be left a solid body, containing 12 faces, each a rhombus, called the body of 12 rhombs.

11. Divide every side of a cube by extream and mean proportion, as the sides *a d*, *d g*, *g k*, and *k a*; in the points *b*, *c*, *e*, *f*, *h*, *i*, *l*, *n*, where each side is equal to $10\underline{0000}$, and the lesser segments *a b*, *c d*, *d e*, *f g*, *g h*, *i k*, *k l*.
Fig. XIV. and *n a*, each equal to $3\underline{8100}$.

Draw right lines from the terms of the lesser segments, on the one side, to the greater on the other side, as the lines *n c*, *l d*, *e k*, and *f i*, which will be parallel to each other. Also intersect them with the like parallels, as *b e*, *a f*, *n g*, *l h*, and draw the right lines *c g*, *b k*, *h d*, *i a*. Divide every face of the cube in the same manner, and
30 *Rhombs.* then will the cube be prepared for the operation. About every solid angle of the cube are three triangles, as the triangles 1, 2, and 3, about the angle *a*, and the triangles 4, 5, 6, about the angle *d*, &c. Therefore every angle must be cut three times, always observing to continue each line, as a part is cut away; otherwise 'twill be a confused work; and thereby at 24 such operations, will

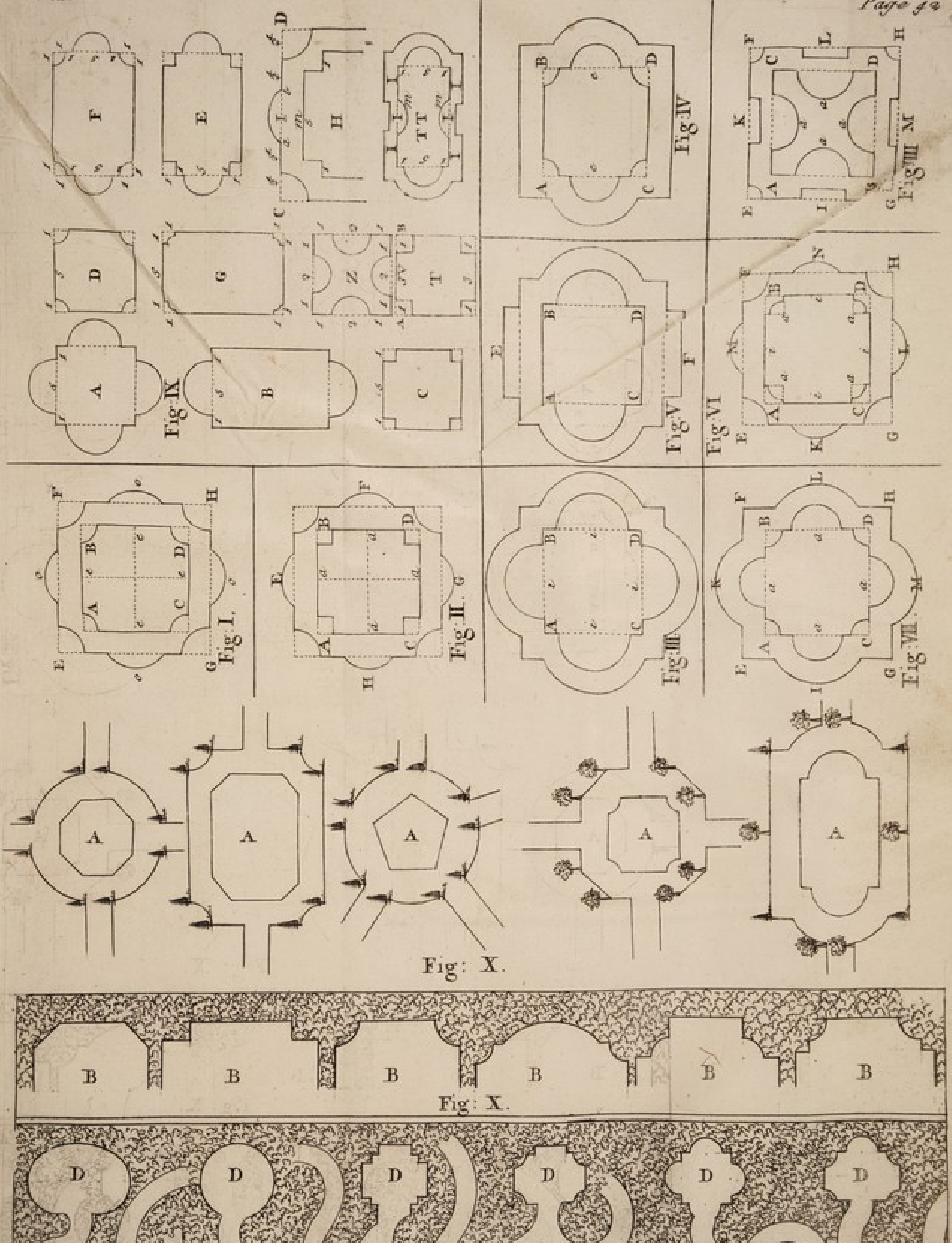
Fig: IX
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Fig: X.

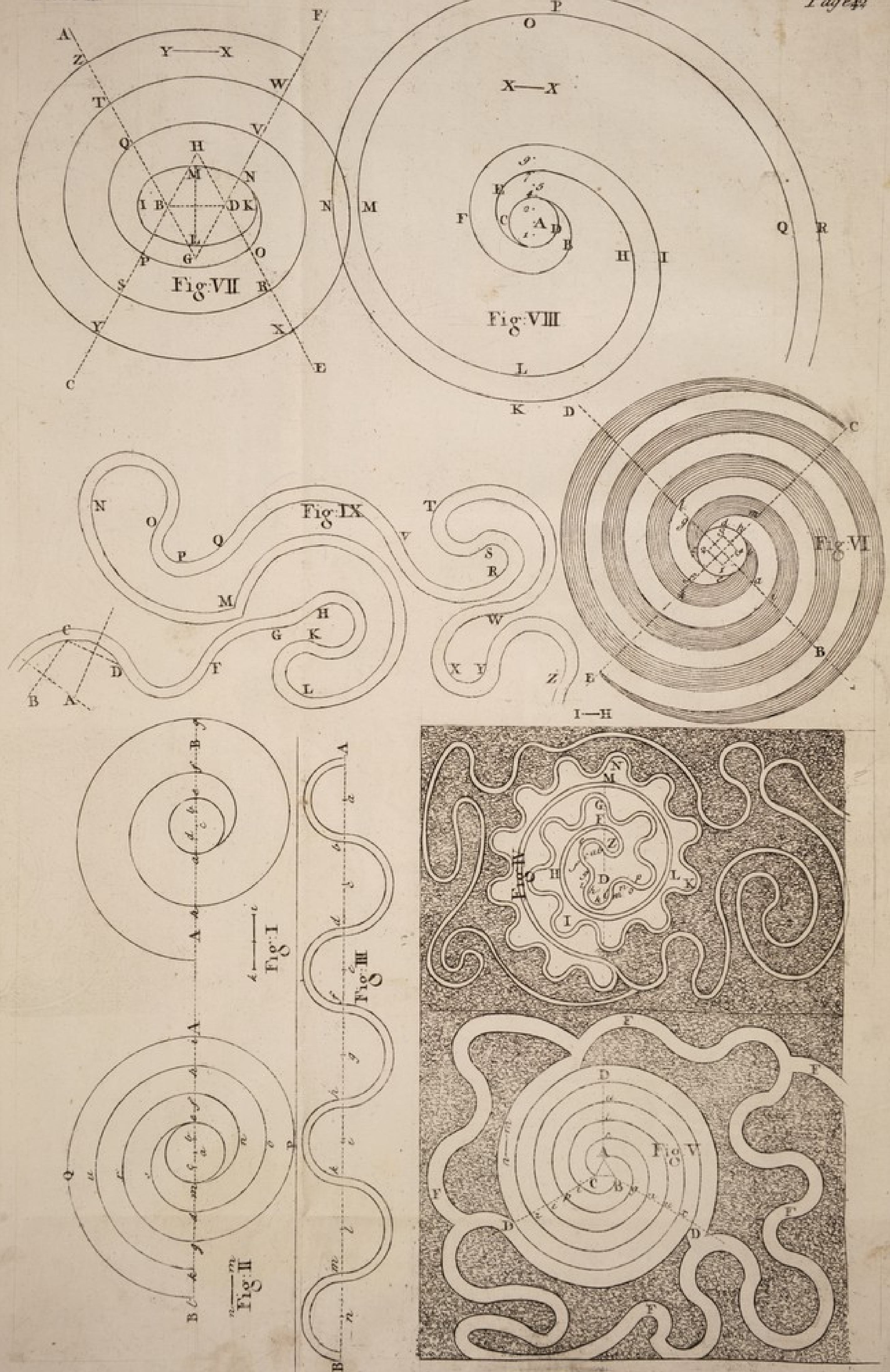
Fig: VII
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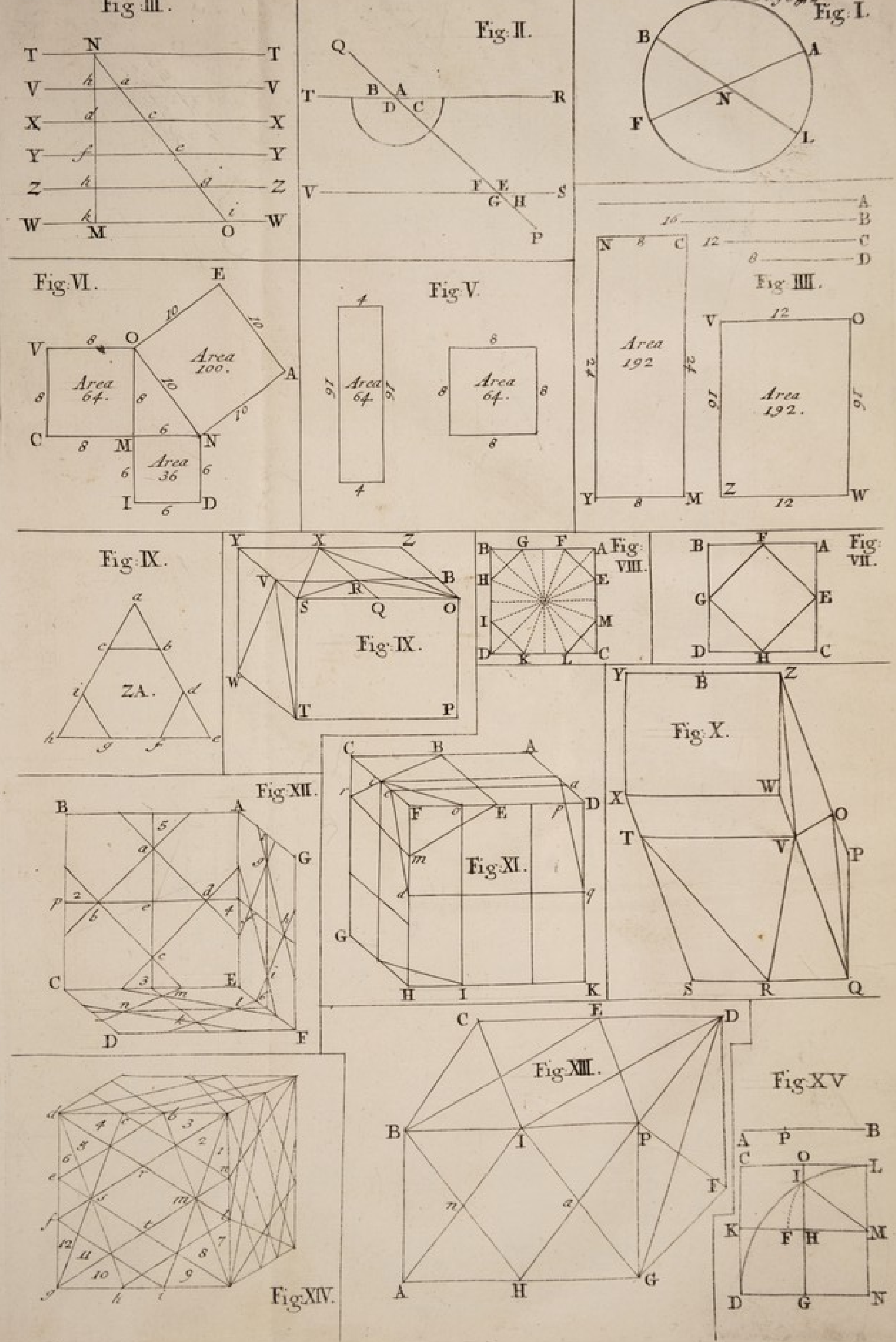


Fig: I.
Fig: II.
Fig: III.
Fig: IIII.
Fig: V.
Fig: VI.
Fig: VII.
Fig: VIII.
Fig: IX.
Fig: IX.
Fig: X.
Fig: XI.
Fig: XII.
Fig: XIII.
Fig: XIV.
Fig: XV
Area 200.
Area 64.
Area 36
Area 64
Area 64.
Area 192
Area 192.
ZA.

appear a ſolid body, containing 30 faces, each a rhombus, and is called the 30 rhombs.

Theſe bodies are not only very beautiful in divers parts of building, but alſo in gardening, being placed on a proper pedeſtal, with a ſun-dial delineated upon every face, which may be ſo contrived as not only to ſhew the hour of the Day, in all parts of the world, according to the ſeveral accounts of time; but alſo all the moſt uſeful parts of aſtronomy, as the ſun's place, declination, amplitude, right aſcenſion, altitude, azimuth, riſing, ſetting, length of day and night, beginning and ending of twilight, æquation of time, &c.

PART

THE

PRACTICE

OF

Architecture, Gardening, Menſuration, and *Land-Surveying,* Geometrically demonſtrated.

PART II.

I. *The Geometrical Conſtruction of the Tuſcan, Dorick, Jonick, Corinthian Compoſita, French and Spaniſh orders of Architecture, according to any proportions aſſigned, as alſo of all kinds of plans and uprights whatſoever.*

II. *The Geometrical and Trigonometrical Conſtruction of all ſorts of Plans, or Draughts of Gardens, Wilderneſſes, Labyrinths, Groves,* &c. *and Maps of Cities, Towns, Pariſhes, Lordſhips, Eſtates, Farms,* &c.

SECT. I.

Of the Geometrical Conſtruction of Plans and Uprights.

PLATE. V.

TO delineate the geometrical plain, or ichnography of a building is to accurately deſcribe a geometrical figure of the ſeveral parts thereof in true proportion.

The

The common meaſure uſed herein is the engliſh foot, divided into 12 equal parts, called inches, each being equal to the length of 3 barley corns placed in a right line, therefore, an engliſh foot is equal to the length of 36 barley corns. The inches graduated on a foot, or two foot rule, are ſubdivided in 4, 8, 10, 12, &c. equal parts, according to the pleaſure of the architect, &c.

The length, breadth, depth, &c. of any building, (or its parts) are called its dimenſions, and the meaſuring of thoſe dimenſions, is called taking the dimenſions.

All dimenſions, or meaſures of feet and inches, when taken, are thus written and expreſſed, *viz.* a dimenſion, whoſe length is ſix feet and ten inches, is written 06*f.* 10*i.* and ſixty two feet, and five inches, thus 62*f.* 5*i.* alſo if a dimenſion be fourteen feet and eleven inches in length, by nine feet ſeven inches in breadth, and two feet ten inches in depth, or thickneſs, 'tis thus written.

$$\begin{array}{ccl} f. & & i. \\ 14 & : & 11.\ L \\ 09 & : & 07.\ B \\ 02 & : & 10.\ D \end{array}\Bigg\}\text{\&c.}$$

To expreſs one, two, three, &c. feet by a plain ſcale (or ſcale of equal parts); every ſuch equal part (as an inch, &c.) doth repreſent a foot, and two inches, two feet, &c. and if the inches are divided into 12 equal parts, each of thoſe parts will repreſent an inch. Therefore ſix feet and ten inches, is repreſented by ſix inches and $\frac{10}{12}$, and ſixty two feet five inches, by 62 inches 5 parts. And what is here ſaid of the diviſion of an inch into 12 equal parts (for the repreſentation of inches) the ſame is to be underſtood in the diviſion of any other length, as $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, &c. of an inch, foot, yard, &c.

When the dimenſions of a building is taken in foot meaſure only (without regard had to inches, which in ſome works is very common) then any equal diviſion, as is moſt convenient, may repreſent one foot, as $\frac{1}{12}$ of an inch, which before repreſented but one inch, may now repreſent one foot, and conſequently an inch 12 feet; and the like of any other equal part, or diviſion whatſoever. And for the better information hereof, that the young ſtudent may have a perfect clear idea, I will here demonſtrate the conſtruction of ſuch plain ſcales, as is moſt convenient for his purpoſe.

Problem I.

To make divers ſcales of equal parts, as ſhall repreſent feet and inches.

1. Draw the right line D B, and at B erect the perpendicular B A, and make B A equal to B D.

2. Divide D B into 12 equal parts, at the points 1 2 3 4, &c. And alſo A B at the points 1 2 3 4, &c.

Fig. I. 3. Draw, or continue B D to ſuch a length as you would have the ſcale to contain; as to E, and draw A A parallel, and equal in length thereunto.

4. Draw A E, and divide it into 12 equal parts, at the points 1 2 3 4, &c.

5. Draw the lines 1, 1. 2, 2. 3, 3. 4, 4, &c. parallel to A A and E B.

6. From the point A to D, draw the right lines A D, A 1, A 2, A 3, A 4, A 5, A 6, A 7, A 8, A 9, A 10, A 11, and the line A B is the 12 diviſion.

The 12 centeral lines thus drawn, do divide the ends of the 12 parallels, each into 12 equal parts; therefore each of thoſe lines, ſo divided, doth repreſent one foot divided into 12 inches, as Z 1, and if you take the diſtance Z 1 in your compaſſes, and ſet that diſtance from Z to F, and from F to G, and from G to H, &c. each of thoſe diviſions ſhall be a foot, and equal to Z 1, the foot divided in 12 parts. And to take off with your compaſſes any number of feet and inches required, proceed as follows,

Let it be required to take off four foot eleven inches.

Practice.

Fig. I. Set one point of your compaſſes in the point 4 I, and extend the other on the ſame line, to the point of interſection of the centeral line A 11, and the line 1, 1, from which you take the meaſure, and that length ſhall truly repreſent four foot and eleven inches, according to the diviſion of that line. And what is here ſaid in reſpect to the diviſion of this line, the ſame is alſo to be underſtood of all others. And from hence it appears, that therein

there

there is contain'd 12 various ſcales, and each repreſenting feet and inches, which is what was required to be done. The conſtruction of the ſcales of foot meaſure fig. II. are made by the very ſame rule, only the ſides K L and L M, are divided into 10 equal parts each, inſtead of into 12, as in fig. I. Fig. II.

I ſhall now proceed to the conſtruction of one other uſeful ſcale, which is called a ſcale, or line of chords, and is of as great uſe in meaſuring the angles of a building, as the other in meaſuring the ſides, &c.

Problem II.

To make a line (or ſcale) of chords, to any aſſign'd length.

Definitions.

A chord, or ſubtenſe, is a right line joining the extremity of an arch; ſo A C is the chord of the arch A M C.

A line of chords is no other than 90 degrees of the arch of any circle, transferr'd from the limb of a circle to a right line.

Every circle (great or ſmall, ſee problem III. part I. ſect. I.) is divided into 360 equal parts, term'd degrees, and conſequently a ſemicircle into 180, and a quadrant into 90. The ſemidiameter of a circle, or the ſide of a quadrant, is always called the radius, and is ever, in all circles, equal to 60 degrees of the ſame; therefore when the word radius is hereafter mention'd, then ſixty degrees is to be underſtood alſo. Fig. III.

Conſtruction.

2. Deſcribe the ſemicircle B M D O, and on O erect the perpendicular O M, which will divide the ſemicircle into two quadrants.

2. By problem XXX. part I. ſect. I. divide the arch M C D into 90 equal parts or degrees.

3. On the point D ſet one foot of your compaſſes, and extend the other to 10, and deſcribe the arch 10, 10, then open them to 20, and on the ſame point D deſcribe the arch 20, 20, and in the ſame manner the arches 30, Fig. III.

30, 40, 40, 50, 50, 60, 60, 70, 70, 80, 80, and 90, 90, which feveral arches will interfect the diameter B D, in the points 90, 70, 60, 50, 40, 30, 20, and 10, and divide it into unequal parts. This line, thus divided, is the line of chords, divided to every tenth degree, and by the fame rule you may divide it to every degree, and therefore needs no further explication. And as the only ufe of this line is to meafure the quantity of any angle, therefore 'twill not be improper, firft to demonftrate the variety of angles.

Demonftration.

Fig. IV. When two right lines, as E F and F G, join each other, in a right lined pofition, they then make no angle, but do conftitute a right line equal to both their lengths; fo the line E F and F G, meeting together in a right line pofition, at the point F, do conftitute the right line F G. But when two right lines meet, and not in a right lined pofition, as the right lines A D, and H D, (or A D and B D, or H D and D C) fuch lines, by fuch meeting, form an angle. The meeting of fuch lines may happen in three feveral pofitions.

1. Two right lines may meet as the right line B D on the line A C, in the point D, making the diftance from B to A, equal to B C, *viz.* the line B D, perpendicular to the line A C, and thereby conftitute two equal angles, each containing a quadrant or arch of 90 degrees, and are called by the name of right angles. Therefore whenever a right angle is mention'd, an angle of 90 degrees is to be underftood.

2. Two right lines may meet as the right lines A D and H D, and thereby conftitute an angle, lefs than 90, and therefore is called an acute angle.

3. Two right lines may meet, att he right lines H D and D C, and thereby conftitute an angle, more than 90 degrees, and therefore is called an obtufe angle, and the fum of all is, that an angle is either acute, right, or obtufe.

An acute angle is that whofe meafure is lefs than a quadrant, or arch of 90 degrees.

A right angle is that whofe meafure is a quadrant, or arch of 90 degrees. And,

An obtufe angle is that whofe meafure is more than a quadrant, or arch of 90 degrees.

Fig. IV. The meafure of an angle is an arch of a circle, defcribed upon the angular point, intercepted between the two fides,

as

as containeth the angle, (an angle is always expreſſed by three letters, whereof the middle letter always denotes the angular point, as for example, if you expreſs the angle Z X Y, the letter X ſignifies the angular point, and the like of all other angles, in general).

The complement of an angle, (or arch) is ſo much of an arch, as the arch that meaſures the angle wanteth of a quadrant or arch of ninety degrees. So if an angle containeth 60 deg. the complement to an arch of 90 deg. or quadrant is 30 deg. and the like of any other angle.

All angles concurring upon one right line in a center, being taken together, are equal to a ſemicircle, or 180 degrees. Fig. V.

So the angles of the right lines *a a a*, &c. meeting at the point C, are (taken together) equal to a ſemicircle or 180 degrees.

Having thus ſhewn the conſtruction of plain ſcales, ſcales of chords, &c. and the nature of angles, I ſhall now proceed to apply them to practice, in the delineating of plans in general.

Problem III.

To make a plan equal to a plan given.

Let it be required to make the plan X Y, equal to the given plan T V.

1. By problem VII. part I. ſect. I. having firſt drawn the line 1, 2, and made the ſame equal to A B, make the angle 2, 1, 3, equal to the angle B A C. Fig. VI.

2. Make the line 1, 3, equal to A C, and make the angle 1, 3, 4, equal to the angle A C D.

3. Make 3, 4, equal to C D, and make the angle 3, 4, 5, equal to C D E.

4. Make 4, 5, equal to D E, and make the angle 4, 5, 6, equal to D E F, and by the ſame rule paſs through the whole, and thereby you will complete the plan X Y, which will be equal to the given plan T V.

Problem IV.

A ſecond example.

Let it be required to make the plan Y Z, equal to the given plan W X.

1. Make the parallelogram 1, 2, 9, 10, equal to A B L M, and draw the diameters 23, 23, and 21, 22.

2. Make 1, 3, 2, 4, 7, 9, and 8, 10, equal to A G, B H, I L, and K M.

3. Make 1, 19, and 20, 2, equal to A E and F B.

4. Continue the longest diameter infinitely, and make 23, 16, equal to W T, and by problem XI. sect. I. part I. describe the arch 19, 16, 20.

Fig. VII. 5. Make 21, 5, and 22, 6, equal to O R and O S, and, by the aforesaid problem, describe the arches 3, 5, 7, and 4, 6, 8.

6. Continue the end 9, 10, and make 11, 9, and 10, 12, equal to N L and M O.

7. Make the parallelogram 11, 12, 13, 14, equal to N Θ P Q, and make 13, 17, and 18, 14, equal to P C and D Q.

8. Continue 23, 23, infinitely towards 15, and make 23, 15, equal to W, V.

9. By problem XI. part I. describe the arch 17, 15, 18, and 'twill complete the plan as required.

N. B. If any plan has a thickness, as the walls of a building, &c. that thickness (be what it will) must be drawn parallel to the external figure, in such proportion as the thickness is found.

Problem V.

To measure (or take) the quantity of an angle by the help of a two foot rule, five foot, or ten foot rod only.

Fig. VIII. Let C A B be the angle of a building, and 'tis required to draw upon paper an angle equal thereunto.

1. From A towards B, measure, or set off, any number of feet (as for instance in this example five foot) and also from A towards C, at the points 5 and 5.

2. Measure the distance between 5 and 5, and note it down on paper.

3. To draw the same upon paper, first draw a line at pleasure, as D E, and from any scale of equal parts take off five parts, representing the five foot set off from A,

the angle aforesaid. With this distance set one foot on D, Fig. VIII.
and with the other describe the arch *o, o.* Take ten foot in your compasses (the distance between 5 and 5) and set one foot in *o*, and with the other intersect the arch *o, o*, in the point P, through which, from D, draw the right line D P N; so shall the right lines D E and D N, form the angle N D E, which shall be equal to the angle C A B, as required. And what is here said concerning the taking off this angle, the same rule is also to be understood of all other angles in general, be they acute, right, or obtuse.

Problem VI.

How to take the plan of a crooked line, or wall, which is not any part of an ellipsis or circle.

Let it be required to describe the plan of the crooked line A B C.

Practice.

1. On a piece of paper describe a crooked line, as near like the crooked line A B C as you can, and draw the streight line A C; this being done, measure two foot (or more according to the nature of the curve) from C in a right line towards A, as from C to 2.

2. Measure from 2 to the crooked line, as to *e*, and on your paper, or eye-draught, make a mark representing the point 2, and from thence draw a line to the curve, to represent the offset 2 *e*, and thereon set down the measure of the offset 2 · *e*.

3. At a proper distance from 2, as at 4, take another offset, and signify the same in your eye-draught with the Fig. IX.
true measure of the same; as also its distance from C, and in the same manner proceed, making as many offsets as the turn of the curve requires, 'till you have taken the whole down. This being done you may describe the same on paper, truly thus:

1. Draw the line A C, by a scale of equal parts, equal in length to A C.

2. Set from C to 2, the distance measured, and on 2 erect the perpendicular 2 *e*, and thereon set off the length of that offset, as specify'd in your eye-draught.

3. Set

3. Set the diſtance C 4, and on 4 erect the perpendicular 4 *f*, and thereon ſet off the length of that offset as meaſured. And in the like manner lay down the diſtance of every offset from one another, and their proper lengths, and then you have the ends of all your offsets, through which you may exactly trace the crooked line, as required.

Note, That the greater the number of offsets are taken, the more exact the curve may be drawn.

Problem VII.

How to take the plan of any building whatſoever.

The firſt ſtep to this performance, is to make an eye-draught of the ſame, *viz.* a rough draught drawn by hand only, expreſſing every wall, partition, room, door, chimney, window, &c. and the larger theſe kinds of draughts are made, the better 'tis for you, by reaſon you have good room to ſet down every dimenſion, which in a ſmall draught cannot be done.

Let it be required to make a plan of E F G H, which is ſuppoſed to be a real houſe.

Practice.

1. Make your eye-draught thereof as A B C D, and therein repreſent every door, window, paſſage, ſtair-caſe, partition, thickneſs of walls, rooms, &c.

2. With your five foot, or ten foot rod, meaſure the length and depth withoutſide, and note thoſe meaſures down to each reſpective ſide, or length.

3. Meaſure the thickneſs of thoſe outſide walls, and note them down alſo.

Fig. X. 4. By problem XXXII. ſect. I. part I. examine every angle, whether they be ſquare or not. If they are found to be ſquare, note it down, and if not ſquare, as acute, or obtuſe, then meaſure the quantity of one by problem V. hereof, and thereby, with the length of the four ſides given, you may, when you come to draw the plan of the ſame, by problem XIX. ſect. I. part I. delineate the ſame exactly.

5. Meaſure the exact breadth of every door and window withoutſide, and alſo the peers of brickwork between them, and ſet thoſe meaſures down to each reſpective part. The outſide walls being thus meaſured, the next proceeding to be made is in the diſtribution of the parts of the houſe; therefore walk over the ſame, and as you walk draw every particular room, with its chimney, doors, &c. as near the truth as may be, as alſo every ſtair-caſe, paſſage, cloſet, &c. which being finiſhed, your eye-draught is now fitly prepared to receive every dimenſion that is to be taken. To which proceed, *firſt*, as 'tis beſt to begin in a corner room. Therefore make a begining at I, where you Fig. X. muſt meaſure the exact length of every part thereof, as alſo the thickneſs of its party walls, or partitions, and note each meaſure down ſeverally in its reſpective place, and then proceed to K, and there perform the ſame, as alſo at L, M M, N, O, P, Q, &c. and thereby you'll have taken the juſt dimenſion of every part contain'd on that floor. And in the very ſame manner, may you take the plan of the cellars and other lower offices, or chambers, when required.

Your eye-draught being thus finiſhed, the next work is to delineate a true draught thereof from thoſe meaſures taken, which thus perform.

1. By the meaſures taken, it appears the houſe is a parallelogram 60 foot in front, and 40 foot in depth; therefore, with your ſcale of equal parts, deſcribe a Parallelogram, whoſe longeſt ſides are each equal to 60 parts, and the ſhorteſt to 40 parts.

2. The thickneſs of the outſide walls are found to be three bricks in thickneſs, which is equal to two foot and three inches, therefore, at the diſtance of two foot and Fig. X. three inches, of your ſcale, draw the interiour line, parallel to the exteriour, and thoſe two parallel lines do repreſent the thickneſs of the outſide walls.

3. By the meaſures of the eye-draught the diſtance from the angles to either of the adjacent windows is four foot, as alſo every window and peer of brickwork between. Therefore, divide the external lines A B, B D, A C and C D, in ſuch proportion, as the eye-draught doth exhibit, as alſo the internal line likewiſe, and thereby every window and out doors are truly divided in their proper places.

4. Draw the diameters O K and M M, and on each side the diameter OK set of ½ the breadth of the halls O and K, *viz.* 8 foot 10 inches, and draw on each side the lines V V and V V, and also the thickness of those walls, as they are found to contain.

5. On each side the diameter M M set off two foot the ½ breadth of the entrance, and draw the parallel lines X X and X X, which will divide the parts N L and P I, into four equal parts.

6. Draw the thickness of the lines X X and X X, as they are found to contain.

7. Give to the door of every room, as Z Z Z Z Z, its proper breadth, and from thence set off the side of each room towards the chimney, and draw the front of every chimney, as also set off the jaumes and chimney likewise, according to every respective measure of your eye-draught. Fig. X.

Lastly, Divide the two stair-cases according to each respective measure, and the plan will be completed, as required.

N. B. That the space contain'd between any two parallel lines, that represents the thickness of a wall, must always be fill'd up with Indian ink, &c. that thereby the same may be understood to be a solid, as likewise the basis of columns, as *y y y y* and *y*, &c. and those parts that represent a door, or window, to be left clear without any filling up. See fig. X.

☞ I do advise the young practitioner to consider this problem well, and to practice herein for some time, before he proceeds any further, that he may be perfect, which may be done by a few days practice.

This problem of taking the plans of houses, is one of the most useful in architecture, and the easiest to be acquired ; therefore consider the reasons of the same judiciously before you proceed to problem VIII.

PROBLEM

Problem VIII.

How to draw the geometrical upright (or front) of any building.

Let it be required to draw a geometrical upright of the houſe A C B D, which is an elevation raiſed from the plan E F G H, fig. X. Fig. XI.

1. Make your eye-draught X, and then repair to the building, and meaſure the whole front from B to D, which being juſt 60 feet, write down the ſame at the bottom of your eye draught.

2. Meaſure the whole height from the ground at B to A, which being juſt 37 feet, write down the ſame on your eye-draught againſt the middle of the height.

3. Meaſure the diſtance from B to *o*, from *o* to *p*, from *p* to *q*, from *q* to *u*, from *u* to *r*, from *r* to *s*, from *s* to *u*, from *u* to *w*, from *w* to *x*, from *x* to *y*, from *y* to *z*, from *z* to *z a*, from *z a* to *z b*, and from *z b* to D; and write down the ſeveral meaſures in each reſpective place.

4. Meaſure the diſtance from G to *h*, from *h* to *i*, from *i* to *k*, from *k* to *l*, from *l* to *m*, from *m* to *n*, and from *n* to A, and write down the ſeveral dimenſions, or meaſures, in their reſpective places, as may be ſeen in the eye-draught.

The meaſures, or dimenſions, being thus taken, and noted in your eye-draught, proceed to the delineation thereof as follows.

1. Make the parallelogram A C B D, in ſuch proportion that A C and B D, do contain 60 feet of any plain ſcale, and the ſides A B and C D 37 feet, as noted in the eye-draught.

2. On the lines B D and A C, ſet off the ſeveral meaſures *h*, *o*, *p*, *q*, *u*, *r*, *s*, *t*, *u*, *w*, *x*, *y*, *z*, *z a* and *z b*.

3. Draw the lines *o o*, *p p*, *q q*, *u u*, *r r*, *s s*, *t t*, *u u*, *w w*, *x x*, *y y*, *z z*, *z a z a* and *z b z b*.

4. On the lines B A and D C, ſet off the ſeveral meaſures 3, 4, 8, 4, 8, 4, 6, at the points *h*, *i*, *k*, *l*, *m*, *n*, E, and draw the lines *h h*, *i i*, *k k*, *l l*, *m m* and *n n*, which will interſect the former, and truly form every window, door, &c. contained therein, and thereby complete the geometrical upright as required.

Problem IX.

Plate VI.

To delineate the geometrical upright of any of the five orders of architecture (contained in any ſtructure) according to any proportion aſſigned.

For Example,

Let it be required to delineate the geometrical upright of the attick baſe, with the dorick capital, architrave, freize and corniſh.

The meaſuring rod, with which the ſeveral parts of a column and its entablature are meaſured, is the diameter of the column divided into 60 equal parts, called minutes. Every architect divides the members, or parts of his orders, in ſuch proportion as he thinks moſt agreeable, as may be ſeen in the laſt folding pages hereof, wherein are exhibited, not only the geometrical profiles and ſections of the moſt noble antient orders of the *Romans*, but alſo of *Vitruvius*, *Palladio*, *Scamozzi*, *Serlio*, *Vignola*, *D. Barbaro*, *Cataneo*, *L. B. Alberti*, *Viola*, *Bullant*, *P. De Lorme*, *Perrault*, *Le Clerc*, *A. Boſſe* and *Michael Angelo*; which I thought fit to ſubjoin to this work, in ſuch a manner, as for the young ſtudent to behold, at one view, the great variety contained among them, as well as to make choice of ſuch as might beſt ſuit his purpoſe.

The diviſion of each member is a line, and the diſtance between any two of thoſe lines is called the height of the member, as the diſtance between the right lines A A and B 40, *viz.* the line A B, or A 40.

The projecture of every member is that length contained between the centeral line of the column and the termination thereof: the entablature of any order is the architrave, freize, and corniſh taken together.

Operation.

Fig. XVI. 1. Let X X be equal to the diameter of a given column, divided into 60 equal parts or minutes, by the help of which we'll deſcribe the attick baſe, as required.

And

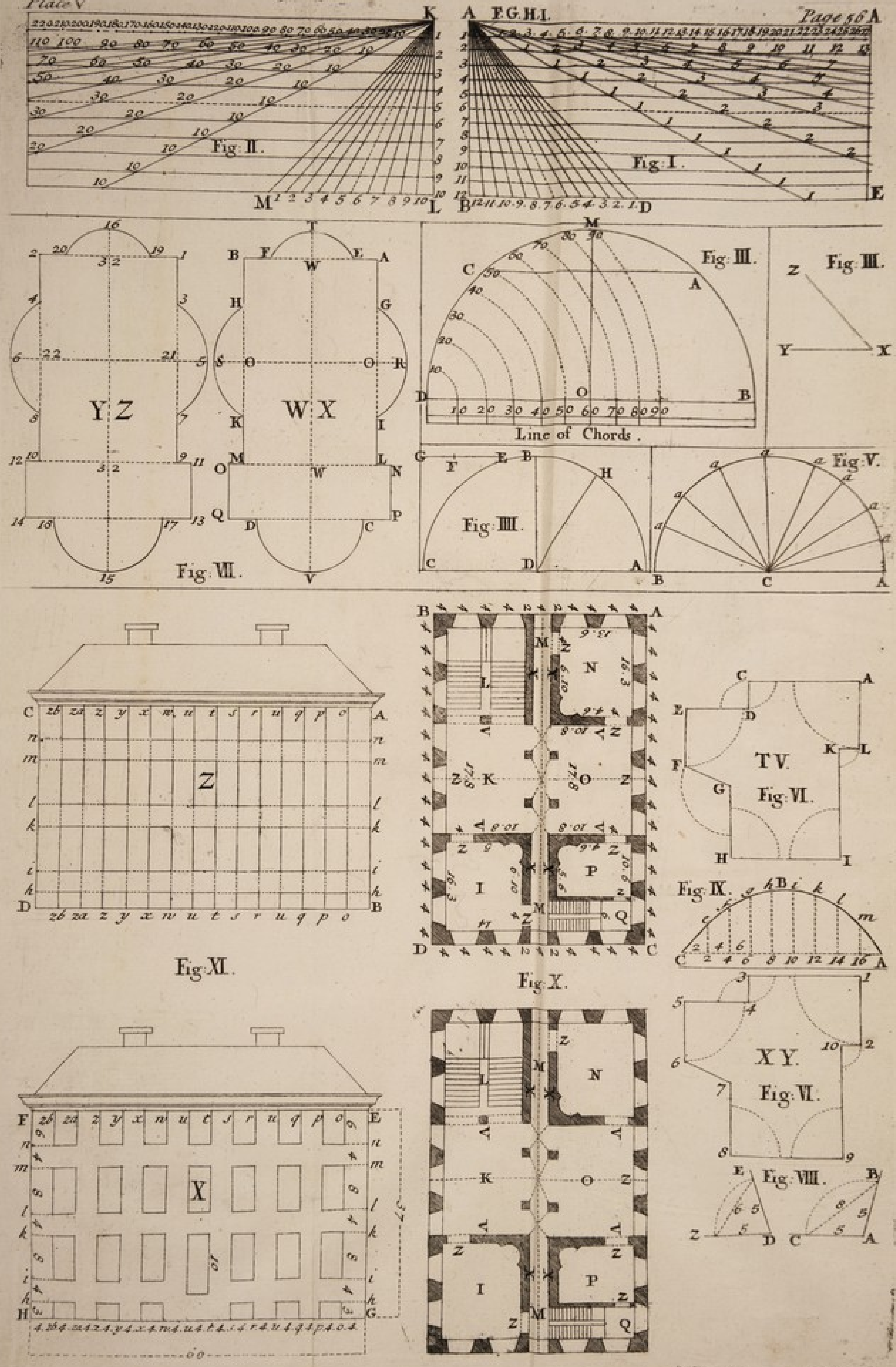


Fig: I.
Fig: II.
Fig: III.
Line of Chords.
Fig: III.
Fig: IIII.
Fig: V.
Fig: VI.
Fig: VI.
Fig: VII.
Fig: VIII.
Fig: IX.
Fig: X.
Fig: XI.

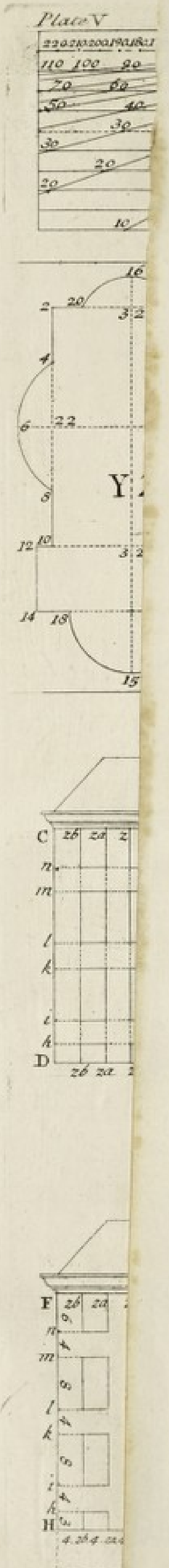


Plate V

And as 'tis uſual for all architects to prefix to every member its exact height and projecture as in the ſeveral figures XVI, XVII and XVIII, therefore draw the right line A B, and make it equal to 40 min. (as there written).

2. On A, erect the perpendicular A D, and let it repreſent the centeral line of the column continued through the baſe; alſo erect the perpendicular A 40, and continue it infinitely.

3. Becauſe the height of A B and A 40 is 10 min. therefore ſet off 10 min. from A to B, and from A to 40, and draw the line B 40.

4. The height of the next member B *c*, is 7 min. $\frac{1}{2}$; therefore ſet off 7 min. $\frac{1}{2}$ from B to *c*, and draw *c* K parallel to B 40.

5. The next member C E is 1 min. $\frac{1}{4}$ in height; therefore ſet oft from *c* to E one min. $\frac{1}{4}$, and draw the line E L infinitely, and parallel to C K.

6. Becauſe the lines C K and E L, are each 36 min. $\frac{1}{3}$ in length; therefore ſet off 36 min. $\frac{1}{3}$ from C to K, and from E to L, and draw the line L K.

7. Continue L K to M, and divide K M into two equal parts at N, and thereon deſcribe the arch M P K.

8. The next member E F, is 4 min. $\frac{1}{2}$ in height; therefore ſet off 4 min. $\frac{1}{2}$ from E to F, and draw the line F *n*, infinitely.

9. The next member F G is 1 min. $\frac{1}{4}$ high; therefore ſet off 1 min. $\frac{1}{4}$, and draw the line G *o*, infinitely, and parallel to all the former.

10. Becauſe the lines F *n*, and G *o*, are each 35 min. in length; therefore ſet off 35 min. from F to *n*, and from G to *o*, and draw the line *n o*.

11. Draw the line *n* L, and divide it into two equal parts in *m*, and thereon, with the diſtance *m n*, deſcribe the arch *n* Q L.

12. The next member G H is five min. $\frac{1}{2}$ high; therefore ſet up 5 min. $\frac{1}{2}$ from G to H, and draw the line H *q* parallel to G *o*, and extend it infinitely.

13. The next and laſt member is one min. $\frac{1}{4}$ in height, therefore ſet up one min. $\frac{1}{4}$ from H to I, and draw the line I *r* parallel to the former, and extend it infinitely alſo.

14. Becauſe the lines H *q* and I *r*, are each equal to 33 min. $\frac{1}{2}$; therefore make H *q* and I *r*, each equal to 33 min. $\frac{1}{2}$, and draw the line *q r*. Fig. XVI.

15. Draw the line *q o*, and divide it into two equal parts at P, and thereon, with the diſtance P *o*, deſcribe the arch *o*, R, *q*.

16. Make H S equal to 30 min. and on the point S erect the perpendicular S *t*, and make S *t* equal to twice S *q*.

17. Draw the right line *t r*, and on *r*, with the diſtance *r t*, deſcribe the arch *t u*, and with the ſame opening on *t*, the arch *r u*, interſecting the former in *u*.

18. On the point *u*, deſcribe the curve *r t*, and 'twill complete one half of the attick baſe and baſe of the ſhaft, as required.

Dorick Capital. 2. *Let it be required to delineate the getmetrical upright of the dorick capital*, fig. XVII.

1. Draw the right line A *a*, infinitely, and at A erect the perpendicular A I, for the centeral line of the capital.

2. At 1 min. $\frac{1}{2}$ diſtance from A *a*, draw the line B *b* parallel to A *a*, and make A *a* and B *b* each equal to 28 min. and draw the line *a b*.

3. At 3 min. $\frac{1}{2}$ diſtance from B *b*, draw the line C *d* infinitely, and parallel to B *b*.

4. Continue *a b* to *e*, and divide *b e* into two equal parts in the point *c*, and thereon, with the diſtance *c b*, deſcribe the ſemicircle *b* 30, *e*.

5. Set up 9 min. from C to D, and draw the line D *f*, infinitely.

6. Take 26 min. in your compaſſes, and ſet that diſtance from C to *d*, and from D to *f*, and draw the line *d f*.

7. Set up 3 min. $\frac{1}{3}$ from D to E, and draw E L infinitely.

8. Divide E D into three equal parts at the points *a a*, and draw the line *a g* and *a h*, infinitely.

9. Set 30 min. from E to *k*, and continue *d f* to L, and divide L *k* into three equal parts at the points *m* and *n*, from which draw lines parallel to *f* L, and they ſhall terminate the lines *f g h i*.

10. Set up 6 min. and $\frac{1}{2}$ from E to F, and draw the line F *n* infinitely, and parallel to the line E L.

11. Make F *n* equal to 36 min. and draw the line K *n*, which divide into 5 equal parts, and on the points K and *n*, with an opening of 4 of thoſe diviſions, deſcribe the arches 2 2 and 4 4, interſecting each other in the point *m*, whereon, with the radius *m* K, deſcribe the arch K *n*.

12. Set up 6 min. $\frac{3}{4}$ from F to G, and draw the line G *o*, infinitely, and parallel to the line F *n*, and at *n* erect the perpendicular *n o*, and make G *o* equal to 37 min.

13. Set

13. Set up 2 min. $\frac{2}{3}$ from G to H, and draw the line H *s* infinitely, and parallel to G *o*, and make H *s* equal to 39 min. as alſo the line I *t*, at the parallel diſtance of 1 min. $\frac{3}{4}$.

14. Fig. Z repreſents the face of the member H *s o* G, which deſcribe as follows, *viz.* draw the line *o* S, and biſſect it in R, and divide each half into 7 equal parts, and with the diſtance of 6 of thoſe parts, on the point *o*, deſcribe the arch 7 7; alſo with the ſame diſtance on R, deſcribe the arch 6 6, interſecting the former in the point 8, and alſo deſcribe the arch 5 5. This being done with the ſame opening on the point S, deſcribe the arch 3 3, interſecting the laſt in the point 9. Fig. XVII.

15. The points 8 and 9 are the centers of the arches O R and R S, which compoſe the face of the member, as required.

16. Fig. N repreſents the fillet B *b a* A (under the aſtragal C *d e b* B) with a ſection of the ſhaft, which deſcribe as follows, *viz.* biſſect *n* A in *i*, and make *n m* equal to three times *n i*, and draw the line A *m*, and on *m*, with the diſtance *m* A, deſcribe the arch A S, and on A the arch *m t*, interſecting the former in *r*, which is the center of the arch or hollow A *m*, as will complete the capital with the aſtragal as required.

3. *Let it be required to delineate the geometrical upright of the dorick, architrave, freize and cornice,* fig. XVIII. *Dorick, Architrave, Freize and Cornice.*

Practice.

1. Draw the line A *a*, at pleaſure, and at *a* erect the perpendicular *a*, *o*, which is to repreſent a continuation of the centeral line, from which every meaſure of projecture, and on which every meaſure of height is to be accounted.

2. At the parallel diſtance of 11 min. draw B *c* infinitely, and make *a* A and B *b*, each equal to 26 min. and draw the line A *b*.

3. At the parallel diſtance of 14 min. $\frac{1}{2}$, draw *c d* infinitely, and make B *c* and C *d*, each equal to 27 min. and draw the line *c d*.

4. At the parallel diſtance of 4 min. $\frac{1}{2}$ draw D *g f* infinitely, and make C *e* and D *f*, each equal to 30 min. and draw the line *e f*. Fig. XVIII.

5. At the parallel diſtance of 45 min. draw the line E *i* infinitely, and make D *g* and E *h*, each equal to 26 min. and draw the line *g h*.

6. At the parallel diſtance of 5 min. draw F *k l* infinitely, and make E *i* and F *k*, each equal to 27 min. and draw the line *i k*, alſo make F *l* equal to 30 min. $\frac{1}{2}$.

7. At the parallel diſtance of 5 min. draw G *n* infinitely, as alſo H *o*, and make G *n*, and H *o*, each equal to 35 min. $\frac{1}{2}$.

8. Draw the line *l n*, and divide it into 4 equal parts, and deſcribe the triangle *n m l*, making the ſides *n m* and *m l*, each equal to three parts of *l n*, and the point *m* is the center of the arch *n*, 2, *l*.

9. At the parallel diſtance of 6 min. draw I P *q r* infinitely, and make I *q* equal to 39 min. and $\frac{1}{2}$, and make I *r* equal to 64 min. $\frac{1}{2}$.

10. Draw the line *q o*, and with the diſtance *o q* on *o*, deſcribe the arch *q* P, and on *q* the arch *o* P, interſecting each other in the point P, which is the center of the arch *q*, 7, *o*.

11. At the parallel diſtance of 8 min. draw K S infinitely, and make K S equal to I *r*, and draw *r* S; alſo make S *t* equal to 1 min.

12. At the parallel diſtance of 3 min. $\frac{1}{4}$, draw L *x y* infinitely, as alſo M P, at the parallel diſtance of $\frac{3}{4}$ min. and make L *z* and M P, each equal to 68 min. and draw the line *z* P.

13. Draw the line *t y*, and divide it into two equal parts in *w*, and on *t*, with the diſtance *t w*, deſcribe the arch *w u*, and with the ſame diſtance on *w* deſcribe the arch *t u*, interſecting the former in *u* which is the center of the arch *t w*, and in the ſame manner on *x*, deſ-
Fig. XVIII. cribe the arch *w y*.

14. At the parallel diſtance of 6 min. $\frac{3}{4}$, draw N S infinitely, as alſo O T, at the parallel diſtance of 2 min. $\frac{1}{4}$, and make N S and O T, each equal to 76 min. and draw the line S T.

15. Draw the line P S, and divide it into two equal parts in V, and with the diſtance P V on P deſcribe the arch V Q, and with the ſame diſtance on V deſcribe the arch P Q, interſecting the former in Q, whereon, with the ſame diſtance, deſcribe the arch P V, and in the ſame manner on R, the arch V S alſo, which will complete the profile, or geometrical elevation of the architrave, freize and cornice, as required.

PROBLEM

Problem X.

To delineate the triglyphes of the dorick order.

This ornament is ſeldom uſed in any order beſides the dorick, and is always placed in the freize exactly over the column. The height of this ornament is always equal to the height of the freize wherein 'tis placed, (the capital excepted) and the breadth to half the diameter of the column at the baſe. In every triglyphe are 7 parts, *viz.* two entire glyphes or channels (as *z m*) meeting in an angle, two ſemi-glyphes, as *z i*, and three interſtices or ſpaces, as *z l*, &c. To delineate this ornament you muſt, Fig. XVIII.

1. Take 15 min. and place from D to Z, and from E to *b*, and draw *b* Z.

2. Divide D Z and E *b*, each into 6 equal parts, and draw the lines *a b*, *a b*, &c.

3. Set 2 min. from *b* to *x*, and from E to *z*, and draw the line *z x*.

4. On *x*, with the diſtance *x o*, deſcribe the quadrant *o n*, and with the ſame opening on *m* the ſemicircle *o n o*.

Hence it appears, that the triglyphe muſt be divided into 12 equal parts, of which two muſt be given to each entire channel, as well as to the ſpaces between, and one to each ſemi-channel, at the extreams.

5. Continue the lines *b* Z, *a b*, &c. through the liſt of the architrave towards *o o o*, &c. and draw the line *q q* parallel to C *e*, and *p p*.

6. Make the parallel diſtance of *p p*, equal to 1 min $\frac{1}{2}$, and *q q* to 4 min.

Laſtly, if right lines be drawn from the points of interſection *r r*, &c. towards the points *c c c*, &c. (which are in the midſt of the liſt) till they meet the line *p p*, they will truly form the guttæ, or drops, and complete the whole, as required.

Theſe guttæ, or drops, are made either in ſhape of the fruſtum of a cone, or pyramis, and oftentimes exact cones or pyraments.

When triglyphs are placed throughout an entablature, the empty ſpaces between muſt be exactly ſquare (and are called metops). From whence it happens, that in many ſtructures the triglyphes are left out, on account they cannot be ſo diſtributed, as to make the empty ſpaces, or metops, exactly ſquare. Theſe metops are oftentimes enriched with oxes ſculls, fruit, flowers, &c. according to the nature of the building wherein they are introduced.

Problem XI.

To deſcribe the upright and inverted cima, or cymaiſe, vulgarly called ogee.

I. Of the upright cima. Fig. A B.

Plate VII.

Practice.

1. Draw the right line *a m*, and biſſect it in *n*.

2. On *m*, with the diſtance *m n*, deſcribe the arch *n r*, and alſo on *n* the arches *m r* and *n o*.

3. With the ſame opening on *a*, deſcribe the arch *n o*.

Laſtly, The points *o* and *r*, are centers whereon you may deſcribe the arches *m t n* and *n i a*, which will complete the upright cima, as required.

II. Of the inverted cima. Fig. A D.

Plate VII.

Practice.

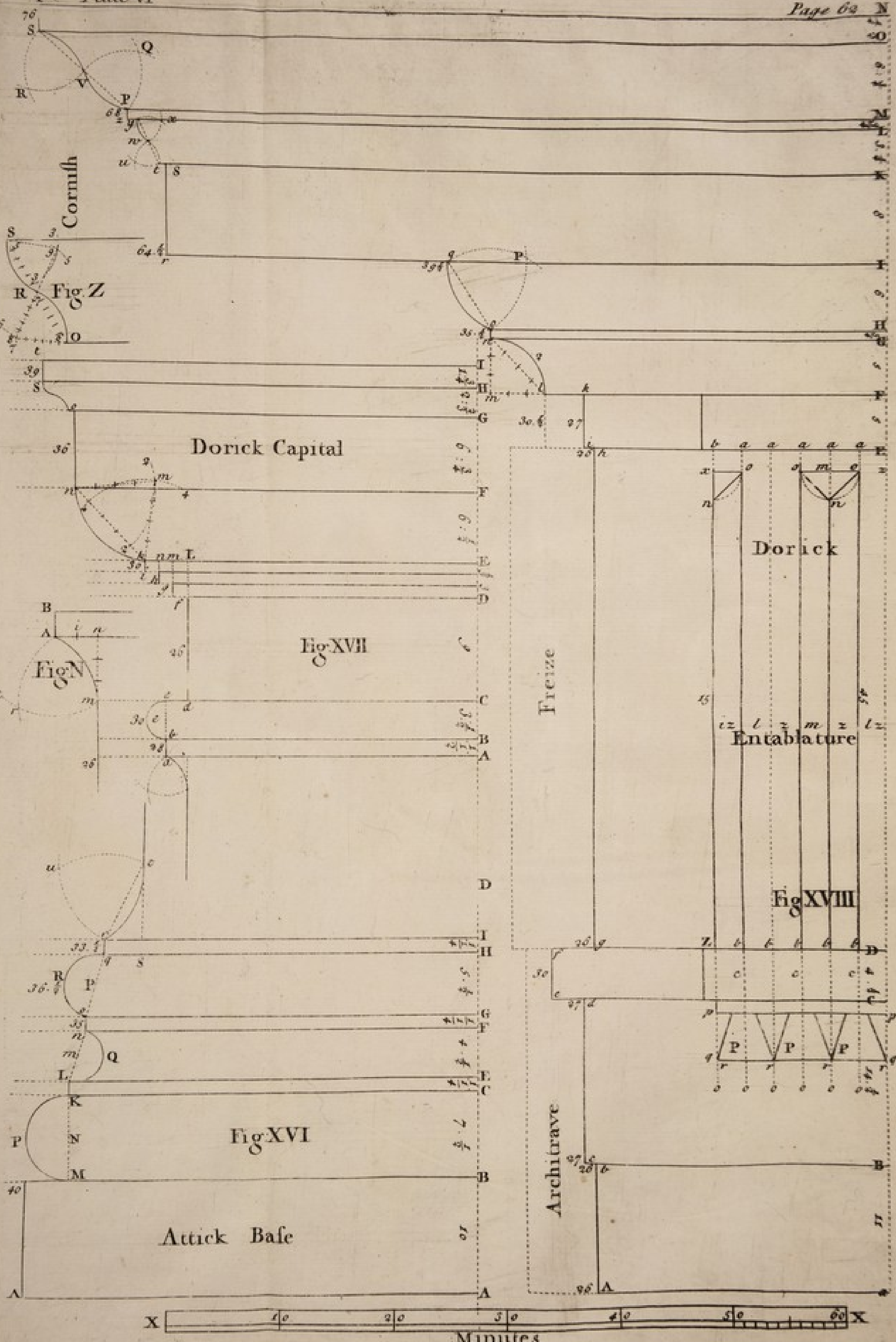
1. Divide the projecture given to the cima, as *a b*, into *6* equal parts.

2. Make *m l* and *g i*, each equal to $\frac{1}{6}$ of *a b*, and draw the line *i m*.

3. Biſſect *i m* in *k*, and then deſcribe the cima, as in the preceding, and the inverted cima will be completed, as required.

Problem XII.

To delineate the geometrical upright of any pillaſter, or column, with its entablature.


Cornish
Fig Z
Dorick Capital
Fig XVII
Fig N
Freize
Dorick
Entablature
Fig XVIII
Fig XVI
Attick Base
Architrave
Minutes

I. Of a pillaster.

PLATE VII.

Practice.

1. Draw the line I H for the centeral line. Fig. I.

2. By the first of problem IX. hereof, delineate the base G.

3. Make K L equal to the assigned height of the pillaster, *viz.* 7 diameters, &c. and through the point L draw B C parallel to E F, and make K F, K E, L C, L B, each equal to the semidiameter of the pillaster, *viz.* 30 min.

4. Draw the right lines B E and C F, and then will the body of the pillaster be completed.

5. By the second of problem IX. hereof, delineate the capital A; and by the third, the architrave, freize and cornish M D N, and then will the whole be completed, as required.

II. Of a column.

PLATE VII.

Practice.

1. Draw the centeral line A Q. Fig. II.

2. By the first of problem IX. hereof, delineate the base B.

3. Make C I equal to the assigned height of the shaft of the column, *viz.* 7 diameters, &c. and through the point I draw the right line L I K at right angles to the centeral line A Q.

4. Divide C I into 3 equal parts, and set up one from C to F, and through the point F draw the right line G F H.

5. Make C D, C E, F H and F G, each equal to the semidiameter of the column at the base, *viz.* 30 min. and draw the right lines D H, and E G, parallel to C F.

6. Make I K and I L, each equal to the semidiameter at the capital or head of the shaft, *viz.* 26 min. &c.

7. On

7. On F deſcribe the ſemicircle G *a a* H, and make the chord line *a a*, equal to L K and parallel to G H, and draw the right lines L *a* and K *a*.

8. Divide the arches *a* H and *a* G, into any number of equal parts (the more the better) ſuppoſe 4, as in the diagram at the points *n m o* G, &c. and draw the lines *n n*, *m m*, and *o*, *o*.

9. Divide F I into the ſame number of equal parts, as *a* G or *a* H, which in this example is 4, at the points 1, 2, 3, I, and through the points 1, 2 and 3, draw the right lines W 1 X, T 2 V and R 3 S, at right angles to the centeral line A Q.

10. Upon the points *n* and *n*, erect the perpendiculars *n* R, *n* S, or at the diſtance of 1 *n*, draw the lines *n* R and *n* S parallel to F I, and they will interſect the line R 3 S in the points R and S.

11. At the diſtance of 2 *m*, draw the parallels *m* T and *m* V, and they will interſect the line T 2 V in the points T V.

12. At the diſtance of 3 *o*, draw the parallels *o* W, and *o* X, and they will interſect the line W 1 X in the points W X.

Laſtly, lines being drawn from G to L, and from H to K, though the ſeveral points of interſection W T R, and S V X, ſhall truly form the diminſhing (or upper) part of the ſhaft, as required.

To which being added the capital and entablature, as before taught, the whole will be completed, as required.

N B. That in conſideration, as the upper part of the ſhaft of every column is ſo much leſſer than the upper part of a pillaſter, by ſo much as the diminution of the column is, as generally in the tuſcan $\frac{1}{4}$, the dorick $\frac{1}{7}$, the ionick $\frac{1}{6}$, the corinthian $\frac{1}{7}$, and the compoſita $\frac{1}{8}$, of their diameters at the baſe, therefore when you are to delineate any pillaſter, &c. with its entablature, from any of the geometrical elevations, at the end hereof, you muſt add to the projecture of every member, half the diminution of the column, and thereby every member will have its true projecture.

PROBLEM

PROBLEM. XIII

To delineate the geometrical upright of any wreath'd, waved or twisted columns.

These kind of columns may be described divers ways, but none better than the following.

PLATE VII.

Practice.

1. By the preceeding problem, delineate the corinthian shaft B O D N, and make B A equal to B D. Fig. III.

2. Draw the right line A D, and on the point A with any radius, describe an arch as C Z, which divide into 12 equal parts at the points 1, 2, 3, 4, &c.

3. Lay a ruler from A to the several points 1, 2, 3, 4, 5, &c. and draw right lines to the side of the column D B, as to the points *n*, *n*, *n*, &c.

4. From the several points *n*, *n*, *n*, &c. draw the right lines *n m*, *n m*, *n m*, &c. parallel to the base D N.

5. On N, with the distance N *m*, describe the arch *m i*, and with the same opening on *m*, describe the arch N *i*, intersecting the former in the point *i*, which is the center of the arch N *m*.

6. Perform the same operation at the several divisions, and thereby you will complete the shaft as required.

PLATE VII.

Shewing how to perform the aforesaid operation a different way from the foregoing. Fig. IV.

Practice.

1. By the preceeding problem, delineate the ionick shaft E R P Q, and make P E equal to one third of F P, and draw the right line F E.

2. With the distance E F, on E describe the arch F V, and on F the arch E V, and also on V the arch E 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, F.

3. Divide the arch E 1, 2, 3, &c. F, into 12 equal parts, at the points 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and from them draw right lines parallel to the baſe P Q, 'till they interſect the column in the points *n*, *n*, *n*, &c. and *o*, *o*, *o*, &c.

4. Divide each of the diviſions *n*, *n*, &c. and *o*, *o*, *o*, &c. as Q *o*, or P *n*, into 4 equal parts, and with the diſtance of 3 of thoſe parts, deſcribe the ſeveral arches therein on the points P, *n*, *n*, *n*, &c. and Q, *p*, *o*, *o*, &c. interſecting each other in *r*, *r*, *r*, &c. which points of interſection are the centers of the ſeveral arches that compoſe the column, and being deſcribed will complete the ſhaft, as required.

Plate VII.

Shew the like operation in ſmall columns.

Practice.

Fig. V. 1. By the preceeding problem delineate the dorick ſhaft S T G I, and make I K and G H, each equal to G I, and draw H K, and the diagonals K G and H I, interſecting each other in *n*, whereon deſcribe the arch K I.

2. Make the triangle G *m* H, equal to the triangle I *n* K, and on *m* deſcribe the arch H G.

3. Make K M and H L equal to H K, and draw the line L M and the diagonals M H and L K, interſecting each other in *u*, the center of the arch H L.

4. Make the triangle K *w* M equal to K *u* M, and on *w* deſcribe the arch K M, and ſo on with all the others, and thereby the whole will be completed as required.

The ſhafts fig. VI, VII, and VIII. are the ſame ſhafts completed, whereby their effect may be adjudged.

Problem XIV.

Plate VIII.

How to divide the breadth of any pillaſter into its flutes and fillets, and to delineate the geometrical upright of the ſame.

1. The general received proportion for dividing the breadth of a pillaſter, is to divide every pillaſter into ſeven flutes and eight fillets, and that the breadth of e-

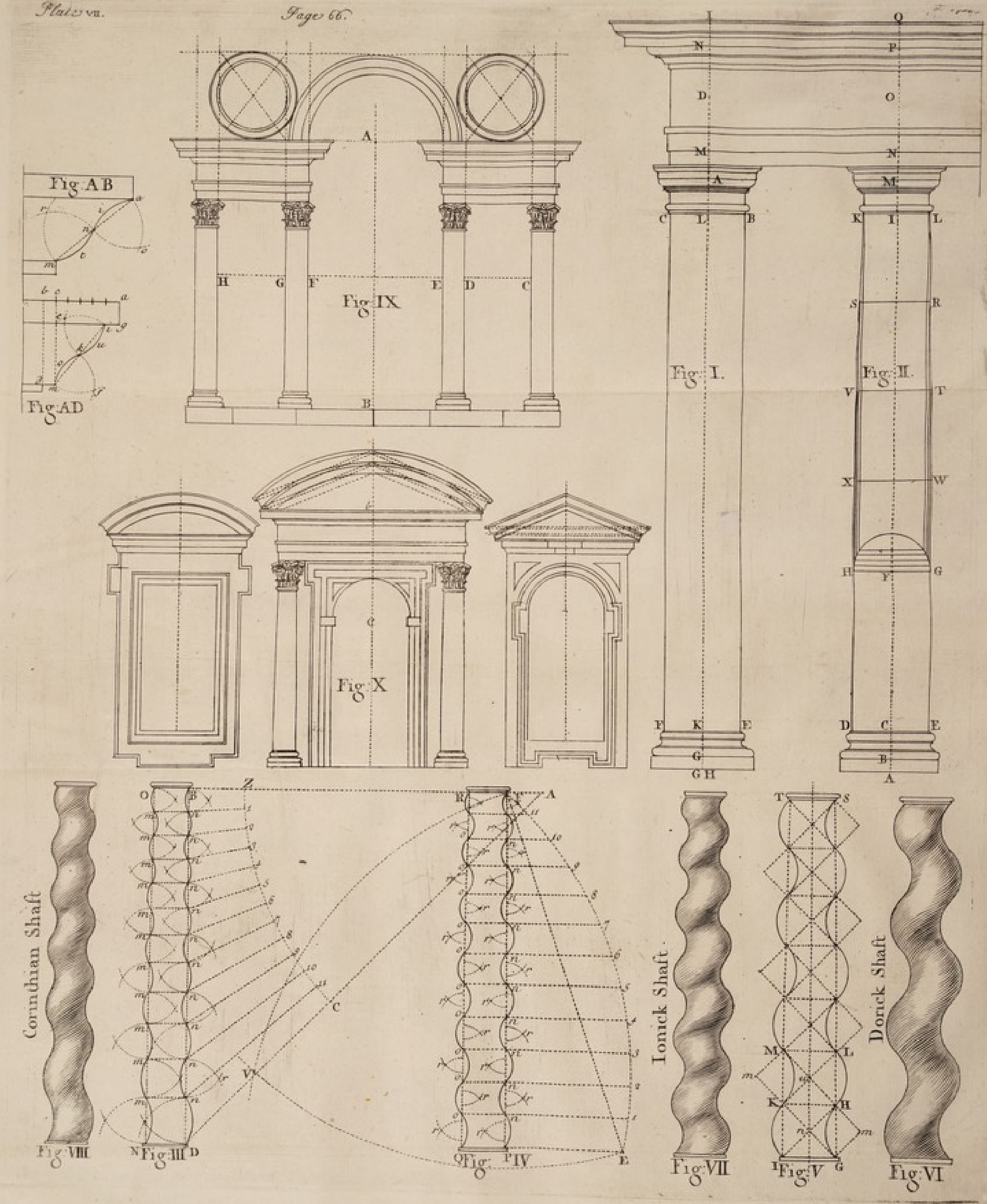


Fig. AB
Fig. AD
Fig. IX
Fig. I.
Fig. II.
Fig. X
Corinthian Shaft
Fig. VIII
Fig. III
Fig. IV
Ionick Shaft
Fig. VII
Fig. V
Dorick Shaft
Fig. VI

very fillet contain $\frac{1}{3}$ part of the breadth of a flute, and thereby the breadth of every pillaſter ſo fluted, is divided into 29 equal parts, *viz.* eight equal parts contained in the eight fillets, and twenty one equal parts in the ſeven flutes, each containing three, and thereby every fillet is Fig. XIX. equal to $\frac{1}{3}$ of a flute as aforeſaid. This being well underſtood, we'll now proceed to the geometrical conſtruction thereof.

PLATE VIII.

Let the line F G *be the given breadth of a pillaſter, to be divided into its flutes and fillets, as aforeſaid.*

1. Draw a line at pleaſure, as A B.

2. With any ſmall opening of the compaſſes, ſet off 29 times of that opening, beginning at any part thereof, as at B, and ending at A, as in the figure.

3. Having thus ſet off 29 equal parts on the line A B, the next work is to make an equilateral triangle there from, which thus perform.

On the point A, with the diſtance A B, deſcribe the arch B *a*, and with the ſame diſtance on B, deſcribe the arch A *a*, interſecting the former in the point C, and draw the lines A C and C D.

4. From the angle, or point C, draw right lines through all the 29 diviſions marked 1, 2, 3, &c. and continue them infinitely, and thus have you prepared in effect an inſtrument that will at once divide the breadth of any pillaſter that may be given, as ſhall appear by the example in hand.

5. Take the given line F G in your compaſſes, and ſet that diſtance from C to E, and from C to D, and draw the line D E; and becauſe the figure is equilateral, therefore D E is equal to the given line F G, and by the lines C *o*, C *o*, &c. drawn through the 29 diviſions, is divided into 29 equal parts alſo, which is the diviſion of the pillaſter required.

Operation.

1. Erect the perpendicular E H, which repreſents one ſide of the pillaſter.

2. The firſt fillet being equal to $\frac{1}{29}$ of D E, therefore at the diſtance E *b*, draw *b b* parallel to E H, and it ſhall be the firſt or outſide fillet.

3. As

3. As every flute is equal to three fillets, therefore number three equal parts from *b* to *c*, and draw *c c* parallel to *b b*, and it shall be the first or outside flute.

Fig. XIX. 4. At the distance of one division from *c* to *d*, draw *d d* for the next fillet, and also at the distance of three divisions from *d* to *e* draw *e e* for the next flute, and in the same manner, taking one division for a fillet and three for a flute, you will complete the flutes and fillets of the pillaster, as required.

N B. The depth of every flute in the pillaster is $\frac{1}{3}$ the breadth of the flute, therefore to describe the circular termination, set up $\frac{1}{6}$ of the breadth of the flute from *x* to *z* and that will be the center of the curve that terminates the flute *c c*, and the like of all others.

☞ 'Tis to be observed (as I said before) that in respect to the figure being equilateral, the breadth of any pillaster may thereby most readily be divided, be the same but the tenth of an inch, or 1000 feet, &c. and therefore of universal use.

Fig. XIX. The line M N is the breadth of a smaller pillaster, which is divided in the same proportion and by the very same rule, and is inserted to shew the reason of the figure without any more words, to which I refer you.

Problem XV.

To divide the basis, or plan of the shaft of a column into its 24 flutes, and 24 fillets.

The number of flutes were formerly limited to every order, the dorick being allowed 20, and the ionick 24. But that limitation has been dispensed with, with divers of our modern architects. In this example 'twill be sufficient to divide a semicircle, or the semi-basis of the shaft, instead of the whole, the last being but the first repeated.

Practice.

Practice.

1. Let B D be the diameter of the basis of a column given. Fig. XX.

2. Divide the same into two equal parts in A, and thereon, with the distance A B, describe the semicircle B C D.

3. Divide the same into two quadrants by the perpendicular A C, and divide each quadrant into 12 equal parts, and draw the lines *a, a, a, a,* &c. through the same. And thus is the semi-basis prepared for the description of the flutes and fillets.

4. Divide any of the 12 parts (as B *z*) into eight equal parts.

5. Take three of those eight equal parts in your compasses, and on those points where the lines *a, a, a,* &c. intersect the semicircle B C D, describe the several arches *i, i, i, i,* &c. which shall be the flutes, and intervals of the fillets, as required.

PROBLEM XVI.

To divide the basis, or plan of the shaft of a column, into its 24 flutes without fillets, as is usual in the dorick order.

I shall here (as in the last) make use of the semi-basis only. Fig. XX.

Practice.

1. Complete the semicircle B C D, and divide the same also into 12 equal parts, by the lines *n, n, n,* &c.

2. Divide any one of those parts, into eight equal parts, as the part 1 and 2.

3. From the several points where the lines *n, n, n,* &c. intersect the semicircle, on those several lines set off two of those eight parts, as at the points *o, o, o, o,* &c. which are the centers of each flute. Therefore on those points, with the distance *o* 1 or *o* 2, &c. describe the several arches, and they will complete the flutes of the semi-basis, as required. Fig. XX.

Problem XVII.

To describe on a paper drawing, wall, &c. the geometrical upright of a column, with its flutes and fillets.

To describe the geometrical upright of a column, is to shew in what manner the flutes and fillets diminish in their breadth, as they approach the extream parts of the column.

Practice.

Fig. XX. If from the intersection of the flutes and fillets, you draw the lines *r, r, r, r,* &c. perpendicular to B D, and complete their terminations with circular lines, as in the figure, they will complete the geometrical upright of that part, as required, and every flute and fillet have its due breadth, according to the rules of perspective.

Problem XVIII.

To describe (in the aforesaid manner) the geometrical upright of a column, with its flutes only, as often used in the dorick order.

Practice.

Fig. XX. 1. If from the intersection of the flutes in the semicircle B E D, you draw the lines *s, s, s,* &c. perpendicular to B A D, and complete their terminations with circular lines, as in the figure, they will complete that geometrical upright, as required.

Problem XIX.

To divide the base, or plan of the shaft of a column into its 20 or 24 flutes, according to Vitruvius.

Practice.

Fig. XXI. 1. On A describe the base of the shaft, as the circle B *a b* D E.

2. Divide the circumference into 20 or 24 equal parts by the lines *n, r, r, r,* &c..

3. Make

3. Make *i a* and *i b*, each equal to $\frac{1}{2}$ *i m*, and draw the right line *a b*.

4. Complete the geometrical ſquare *a d c b*, and draw the diagonals *a c* and *d b*, interſecting each other in *n*, the center of the flute *a o b*.

5. On A, with the diſtance A *n*, deſcribe the circle *n r r r*, &c. interſecting the lines *r*, *r*, *r*, &c. which are the 24 centers of the 24 flutes, whereon, with the radius *n b* or *a n*, you may complete the whole, as required.

Problem XX.

To divide the baſe, or plan of the ſhaft of a column into its 20 *or* 24 *flutes, according to* Vignola.

Practice.

1. On E deſcribe the baſe of the ſhaft, as the circle A *d b* B D. Fig. XXII.

2. Divide the circumference into 20, or 24 equal parts by the lines *e*, *e*, *e*, &c.

3. Make *i b* and *i d*, each equal to $\frac{1}{2}$ *i h*, and draw the right line *d b*.

4. Complete the equilateral triangle *d a b*, and then will the angle *a* be the center of the flute *d n b*.

5. On E, with the diſtance E *a*, deſcribe the circle *e e e*, &c. interſecting the lines *e*, *e*, *e*, &c. in the points *e*, *e*, *e*, &c. which are the 24 centers of the 24 flutes, whereon, with the radius *a b* or *a d*, you may complete the whole, as required.

N. B. That although both the ſhafts in theſe examples are divided into 24 flutes, yet you are to underſtand that neither *Vitruvius* or *Vignola* made uſe of any more than twenty; therefore if you are willing to follow their rules therein exactly, you muſt divide the circumference of the ſhaft into 20 parts, inſtead of 24, and then proceed in all other reſpects, as in the preceding problems, and thereby you will complete the whole, as required.

Problem XXI.

To divide the baſe of the ſhaft of a column, into its cabled flutings.

Practice.

Fig. XXIII. 1. On A describe the base of the shaft, as the circle *a a a*, &c.

2. By problem XV. hereof, delineate the flutes and fillets thereof.

3. On *o o o*, &c. with the radius *o, a, o, a*, &c. describe the arch *r a s*, &c. and thereby you will describe the cabled fluting, as required.

PROBLEM XXII.

To divide the base of the shaft of a column into its 24 flutes and 24 fillets, after the manner of the columns within the Pantheon.

Practice.

Fig. XXIV. 1. Describe a circle representing the base of the shaft, and divide the circumference thereof into 24 equal parts by the lines *a, a, a*, &c.

2. Divide each part into 5 equal parts, of which give 4 to every flute, and one to each fillet.

3. Make the depth of each flute, equal to the breadth of every fillet, and then will the whole be completed, as required.

Fig. XXV. is the plan of the dorick shaft cut into cants instead of flutings withou any cavity, first taught and practiced by *Vitruvius*, which I here insert, to shew the young student what a great variety there is contained in the form and manner of fluting columns.

PROBLEM XXIII.

To describe the ionick voluta according to the antique manner.

PLATE IX.

Practice.

Fig. I. 1. Delineate the Abacus B A, and from the point 2 8 $\frac{1}{2}$, let fall the cathetus, perpendicular, and delineate the hollow of the voluta B B, the ovolo B D, the astragal B E, and the cincture or annulet B F.

2. Draw

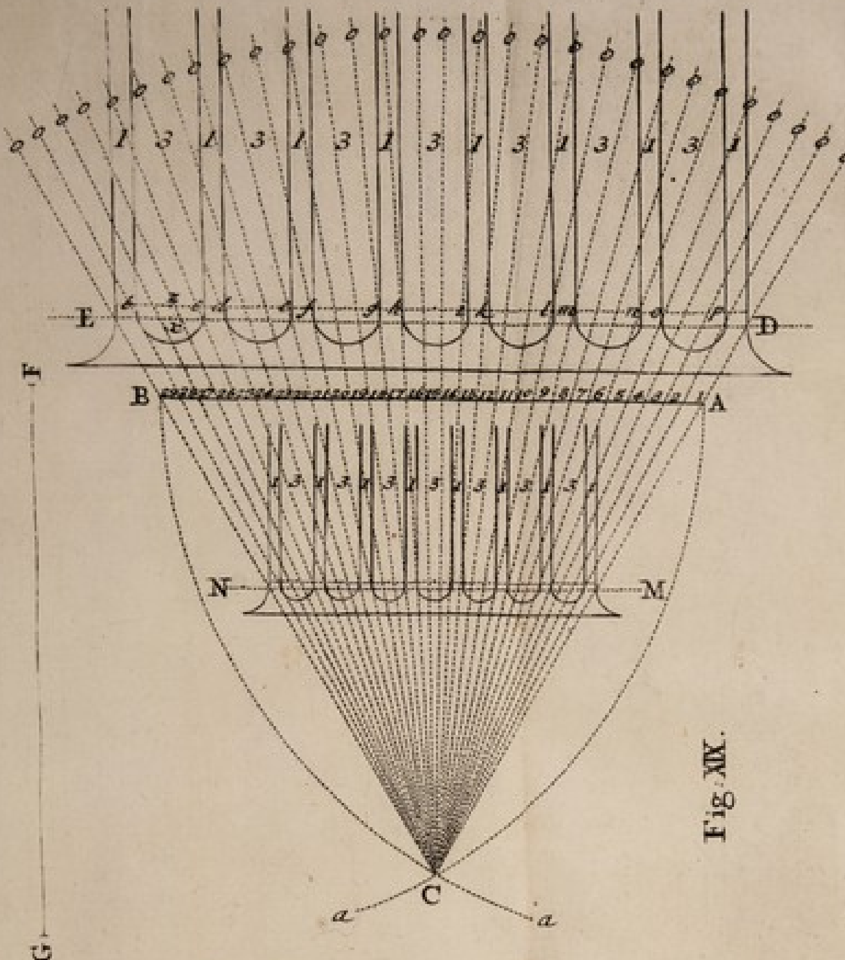


Fig: XIX.

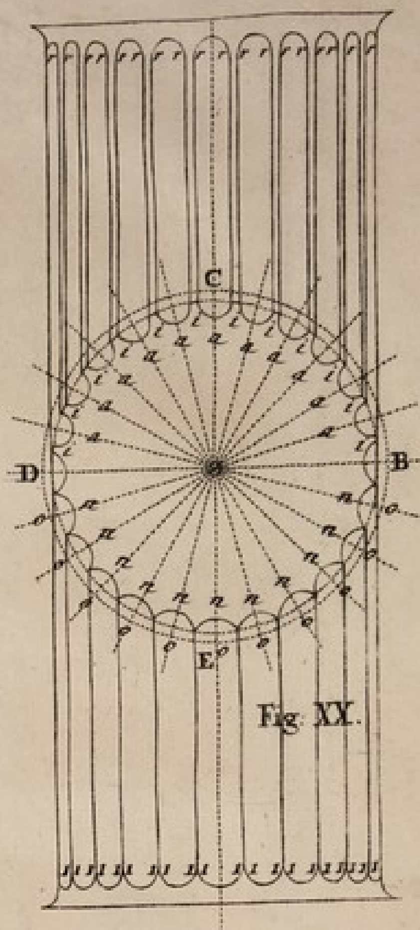


Fig: XX.

Fig: XXIV.

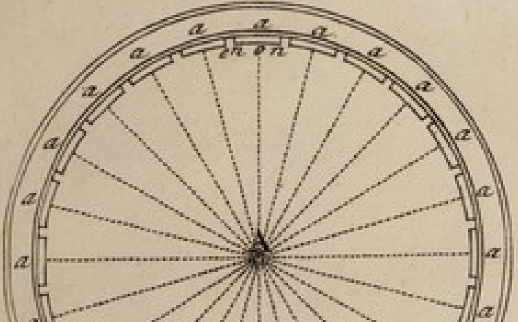


Fig: XXIII.

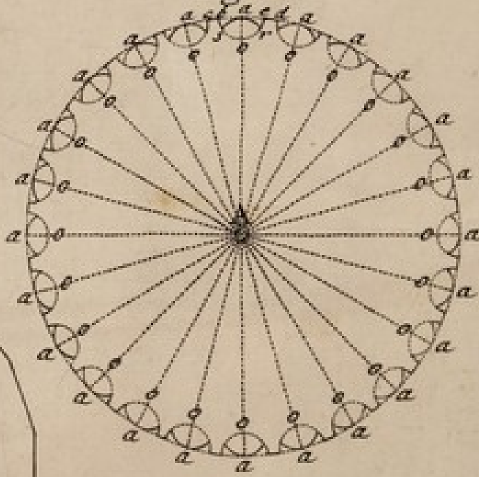
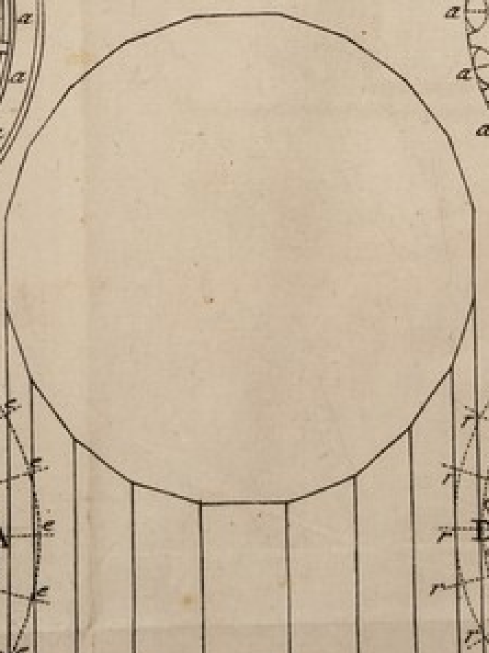


Fig: XXV.



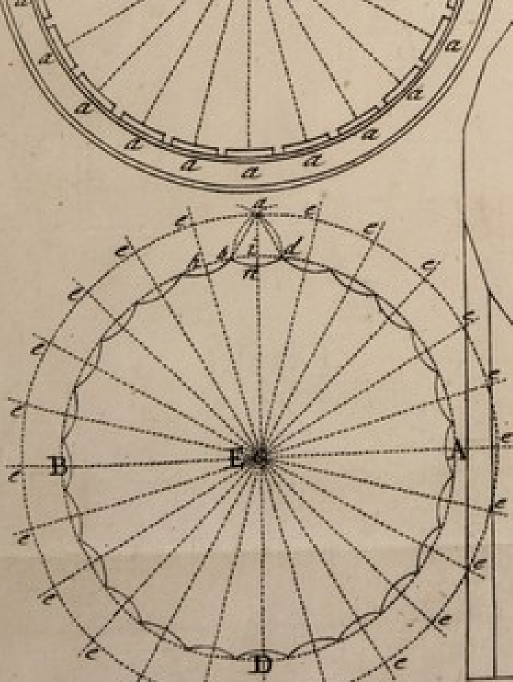


Fig: XXII.

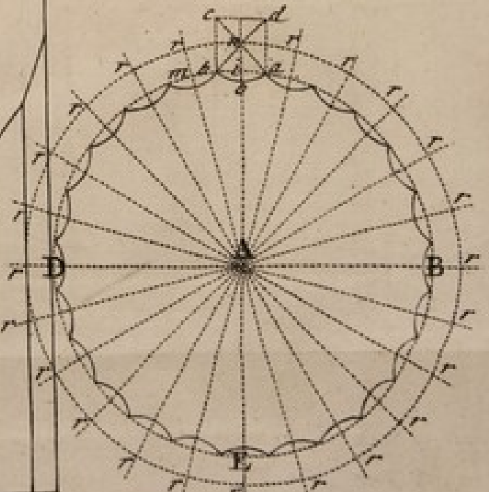
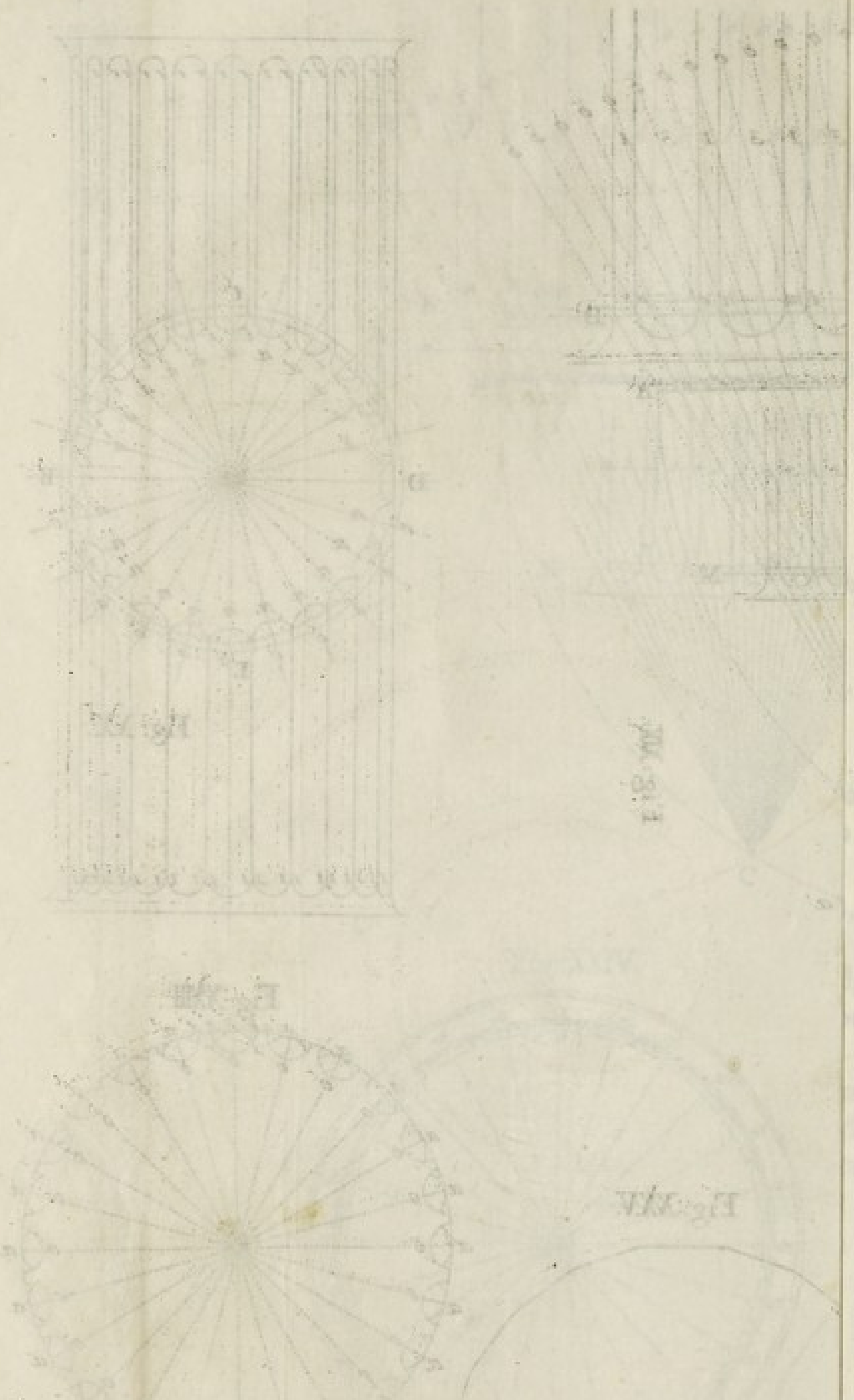


Fig: XXI.



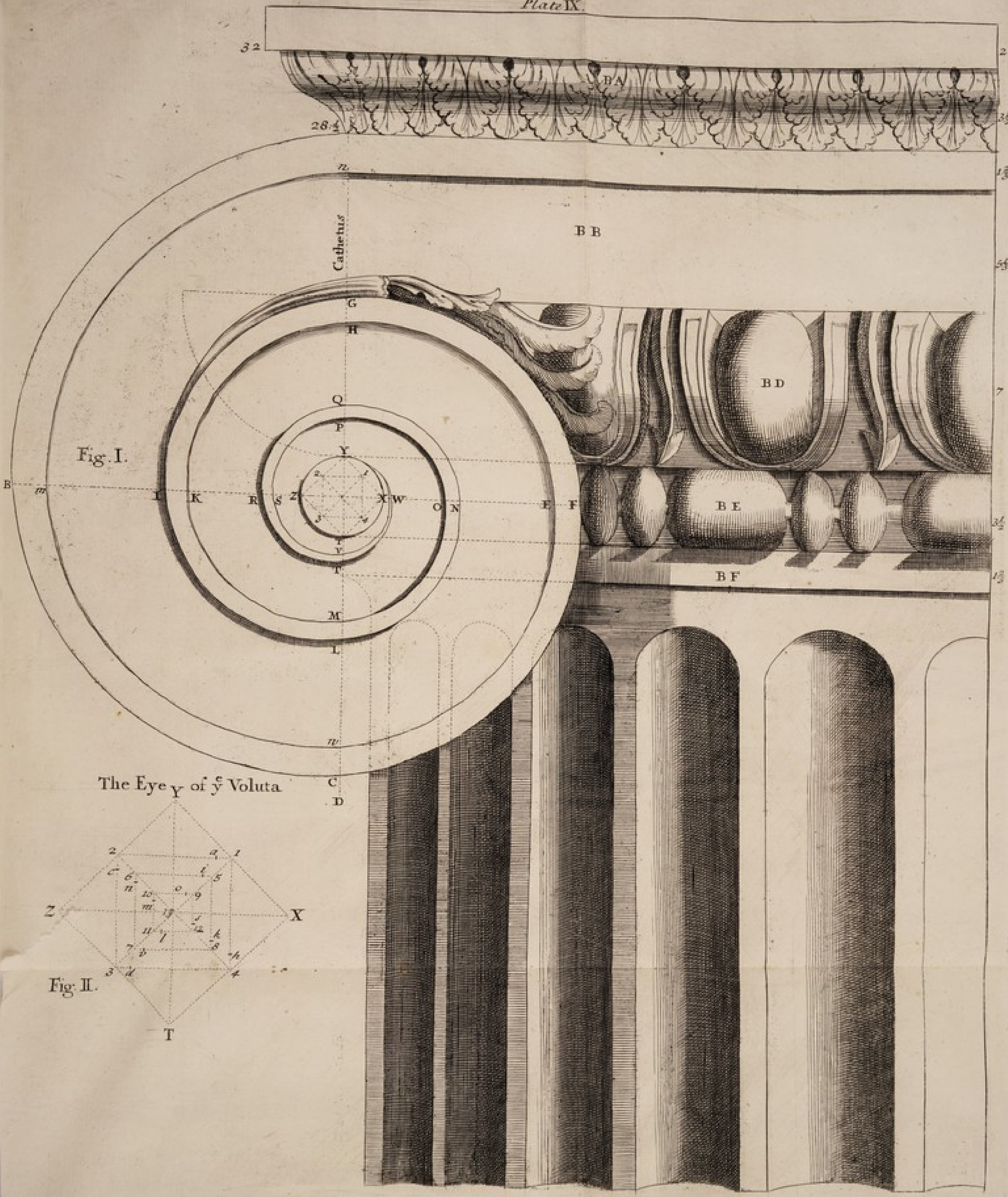
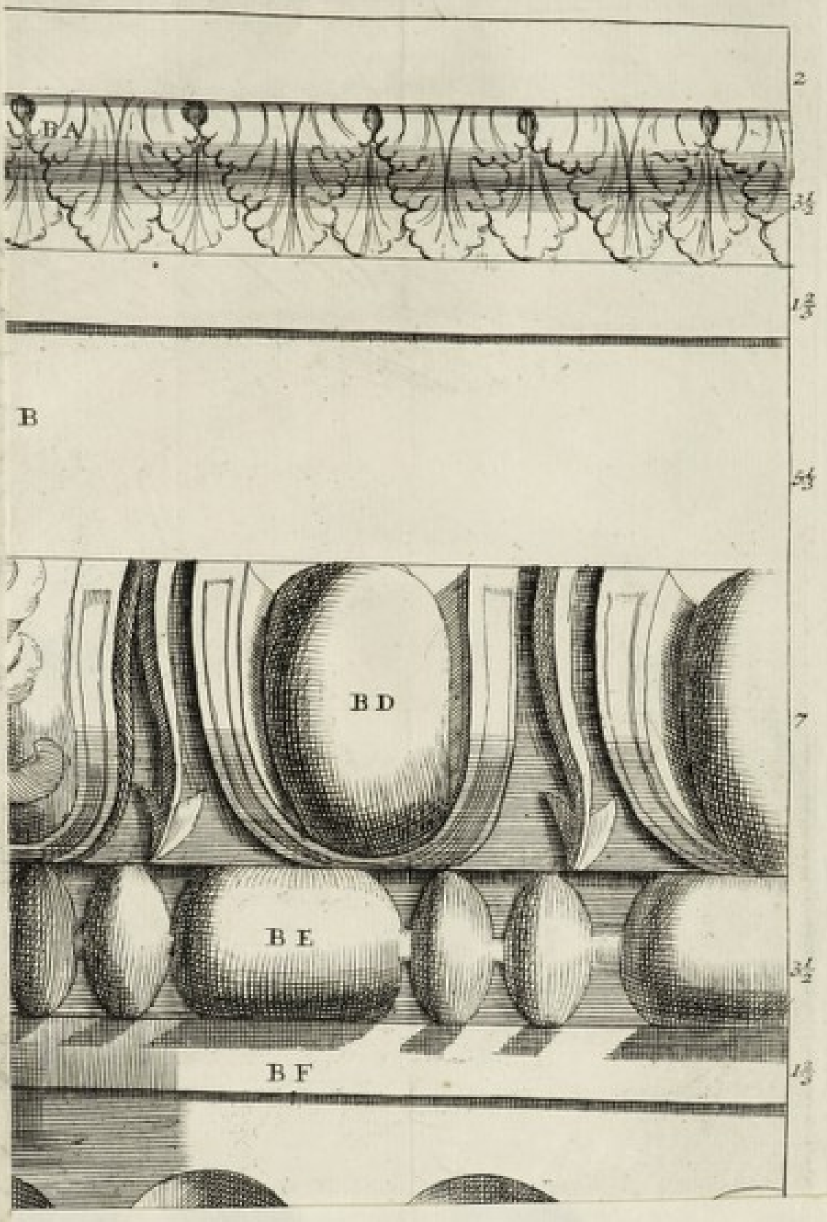


Plate IX.
Cathetus
BA
BB
BD
BE
BF
Fig. I.
The Eye Y of y^e Voluta
Fig. II.



BA
B
BD
BE
BF
2
3⅓
1⅔
5⅓
7
3½
1⅓

2. Draw the right line F B so as to pass through the middle of the astragal B E, intersecting the cathetus in the point 1 3.

3. On the point 1 3, with the distance 1 3 Y, describe the circle or eye of the volute Y X Z, and draw the geometrical square Y X T Z.

4. Bissect Y X, X T T Z and Z Y in the points 1, 2, 3, 4, and draw the geometrical square 1 2 3 4, and also the diagonals 1 3 and 2 4.

5. Divide each diagonal into 6 equal parts at the points 5, 9, 11, 7, 6, 10, 12, 8.

6. Make 1 *a* equal to $\frac{1}{8}$ of 1 2, as also 2 *c*, 3 *d*, 4 *h*, 5 *i*, 6 *n*, 7 *v*, 8 *k*, 9 *o*, 10 *m*, 11 *t*, 12 *s*, and thus will you have divided the eye of the volute into its proper centers, on which you may describe it as follows, *viz.* on the point 1, with the opening 1, 28 $\frac{1}{2}$, describe the arch 28$\frac{1}{2}$ B, and on the point *a* the arch *n m*, also on the point 2 the arch B C, and on *c* the arch *m w*; likewise on the point 3 the arch C F, and on *d* the arch *w* E, and so by removing to the other centers 4 *h*, &c. you will complete the whole voluta, in the most elegant manner as can be desired. And that the young student may have a perfect idea of the centers thereof (which in number are 25) I have in fig. II. described the eye of the volute at large, wherein the numerical figures denote the centers of the exteriour line, and the small italick letters the centers of the interiour, which in an instant will enable him to delineate the same with great ease and delight.

Sect. II.

Of the Derivation, Proportion, Diminution and Intercolumnation of the Tuscan, Dorick, Ionick, Corinthian and Composite Orders of Architecture.

I. Of the Tuscan order.

THE Tuscan or rustick order (saith *Vitruvius*) is the most simple and strongest of all the orders of architecture, it hath no ornaments and but few mouldings. This order was first made by the *Asiatic Lydians*, who are ſaid to be the firſt that inhabited *Italy*, and brought it into that part, called Tuſcana or Tuſcany, and from thence was called the *Tuſcan* order.

And altho' this order is of all others the moſt plain and ſimple, yet many noble ſtructures have been built therewith, as the ports and entrances into cities, amphitheatres, bridges, &c. and particularly that famous column of the *Trojans*, that of *Antoninus* at *Rome*, and likewiſe that of *Theodoſius* at *Conſtantinople*, which are all remaining to this day.

The proportion, diminution and intercolumnation of this rural order is as follows.

1. The ſhaft only without its baſe and capital is in length ſix diameters of the ſhaft's baſe, and the height of the baſe and capital each a ſemidiameter thereof.

2. The entablature of this order is ſeldom leſs than $\frac{1}{4}$ of the ſhaft's height.

3. The pedeſtal hath two diameters of the ſhaft's baſe for its height, and the ſhaft at the upper part diminiſhes $\frac{1}{4}$ of its diameter at the baſe.

4. The intercolumnation of this order may be made very large, by reaſon the architrave is generally made of wood, but the moſt uſual is about 4 diameters of the ſhaft at the baſe.

II. Of the Dorick order.

The Dorick order is of all others the moſt grave and maſculine, and the moſt agreeable to nature. *Scamozzi* calls it Herculean aſpect, in regard to its excellent proportion. This order had its original and name from the *Dorians*, a *Grecian* people of *Aſia*, or as ſome ſay, from *Dorus* King of *Achaſis*, who is ſaid to be the firſt that built at *Argos*, and dedicated a temple of this order to *Juno*.

The proportion, diminution and Intercolumnation of this noble order, is as follows.

1. The ſhaft, excluſive of the baſe and capital (when alone) is in length ſeven diameters, but when in porticos and mural work but ſix.

2. The height of the capital is a ſemidiameter of the ſhaft's baſe, as alſo the Attick baſe, &c. when uſed herein.

in. For you muſt note, that this order was anciently made without any baſe, as may be ſeen by the geometrical profiles of the *Theatre* of *Marcellus*, the Bath of *Dioclctian*, &c. at *Rome*, at the end hereof.

3. The entablature is generally two diameters in height, and is oftentimes enriched in the freize with triglyphes and metops. The ſhaft of this order is oftentimes fluted, with a ſhort edge without any fillets, as laid down by *Palladio* and *Vignola*, in the preceding problems of ſect. I. hereof. And as I ſaid before, that the ancients, never uſed any baſe to this order, ſo 'tis alſo to be underſtood of pedeſtals; therefore when any are uſed herein, *Palladio* allows their height to be two diameters, and $\frac{1}{3}$ of the ſhaft's baſe.

4. The diminution of the ſhaft is $\frac{1}{7}$ of the ſhaft's diameter at the baſe. And the intercolumnation of this order is three diameters, except at ſuch times when the diſtribution of the triglyphes and metops require ſomething more or leſs.

III. Of the Ionick order.

The Ionick order is an exact mean proportion, between the delicate and the robuſt. *Vitruvius* compares it to a matron decently dreſs'd. It was firſt invented, or introduced by *Ion*, in *Ionia*, a province in *Aſia*, and 'tis ſaid that the Temple of *Diana*, at *Epheſus*, was built of this order.

The proportion, diminution, and intercolumnation of this decent feminine order, is as follows.

1. The ſhaft with its baſe and capital, were anciently but 8 diameters, which by the moderns was thought too little, and therefore to give it proper ſtature, they added one diameter, ſo that it now contains 9 diameters in height. The ſhaft is fluted with 24 flutes, with fillets between, whoſe breadths are equal to $\frac{1}{3}$ of a flute.

2. The entablature is $\frac{1}{7}$ of the altitude of the column, and its corniſh is always adorn'd with denticules.

3. The height of the pedeſtal is two diameters and $\frac{2}{3}$, and its intercolumnation two diameters and $\frac{1}{4}$, which is the moſt elegant manner of intercolumnation, and by *Vitruvius* is called *Euſtillos*.

Laſtly, The diminution of the ſhaft is $\frac{1}{6}$ of the diameter at the baſe of the ſhaft.

IV. Of

IV. Of the Corinthian order.

The Corinthian order is the very pride and delicacy of all the other orders. It was firſt deſign'd by an architect of *Athens*, and executed at *Corinth*, a noble city of *Peloponneſe*, or *Morea*, from whence it had its original and name of Corinth in order.

The proportion, diminution, and intercolumnation of this beatiful order, is as follows.

1. The ſhaft with its baſe and capital is 9 diameters and a half, and ſometimes 9 and $\frac{3}{4}$, and oftentimes 10 diameters in length. If the ſhaft be fluted, the flutes muſt be made according to problem XV. ſect. I. hereof.

2. The height of the capital is one diameter of the ſhaft at the baſe, of which the abacus muſt be a ſixth, or ſeventh part, and the remaining quantity being divided into 3 equal parts, the two lowermoſt is the true height of the firſt and ſecond toure of leaves, and the third or uppermoſt part being divided into two equal parts, the upper part of thoſe two parts ſhall be the extreams of the volutas and the lower the cauliculi.

3. The height of the entablature is $\frac{1}{5}$ of the column, including the baſe and capital, except when applied to great and magnificent buildings, as the *Roman Pantheon*, &c.

4. The height of the pedeſtal muſt be $\frac{1}{4}$ of the altitude of the column, and the diminution of the ſhaft $\frac{1}{7}$ of the diameter at its baſe.

5. The intercolumnation is two diameters and $\frac{1}{4}$, as in the preceding order of the Ionick.

V. Of the Compoſite order.

The Compoſite order, is of Roman extraction, and by many called the *Italian* order, and oftentimes the *Roman* order. 'Tis compoſed of the Ionick and Corinthian orders, and therefore is called the compoſed order.

The proportion, diminution and intercolumnation of this order, is as follows.

1. The ſhaft, with its baſe and capital, is ten diameters in length, or height; and its entablature $\frac{1}{4}$, or $\frac{1}{5}$, thereof.

Its

its diminution at the head of the ſhaft is $\frac{1}{8}$ of the diameter at the baſe, and its intercolumnation one diameter and $\frac{1}{2}$, or $\frac{3}{4}$.

The height of the pedeſtal is generally equal to $\frac{1}{3}$ of the column's altitude, and its baſe is either attick, or a compound of the attick and ionick.

And altho' theſe proportions of all the five orders are thus eſtabliſhed, yet not with ſo great a ſtrictneſs, but that the architect may vary therefrom, upon juſt occaſions, as the grandeur and conveniency of a building may require.

Sect. III.

Of Architectonical Axioms and Analogies.

I. Of doors.

THat the height of all doors be double their breadth.

That doors in general be proportional to the magnitude of the rooms.

That the breadth of inner doors be never leſs than 2 feet $\frac{1}{2}$, nor more than 6 feet.

That the doors of the 2d ſtory be placed exactly over the doors of the firſt, and the like of the 3d, &c.

That an arch of brick or ſtone be turned over every door, to diſcharge the weight that preſſes upon them, which oftentimes ruines the ſtructure.

II. Of windows.

That the magnitude and number of windows be proportional to the rooms that they are to illuminate.

That the height of every window in the firſt ſtory be double its breadth, with the addition of $\frac{1}{4}$, $\frac{1}{3}$ or $\frac{1}{2}$ part, as found to be neceſſary.

That the height of the windows in the 2d ſtory be $\frac{11}{12}$ of the firſt, and the height of the attick or 3d ſtory $\frac{3}{4}$ of the ſecond ſtory.

That windows be not placed too near the angles of any building, that thereby the ſtructure be not weaken'd.

That over every window be turn'd an arch to discharge the weight that lies over them.

That no girder be laid over any door or window, but always on the most substantial part of the brick or stone peers, &c. that solid may rest upon solid.

That *Venetian* windows have their proportions, as follow, *viz.* (fig. IX. plate VII.) that the height A B be equal to twice E F, and that G H and C D be each equal to $\frac{1}{2}$ E F.

That the centers of all pediments be placed down the centeral line at the distance of $\frac{1}{2}$ the length of the corona. So the point *c* of fig. X. plate VII. is the center of that pediment, being the distance of *a*, *b*, set down to *c* and the like of all others in general.

III. Of gates.

That the breadth of principal gates of entrance be never less than 7 feet $\frac{1}{2}$, nor more than 12 feet.

That the height of principal gates of entrance be never less than their breadth and $\frac{1}{2}$, nor more than twice, which is the best proportion.

IV. Of halls.

That the length of halls, be not less than twice their breadth, nor more than three times.

That the height of halls, whose cielings are flat, be not less than $\frac{2}{3}$ of the breadth, or more than $\frac{3}{4}$ of the length.

That the height of halls whose cielings are arched be not less than $\frac{5}{6}$, nor more than $\frac{11}{12}$ of their breadth.

V. Of galleries.

That their site be towards the *North*, on account that the *North* light is the best for painting, pictures, &c.

That the breadth of galleries be not less than 16 feet, nor more than 24.

That the length of galleries be not less than 5 times their breadth, nor more than eight at most.

That the height of galleries be equal to their breadth, if with flat cielings, but if arched, the breadth and $\frac{1}{5}$, $\frac{1}{4}$ or $\frac{1}{3}$.

VI. Of antichambers.

That the length of all antichambers be equal to the hypothenuse of a right angled plain triangle, whose legs are each equal to the breadth of the antichamber.

That

That the breadth of all antichambers be proportional to the whole ſtructure. That the height of antichambers be not leſs than $\frac{2}{3}$ of the breadth, or more than $\frac{3}{4}$ of the length, when the cieling is flat, and when arched, to be not leſs than $\frac{5}{6}$, nor more than $\frac{11}{12}$ of their breadth.

VI. Of chambers.

That all principal chambers of delight be placed towards the beſt proſpects of the country, and if poſſible to the *Eaſt*.

That the length of chambers never exceed the breadth and $\frac{1}{5}$ of the breadth; therefore the length may be the breadth exactly, or the breadth and $\frac{1}{8}$, $\frac{1}{7}$, $\frac{1}{6}$ or $\frac{1}{5}$.

That the height of all chambers of the firſt ſtory, whoſe cielings are flat, be not leſs than $\frac{2}{3}$ of the breadth, or more than $\frac{3}{4}$ of the length.

That the altitude of chambers in the ſecond floor be $\frac{11}{12}$ of the firſt ſtory.

That the altitude of the chambers in the third floor be $\frac{3}{4}$ of the ſecond.

VII. Of Floors.

That the floor of every ſtory in a building be truly level throughout, ſo as to paſs out of one room into another, without going up or down ſtairs, as is common in many buildings.

That the height of the level of the firſt (or ground) floor, be never leſs than one foot, nor more than four feet.

VIII. Of chimneys.

1. Of hall chimneys.

That the proportion of hall chimneys be as follows, *viz.* Their diſtance between the jaums from 6 to 8 feet; their height from 4 feet $\frac{1}{2}$ to 5 feet; their projection from 2 feet $\frac{1}{2}$ to 3 feet at moſt; the breadth of the jaums from 8 to 24 inches or more, as occaſion may require, according to the order that the chimney is adorned with.

2. Of chamber chimneys.

That the proportion of chamber chimneys be as follows, *viz.* their breadth from 5 to 7 feet, their height 4 feet $\frac{1}{2}$, and projecture 2 feet and $\frac{1}{2}$.

3. Of chimneys in ſtudies, &c.

That the proportion of chimneys in ſtudies be as follows, *viz.* their breadth from 4 to 5 feet at moſt; their height 4 feet $\frac{1}{2}$, and projecture 2 feet $\frac{1}{2}$.

That the funnels of chimneys of chambers, or ſtudies, be not narrower than 10 inches, or wider than 15, which is a good ſize for kitchin chimneys.

IX. Of the funnels of chimneys.

That the funnels of chimneys be carried a ſufficient height above the ridge, that reflex winds may not repulſe the ſmoke.

That the funnels of chimneys be not wide, whereby the wind may drive down the ſmoke into the room, or too narrow, where it cannot have a free paſſage.

That the funnels of chimneys be truly perpendicular, otherwiſe the ſmoke cannot freely paſs, and thereby will be offenſive.

That no timber, joiſt, &c. be laid nearer to the jaums than one foot.

That no trimming joiſts be laid nearer than 6 inches to the back of any chimney.

That the funnels of all chimneys have not any timber, as girders, joiſt, &c. laid therein, otherwiſe the building will be in danger of being reduced to aſhes.

X. Of joiſts, rafters, and girders.

That the greateſt diſtance that joiſts, or rafters, are laid from each other, do not exceed 12 inches, and quarters 14 inches.

That no joiſt bear at a greater length than 12 feet, or ſingle rafters more than 10 feet.

That the length of joiſts laid in the wall be not leſs than 9 inches, and no girder be leſs than 12 inches.

XI. Of ſtair caſes.

That ſtair caſes be ſpacious, light and eaſy in aſcent.

That the breadth of ſtair caſes be not leſs than 4 feet, or more than 12 feet.

That the height of ſteps be never leſs than 4 inches, or more than 6.

That the breadth of ſteps be never more than 18 inches, or leſs than 12 inches.

XII. Of

XII. Of materials, &c.

1. That money and materials be always ready from the beginning, or laying of the foundation, to the turning of the key when the whole is completed.

2. That great care be taken in the goodneſs of foundations, and that they be truly level.

3. That the thickneſs of all foundations be double to the inſiſtent wall.

4. That the moſt heavy materials be imployed in the foundations.

5. That all walls diminiſh in thickneſs, according to the nature and height of the ſtructure.

6. That every wall be perpendicular.

7. That ſuch bricks as are not well burnt, be not uſed in any building.

8. That the depth of all fabricks in the ground that have cellars, vaults, &c. be $\frac{1}{7}$ of the whole height, and thoſe that have no cellars to be $\frac{1}{6}$ of the height.

9. That the kitchin be ſpacious and light, and as remote from the parlor as poſſible, and to be under ground; as alſo the pantry, bake-houſe, ſtill-room, buttry, dairy, and ſervants offices in general.

10. That corniſhes do not project too far out from the building, whereby the windows be darken'd.

11. That of all kind of arches none is ſo ſtrong as the ſemicircle.

12. That the depth of all ruſticks be never more than 1 foot, nor leſs than 9 inches.

13. That the thickneſs of pillaſters, of doors and windows, be not more than $\frac{1}{5}$ of their aperture, nor leſs than $\frac{1}{6}$.

14. That the projecture of pillaſters in general, be $\frac{1}{2}$ of their thickneſs.

15. That the roofs of all buildings be not too heavy, or too light, and that the interiour walls ſupport part of the ſame.

16. That convenient ciſterns be well placed, plentifully to furniſh every office with water, and that proper machines be made to raiſe the ſame therein.

Laſtly, That convenient drains, to carry away ſoil, &c. be well contrived, and ſecretly placed, with vents to diſcharge the noiſome vapours.

SECT. IV.

PLATE X.

Of the Deſcription and Uſe of an inſpectional plain Scale, for delineating Architecture, Gardening, &c.

THIS ſcale being deſigned but for the drawing of architecture and gardening, it is therefore made to ſuch a breadth and length as is ſuitable to the magnitude of any draught whatſoever. And although this inſtrument was deſigned for drawing only, yet it may, with a great deal of eaſe and delight, be applied to the practice of architecture, which at the end hereof I ſhall demonſtrate. In the uſe of this inſtrument 'tis required to have ſuch a te-ſquare as is uſed with a drawing table, well known by all architects, &c. and the breadth thereof muſt be exactly equal to ½ the breadth of the inſtrument. The lines on this ſcale are of two kinds, *viz.* parallel, as the lines *a, a, a,* &c. and centeral, as the lines of the trigons G H I K L, and the chords over the trigons MGI. The parallelogram CDEF, repreſents ¼ of a pillaſter or column, and C E its ſemidiameter, and conſequently either C D or E F, the centeral line of the pillaſter or column. The diagonal ſcale at the end thereof is treble; for *firſt* you have an inch in a hundred parts, *ſecondly* an ½ inch, and *laſtly* ¼ of an inch in the ſame proportion. Which ſcales are of great uſe in delineating maps, that were meaſured with *Gunter*'s chain, which is divided into 100 links. The trigon adjoining thereunto hath its baſe divided into 90 unequal parts, and is a line of chords from which, to the center, are drawn right lines, which divide the ſeveral parallels therein in the ſame proportion, and thereby you have 20 lines of chords to 20 different radius, &c. The diagonal lines C F and E D are drawn, to ſet thereon the half length of any column or pillaſter. The diagonal E D is to be uſed, when any queſtion is to be anſwered by the trigons I K, and the other diagonal CE, when by the trigons MGHL. The trigon G hath both its ſides equal to the ſemidiameter C E, whereof the outward is divided into 30 equal parts, each repreſenting a minute, from which are centeral lines drawn to the center, which divide all parallel right lines drawn therein, in the ſame proportion.

The trigon H hath its ſide oppoſite to the center divided in ſuch proportion, as the whole breadth of a pillaſter is divided by its 8 fillets and 7 flutes; from which diviſions are lines drawn to the center, which alſo divide any line that is parallel to the outſide, in the very ſame proportion.

The trigons I and K, are divided after the ſame manner, as that of I in the diviſion of the diameter of a column with flutes only, and that of K with its flutes and fillets.

The trigons L and M are made, to furniſh the young ſtudent with ſcales of all ſizes, either for meaſures of feet and inches, as that of L, or feet only, as that of M.

Problem I.

The height of a pillaſter, or column, being given, to find the ſemidiameter thereof, divided into its 30 min. by which the whole pillaſter, or column, with its architrave, freize, and corniſh is meaſured.

Let A B be the half height of a column given, to find the ſemidiameter divided into minutes.

Practice.

1. Lay your te-ſquare on the inſtrument, and taking A B in your compaſſes, move the edge of your ſquare to the outſide at C, and at C make a mark on the ſquare exactly over the line C E, and from that mark ſet off the diſtance of A B taken in your compaſſes, on the edge of the ſquare as at X.

2. Slide back the ſquare, 'till the point X lie over the diagonal C F, in the point Y, and then ſhall that edge of the ſquare that lies over the trigon G be the ſemidiameter of the given column, and the centeral lines be divided into 30 min. as required.

☞ 'Tis beſt, when the diameter is thus found, to draw a fine line with a black lead pencil by the ſide of the ſquare, over the whole breadth of the trigon, and then you may take away the ſquare and work from the diviſions of the black lead line, as occaſion requires.

PROBLEM II.

The height of a pillaster being given, to find its breadth, and division into 7 flutes and 8 fillets.

Practice.

1. Let it be required to find the breadth and division of the pillaster, whose ½ height is equal to the aforesaid given line AB.

2. Place the point X on Y (as before) and then will the other edge of the square cut the trigon H in the point *n n.*

3. The line *n n* is the breadth of the pillaster, and its divisions, by the centeral lines, are the true breadths of every flute and fillet, as required.

PROBLEM III.

The height of a column being given, to find the diameter, and measure (or true breadth) of every flute and fillet, contained in the geometrical upright of the same.

The trigon for flutes and fillets is the trigon K, therefore you must use the diagonal E D.

Let the height of the column be (as afore) equal to twice the given line A B.

1. Place the ½ height CX at Z, then will the other edge of the square cut the trigon K in the points *n n.*

2. The line *n n* is the diameter, or breadth, of the column, and its divisions by the centeral lines, the true breadths of every flute and fillet, as required.

PROBLEM IV.

To find the true measures of the flutes contained in the geometrical upright of a column, that is fluted without fillets (as often practiced in the dorick order) to any height assigned.

Let the height of the column be as aforesaid, equal to twice the given line A B.

1. Place the point X over Z, then will the other edge of the square, cut the trigon I in the points *o* and *o.*

2 The line *o o* is the diameter of the column, and its divisions, by the centeral lines, are the true breadth of every flute, as required.

☞ *Note*, That to find the breadth, or magnitude of the flutes and fillets, &c. at the top of the column, where they are narrower than at the base, you must place the

the diameter upon the respective trigon, so as to intersect the sides and be parallel to the base hereof, and the lines of the trigon will divide the diameter into its true divisions of flutes and fillets, &c. as required. And the like of any other part of the column whatsoever.

PROBLEM VI.

To reduce any part of a line, as a model, minute, &c. into feet and inches, and thereby make this instrument universal in practice.

Let *a b*, in the trigon L, represent 5 inches, and 'tis required immediately to find a scale of 12 inches suitable to it, whereby any part may be measured by feet and inches.

1. Take the line *a b* in your compasses.

2. Fix the edge of the square to the center H of the trigon L, and set off the line *a b*, on the edge of the square from H to *i*.

3. Move the square towards the line 1, 2, 3, &c. 'till the point *i* exactly lie over the line H 5 (as on the point E) and draw by the edge of the square the line I K, which by the 12 centeral lines will be divided into 12 equal parts, (5 of which are equal to the given line *a b*) and is the scale of 12 inches suitable, or proportionable to the line *a b*, as required.

A second example.

Suppose C E *to represent* 20 *inches, how to find a scale of* 12 *inches proportionable thereunto.*

Practice.

1. The $\frac{1}{2}$ of 20 is 10, therefore lay the edge of the te-square to H (as in the last example) and set off the $\frac{1}{2}$ of C E.

2. Move back the edge of the square till the point, or $\frac{1}{2}$ of C E, cut the line H 10.

3. The edge of the square being not moved, draw a line by the same through the trigon L, which by the 12 centeral lines will be divided into 12 equal parts, representing inches, and proportional to C E that contains 20 inches, as was required to be done.

☞ When your column, or pillaster, contains any number of odd inches, radius or diameter, as 27, &c. take $\frac{1}{3}$, &c. thereof, as 9, &c. and find the scale

Z for

for that number, and that fcale fo found fhall be the fcale proportionable to 27, as required.

The trigon M is an infinite number of fcales each divided into tenths, by the 10 central lines, as may be at once underftood by a fingle view of the fame. Thefe decimal fcales are of great ufe in meafuring plans of gardening, and fmall enclofures, taken by foot meafure. And

The trigon L which is alfo an infinite number of fcales of twelfths, is of great ufe in meafuring plans of buildings taken by feet and inch meafure, which I recommend to the young ftudent for the very beft plain fcale that was ever yet made publick. The excellency and ufe of it will be demonftrated in the feveral parts of this work, as they have relation thereunto.

SECT. V.

PLATE XI.

Of plain Trigonometry.

I. Of right lined triangles.

Fig. I. RIght lined triangles are diftinguifhed by the difference of their fides, or by the difference of their angles. As to the difference of their fides, they may be all equal, as A, which is called an equilateral triangle, or two fides may be equal and the third unequal, as B, which is called an ifofceles triangle, or all the fides may be unequal as C, which is called a fchalenum triangle. And thefe are the diftinctions, in refpect to their fides. The diftinctions of triangles, in refpect to their angles, are three alfo.

1. When a triangle hath one angle right, as D, 'tis called an orthogonium triangle.

2. When the triangle hath all the angles acute as A, 'tis called an oxogonium triangle.

3. When a triangle hath one angle obtufe as C or B, 'tis called an abligonium triangle. And thefe are the diftinctions, in refpect to their angles.

II. *Of trigonometrical definitions.*

Fig. I. 1. Any two fides of a triangle are termed, or called, the fides of that angle. So the fides F G and E G are the fides containing the angle F G E.

2. Every

2. Every ſide of a triangle is the ſubtending ſide of the angle which is oppoſite to it. So in the triangle F G E the ſide F G ſubtends the angle at E, and the ſide E F ſubtends the angle at G, and the ſide E G the angle at F. For in all plain triangles, the greateſt ſide always ſubtends the greateſt angle, and the leſſer ſide the leſſer angle, and equal ſides equal angles.

3. The meaſure of an angle is an arch of a circle deſcribed upon the angular point, and is intercepted between the two ſides that contain the angle. So the meaſure of the angle H I K is the arch *c c*. See the demonſtration of problem II. ſect. I. part II.

4. Every circle is divided into 360 degrees, and each degree into 60 min. See problem XXX. ſect. II. part. I.

5. A quadrant is $\frac{1}{4}$ of a circle. See definition 16. ſect. I. part. I.

6. The complement of an arch, leſs than a quadrant, is ſo much as an arch wanteth of 90 degrees. So the complement of the arch C L is H C.

7. The exceſs of an arch greater than a quadrant, is ſo many degrees as the arch exceedeth 90 deg.

8. A ſemicircle. See defi. 16. ſect. I part. I.

9. The complement of an arch, leſs than a ſemicircle, to a ſemicircle, is ſo much as the arch wanteth of 180 deg.

10. If a triangle have ſome of its ſides equal, it is either equicrural or equilateral.

11. An equicrural triangle is that which hath two ſides equal, and the third unequal.

12. An equilateral triangle. See the beginning hereof.

13. A triangle is either right angled, or oblique angled.

14. A right angled plain triangle is that which hath one right angle and two acute ones.

15. An oblique angled plain triangle is that which hath all its angles oblique, *viz.* one obtuſe, and two acute.

16. In all plain triangles, the ſum of all the angles are equal to a ſemicircle, or 180 degrees.

17. The third angle of any plain triangle is the complement of the other two, to two right angles, or 180 degrees.

III. *Of the conſtruction of ſuch right lines as are applied to a circle, for the ſolution of right lined triangles.*

The right lines applied to a circle for the ſolution, or calculation of right lined triangles, are chords, ſines, tangents, half tangents, ſecants and verſed ſines, which may be projected to any aſſign'd radius, as follows. PLATE

PLATE XI.

Geometrically.

Fig.II. 1. A chord, or ſubtenſe, is a right line, joining the extremity of an arch. So A C is the chord of the arch A M C.

2. A line of chords, is no more than 90 deg. of the arch of any circle transfer'd from the limb to a right line.

Conſtruction.

1. Draw the right line N V and biſſect it in O, whereon, with the diſtance O N, deſcribe the ſemicircle M N V, and on O erect the perpendicular O M, and by problem XXX. ſect. II. part I. divide the ſemicircle into 180 deg.

2. On V place one foot of your compaſſes, and open the other firſt to 10 deg. on the ſemicircle, and deſcribe the arch 10, 10, and with the opening V 20 the arch 20, 20, and the like at every degree; and thereby you'll transfer the chords from the quadrant V M, to the diameter or right line N V, which is the line of chords required.

3. A right ſine is a right line drawn from the end of an arch, perpendicular to the diameter, through to the other end, or 'tis half the chord of twice the arch.

Conſtruction.

1. From 10 deg. on the one ſide of the ſemicircle to 10 deg. on the other ſide, draw the right line 10 L 10, interſecting the perpendicular O M in L.

2. Perform the like operation throughout the ſeveral degrees, and thereby you will divide the line O M into the line of ſines, as required.

4. A tangent is a right line perpendicular to the diameter, drawn by the extream of the given arch, and terminated by the ſecant drawn from the center, thro' the extream of the ſaid arch.

Conſtruction.

On the point V erect the perpendicular V Y, and to it draw right lines from the center O, thro' each degree of the quadrant O M V, which lines, ſo drawn, ſhall divide the perpendicular V Y into unequal parts, and ſhall be the tangents required.

5. A secant is a right line drawn from the center thro' one extream of the given arch, 'till it meet with the tangent, as the secant E 60, &c.

6. Half tangents are no other than whole tangents, numbered double, as calling 30 min. a whole $\frac{1}{2}$ tangent, and one whole tangent 2 $\frac{1}{2}$ tangents, and therefore 45 deg. of whole tangents is called 90 deg. of $\frac{1}{2}$ tangents, &c.

7. A versed sine is a segment of the diameter, intercepted between the right sine, and the sine of 90 deg.

IV. *Of divers affections incident to plain triangles.*

1. A plain triangle is contained under 3 right lines, and is either right angled or oblique angled.

2. In all plain triangles two angles being given, the third is also given.

3. In the analysis of plain triangles, the angles only being given the sides cannot be found but by the reason or proportion of them. Therefore 'tis wholly requisite that one side be known.

4. In a right angle triangled two terms (besides the right angle) will suffice to find the third, so that one of them be a side.

5. In oblique angled plain triangles there must be three terms given to find a fourth.

6. In right angled plain triangles there are 7 cases, and in oblique angled plain triangles 5 cases.

V. *Of axioms for the solution of the* 12 *cases following.*

Axiom I.

If in a right angled plain triangle, the hypotenuse be made radius, each leg will be the sine of its opposite angles, but if one leg be made radius, the hypotenuse will be the secant, and the other leg a tangent thereunto.

Axiom II.

In all plain triangles the sides are proportional to the sines of their opposite angles.

Axiom III.

As the sum of the sides of any angle is to their difference; so is the tangent of half the sum of their opposite angles, to the tangent of half their difference.

AXIOM IV.

Fig. II. As the baſe or longeſt ſide is to the ſum of the other ſides, ſo is the difference of thoſe ſides to the difference of the ſegments of the baſe.

VI. *Of the ſolution of the 7 caſes of right angled plain triangles.*

In right angled plain triangles, I call thoſe ſides which comprehend the right angle, one the baſe (*viz* the longeſt) and the other the perpendicular, and the ſlope-line, or ſide ſubtending the right angle, the hypotenuſe.

Caſe I.

PLATE VII.

The baſe A B 80, *and the perpendicular* A C 60, *given to find the angle* B C A.

Solution. 1. Geometrically.

Fig. II. 1. Delineate B A equal to 80 equal parts of any plain ſcale, and on A erect the perpendicular A C, and make it equal to 60 equal parts from the ſame ſcale as you laid down B A.

2. From the extreams of the baſe at B, and perpendicular at C, draw the hypotenuſe C B.

3. On C, with 60 degrees of a line of chords, deſcribe the arch *a a*, and taking the quantity *a n*, in your compaſſes, and applying it to your line of chords, you will find it to contain 53 : 00 the angle required.

2. *By* Trigonometrical *calculation.*

Analogies.

Firſt, as the perpendicular C A 60, is to the baſe B A 80, ſo is the tangent of 45 degrees, to the tangent of 37 deg. whoſe complement to a quadrant, or 90 deg. is 53 deg. the angle required. Or,

Secondly, As B A 80 is to the tangent of 45 deg. ſo is A C 60 to the tangent of 37 deg. whoſe complement is 53 deg. the angle required.

Caſe II.

The baſe A B 80, *and the angle* B C A, 53 *deg. given, to find the perpendicular* A C.

Solution.

Solution. 1. Geometrically.

1. Delineate the base A B and make it equal to 80, and on A erect the perpendicular A D. Fig. III.

2. Make the arch *n m*, equal to the complement of the given angle, and through *m* draw the hypotenuse B C, which will intersect the perpendicular in C.

3. The distance C A, being laid on your scale of equal parts, will be found to be 60, which is the length required.

2. *By* Trigonometrical *calculation.*

Analogy.

As the sine of the angle B C A 53 deg. is to the base B A 80, so is the cosine, or complement, of the angle B C A 37 deg. to the perpendicular C A 60, as required.

Case III.

The hypotenuse B C 100, *and the base* B A 80 *given, to find the angle* B C A.

Solution. 1. Geometrically.

1. Make B A equal to 80, and on A erect the perpendicular A D, and on B, with the length of the hypotenuse B C, describe the arch *o m*, intersecting the perpendicular in C. Fig. IV.

2. On C, with 60 deg. of your line of chords, describe the arch *r s*, and take the arch *r s*, and measure it on your line of chords, and it will contain 53 deg. the angle required.

2. *By* Trigonometrical *calculation.*

As the hypotenuse B C 100, is to the radius, or sine of 90 deg. so is the base B A 80, to the sine of 53 deg. the angle required.

Or thus.

As B A 80, is to B C 100, so is the radius to the sine of the complement of 53 deg. the angle required.

Case IV.

The hypotenuse B C 100, *and the angle* B C A 53 *deg. given, to find the base.*

Solution.

Solution. 1. Geometrically.

Fig. V. 1. Draw A C at pleaſure, and on C, with 60 deg. of your line of chords, deſcribe the arch *n n*, and make the angle C equal to 53 deg. the angle given, and draw the hypotenuſe B C equal to 100.

2. On B, with 60 deg. of chords, deſcribe the arch *o o*, and make the angle B equal to the complement of C, and draw B A, which ſhall cut C A, the perpendicular in A, and being meaſured on your ſcale of equal parts, will contain 80, the length required.

2. *By* Trigonometrical *calculation.*

As the radius, or ſine of 90 deg. is to the hypotenuſe B C 100, ſo is the ſine of the angle B C A 53 deg. to the baſe 80, as required.

Or thus.

As the radius, or ſine 90 deg. is to the ſine of the angle B C A 53 deg. ſo is B C the hypotenuſe 100, to the baſe 80, as required.

Caſe V.

The angle A B C 37 *deg. and the perpendicular* A C 60 *given, to find the hypotenuſe* B C.

Solution. 1. Geometrically.

Fig. VI. 1. Draw A B at pleaſure, and on A erect the perpendicular A C equal to 60, and on C, with 60 deg. of chords, deſcribe the arch *i i*, and make the angle C equal to 53 deg. the complement of the given angle, and draw the hypotenuſe C *i* B, which will interſect the baſe B A, in B, and being meaſured on your ſcale of equal parts will contain 100, as required.

2. *By* Trigonometrical *calculation.*

As the ſine of the angle A B C 37 deg. is to the perpendicular A C 60, ſo is the radius, or ſine of 90 deg. to B C the hypotenuſe 100, as required.

Caſe VI.

The hypotenuſe B C 100, *and the perpendicular* A C 60, *given, to find the baſe* B A.

 Solution.

Solution. 1 Geometrically.

1. Draw B A at pleaſure, and on A erect the perpendicular A C, and make it equal to 60, and on C, with the length of the hypotenuſe, deſcribe the arch *b b*, interſecting the baſe in B. Fig. VII.

2. The length B A is the baſe required.

2. *By* Trigonometrical *calculation.*

Analogy.

As the hypotenuſe B C 100, is to the radius, or ſine of 90 deg. ſo is the perpendicular A C 60, to the ſine of 37 deg. the angle A B C. Then

As the radius is to the hypotenuſe 100, ſo is the coſine of the angle A B C 53 deg. to B A 80, the baſe required.

Or thus.

Multiply the perpendicular into it ſelf as alſo the hypotenuſe, and ſubſtract the leſſer product from the greater, then ſhall the ſquare root of the remainder be the length of the baſe required.

Caſe VII.

The baſe B A 80, *and the perpendicular* A C 60 *given, to find the hypotenuſe.*

Solution. 1 Geometrically.

1. Make A B equal to 80, and on A erect the perpendicular A C, equal to 60. Fig. VIII.

2. From B to C draw the hypotenuſe required.

2. *By* Trigonometrical *calculation.*

Analogies.

As the perpendicular A C 60 is to the tangent of 45 deg. ſo is B A the baſe 80 to the tangent of 37 deg. the angle A B C. Then

As the cotangent of 37 deg. is to the baſe B A 80, ſo is the tangent of 45 deg. to the hypotenuſe B C 100, required.

Or thus.

By theorem V. ſect. III. part. I. multiply the baſe into its ſelf, as alſo the perpendicular, and add both the products together, then ſhall the ſquare root of that ſum, be the hypotenuſe required.

VII. *Of the ſolution of the 5 caſes of oblique angled plain triangles.*

Caſe I.

The ſides B C 50 *and* C A 60 *with the angle* A B C 27 *deg. given, to find the angle* C A B.

Solution. 1 Geometrically.

Fig. IX. 1. Draw B A at pleaſure, and make the angle A B C equal to the given angle, and make B C equal to 50.

2. On C, with the diſtance of C A 60, deſcribe the arch *t t*, interſecting the baſe in A, whereon, with 60 deg. of chords, deſcribe the arch *a m*, which being meaſured on the line of chords, will be equal to 22 deg. 30 min. the angle required.

2. *By* Trigonometrical *calculation.*

Analogies. By axiom II.

As the ſide C A 60, is to the ſine of the angle A B C, 27 deg. ſo is the ſide B C 50, to the ſine of 22 deg. 30 min. the angle required.

Or thus.

As the ſide B C 50, is to the ſide C A 60, ſo is the ſine of 27 deg. the angle A B C, to 22 deg. 30 min. the angle required.

Caſe II.

The ſides B C 50, *and* C A 60, *with the angle* A C B 131 *deg.* 30 *min. given, to find the other angles* C A B *and* A B C.

Solution. 1. Geometrically.

Fig. X. 1. Delineate B C and C A, making the angle C equal to the given angle.

2. Join A B the baſe, and with 60 deg. of the line of chords on the points A and B, deſcribe the arches *o p* and *q r*, which being ſeverally meaſured on the line of chords, will be the quantity of the angles required.

2. *By* Trigonometrical *calculation.*

Analogie. By axiom III.

As the ſum of the ſides B C and C A 100, is to their difference,

difference, *viz.* 10. ſo is the tangent of ½ the oppoſite angles 24 deg. 45 min. to the tangent of ½ their difference, *viz.* 2 deg. 45 min. Then

This ½ difference ſubſtracted from the ½ ſum of the oppoſite angles gives the inferior angle; but added to the ½ ſum of the oppoſite angles gives the ſuperior angle.

Or thus.

As the ½ ſum of the given ſides is to their ½ difference, ſo is the tangent of ½ the oppoſite angles to the tangent of ½ their difference.

Then add and ſubſtract as before directed.

Caſe III.

The angle A B C *and* C A B, *with the ſide* B C 50, *oppoſite to the angle* C A B *given, to find the ſide or baſe* A C.

Solution. 1. Geometrically.

1. Make B C equal to 50, and make the angle C B A equal to 131 deg. 30 min. as given, and draw B A infinitely. Fig. XI.

2. Make the angle B C A equal to the complement of the two given angles, to 180 deg and draw A C, which will interſect B A in A.

3. The line A C is the baſe required, and if meaſured on your plain ſcale, will be equal to 100 of thoſe parts, as B C contains 50.

2. *By* Trigonometrical *calculation.*

Analogy. By axiom II.

As the ſine of the angle C A B 27 deg. is to the ſide B C 50, ſo is the ſine complement of the angle A B C, *viz.* 49 deg. to 30 min. the baſe 100.

Caſe IV.

The ſides B C 60, *and* C A 100, *with the angle* C 22 *deg.* 30 *min. comprehended by them given, to find the ſide* A B.

Solution. 1. Geometrically.

Fig. XII.

1. Make A C, B C, and the angle C, equal to the meaſures given, and from their extreams draw A B, and it ſhall be the ſide required.

2. *By*

2. *By* Trigonometrical *calculation.*

1. Find the angle at A, by axiom I. or II. then the analogy is thus, as the ſine of the angle C A B is to B C; ſo is the ſine of the angle A C B to the ſide A B, required.

Caſe V.

The 3 ſides AC 100, A B 50, B C 60, *given, to find the angle* B C A, *or the angle* C A B.

Solution. 1. Geometrically.

1. By problem XIV. ſect. II. part I. delineate the tri-
Fig. XIII. angle A B C equal to the 3 given ſides.

2. With 60 deg. of chords on A and C, deſcribe the arches *n n* and *r r*, which being meaſured on the line of chords, will ſhew the quantity of each angle as required.

2. *By* Trigonometrical *calculation.*

For the ſolution of this caſe, two operations are required, *viz.* the firſt, to find the ſegment of the baſe A D and D C, and the ſecond to find the angles required.

Analogy. Firſt by axiom IV.

As the ſum of the baſe A C 100, is to the ſides A B and B C 110, ſo is the difference of A B and B C, (*viz.* 10) to the difference of the ſegments of the baſe (*viz.* 14.) This ſegment added to the baſe, *viz.* 100, the ſum is 114, whoſe $\frac{1}{2}$, *viz.* 57, is the ſuperiour ſegment D C, which being ſubſtracted from A C 100, leaves A D 43 the leſſer ſegment. And now there are conſtituted two right angled plain triangles, by which the angles may thus be found, by this analogy of caſe III. of right angled plain triangles.

Analogy.

As the hypotenuſe B C 60, is to the radius, or ſine of 90 deg. ſo is the greater ſegment D C 57, to the angle D B C, whoſe complement to 90 deg. is the angle B C A, required.

Again,

As the hypotenuſe B C 60, is to the radius, ſo is the leſſer ſegment A D 43, to the angle D B A, whoſe complement to 90 deg. is the angle B A C, required

☞ I advise that the young student be perfect in these 12 cases, before he proceed any further. For hereon depend not only the principles of framing all kinds of roofs of buildings, measuring all kinds of heights and distances, accessible, or inaccessible, surveying of land, measuring, &c. but also of navigation, fortification, and gunnery, which some youths may delight in the study of, besides the subjects hereof, they being both profitable and delightful.

Sect. VI.

Of the Geometrical Construction of Draughts, Plans, and Maps of Lands, Gardens, Farms, Buildings, &c.

TO enumerate the many mathematical instruments invented for this purpose, and to describe their use would be but a needless amusing work, seeing that herein the only instruments that I make use of are the common *Gunter*'s chain, and a common five and ten foot rod, divided into feet and inches, &c. with which I shall shew how to describe any plan, with much less trouble and in much less time than by the help of any theodilite, plain table, circumferentor, &c. and, if I mistake not, far more exact.

When the measure of any length is taken by a chain, and contains 10 chains 73 links, 'tis thus written 10 : 73, so also is 73 chains 4 links, thus 73 : 04; and when any length is measured that is less than a chain's length, as 73 links, 'tis either written thus 00 : 73, or thus : . 73, with a period or full stop before it, in the same manner, as a decimal fraction.

☞ The reason why the links are often times express'd according to the last way, is, because in taking the measures of offsets, (which are very often under the length of a chain) there is no room to express them according to the former way, between the offsets taken. See the measures of the offsets taken from the line LK, fig. XXI. plate XI. where may be seen, at one view, a demonstration thereof.

The appurtenances belonging to the chain are ten ſmall rods, each about two foot in length, ſhod and ſharp-pointed with iron, to ſtick in the ground at the end of every chain's length, when a length is meaſuring.

The manner of meaſuring a length is as follows.

1. One man takes an end of the chain in his hand, and walks towards the place he is to meaſure to, taking with him, under his arm, the aforeſaid ten ſticks.

2. When he has walk'd the length of the chain, the hindermoſt man cauſes him to move either to the right hand or to the left, &c. 'till he has placed him in a right line poſition from him, to the place to which they meaſure. Which being done, and the chain laid very ſtreight and tight, the foremoſt man ſticks down one of his ſticks and leaves it, and then walks on forward towards the mark he meaſures to, 'till the hindermoſt man comes up to the ſtick, the firſt ſtick'd down. And then (as aforeſaid) the hindermoſt man directs the foremoſt in a right line with the mark. Where after laying the chain ſtreight, he ſticks down a ſecond ſtick, and then walks forward towards the mark, and the perſon behind, alſo, bringing thoſe ſticks with him, as he takes them up at the end of every chain, 'till he comes to the next, and there repeats the ſame again, &c. and thereby he knows what number of chains is contain'd in that length ſo meaſured.

PROBLEM I.

PLATE XI.

Let it be required to make a plan of the field BDEFGHIKL, fig. XXI. plate XI.

1. Walk round the bounds of the ſame, and at every ſudden turn erect a ſtick, or ſtaff, of about five foot high, with a piece of white paper on the top of each, as at the ſeveral turns B, D, E, F, G, H, I, K, L.

2. Go into ſome convenient part of the field, from which you may ſee all the ſtation ſtaffs before erected, as at A, and there drive down a ſmall ſtake.

3. Meaſure from A to any one of the ſtation ſtaffs, as to L, and note down the chains and links contain'd therein, and alſo meaſure from L to K, and from K to A, and then you have the lengths of the three ſides of the triangle ALK, given.

4. By problem XIV. ſect. I. part I. make (or deſcribe) the triangle A L K, whoſe three ſides ſhall be equal to the aforeſaid three lines meaſured.

5. Measure and delineate the several offsets *m o, m o,* &c. by problem VI. sect. I. part II. and describe the crooked line L, *o, o, o, o, o, o,* K.

6. Measure from the station staff at K to I, and also from I to A, and then supposing A K to be a third given line, by problem XIV. sect. I. part I. describe the triangle A K I, and from the line K I set off the several offsets *m r,* Fig. XXI. *m r, m r,* &c. as aforesaid, and delineate the crooked line K *r r r,* &c. I.

7. Measure from the station staff at I, to the next at H, and measure the distance I H, and from H to A, and supposing the line A I to be a third line, by problem XIV. sect. I. part I. delineate the lines I H and H A, and by problem VI. sect. I. part II. measure and set off the several offsets *m s, m s, m s,* &c. and trace the crooked line I *s s s s,* &c. H.

8. Proceed in the very same manner from H to G, and from thence to F, E, D, B and L, and thereby you will, with great ease, exactly describe the plan, or figure of the field, as required.

☞ When you have several fields to survey, then you must know how to place your station in the second field, after you have completed the first, which is to be performed as follows.

1. Go into the second field, fig. XXII. and place your station staffs in convenient places about the same, as at N, O, P, Q, U, R, T and V.

2. In a convenient place, as at M, fix your station as you did in the former field at A.

3. Measure from A to M and set down the measure, and also measure from L to M, and note that also. And then you have the length of two given lines. And if you suppose A L to be the third, then by problem XIV. sect. I. part. I. describe the lines A M and L M, intersecting each other in the point M, from which you may measure to every station staff, &c. and form that field, in the very same manner as the first, and the like rule from thence to X, fig. XXIII. and from that to others, &c.

N. B. When any inclosure is so situated, that you cannot go within side to make a plan thereof, as in the preceding, then you must go round the same without-side, and describe the plan thereof as following.

1. Make

1. Make an eye-draught thereof (which is a rough draught on paper) wherein deſcribe every individual angle turning, &c.

2. Standing at any part thereof, as at *m*, conceive the line *m* A B, and from it meaſure the ſeveral offsets *l*, *l*, *l*, &c. and at their extreams draw the ſide of the field F E D, &c. according to problem VI. ſect. I. part II.

3. Standing at *m*, conceive the line *m g h*, and by prob. V. ſect. I. part II. meaſure the angle *m*, and note it down, and afterwards take the ſeveral offsets *o*, *o*, *o*, &c. as before, and then place yourſelf in another convenient place, as at *g h*, and there conceive the line *h i*, *g h*, and then proceed as before, and ſo from thence to other ſtations, 'till you have taken the whole circumference of the field; after which delineate the ſame from the eye-draught, by the rules before laid down, and thereby you will have an exact plan, as required, notwithſtanding you were not admitted within the ſame; which oftentimes happens by wood, water, &c. or when the land is a perſon's who will not allow a ſurveyor to go thereon.

If you conceive the aforeſaid figure (or at leaſt the circumference thereof) to be the ſide of ſo many ſtreets as incloſes that quantity of ground, you may, by the very ſame rule, delineate any pariſh, town, city, &c. provided that as you go on, you meaſure the offsets to the right hand ſide of the ſtreet as well as to the left, as the offsets *m r*, *m r*, &c. in the figure, and by their extreams deſcribe that ſide of the ſtreet, &c. alſo. But when the ſides of ſtreets are ſtreight lines, then there need none of theſe offsets, and the work is performed with much leſs trouble, and therefore I made choice of this moſt difficult part for an example.

PROBLEM II.

PLATE XII.

To make a plan or draught of any garden, wilderneſs, &c. and beautify the ſame with proper colours.

Let I K L M be a garden divided into walks, parterres, borders, &c. and 'tis required to draw a draught of the ſame, and to diſtinguiſh each particular with proper colours.

1. Draw the centeral line O N.

2. Meaſure the breadth of the middle walk B, and at the parallel diſtance of $\frac{1}{2}$ B C, draw the lines B F and C G, infinitely.

3. On

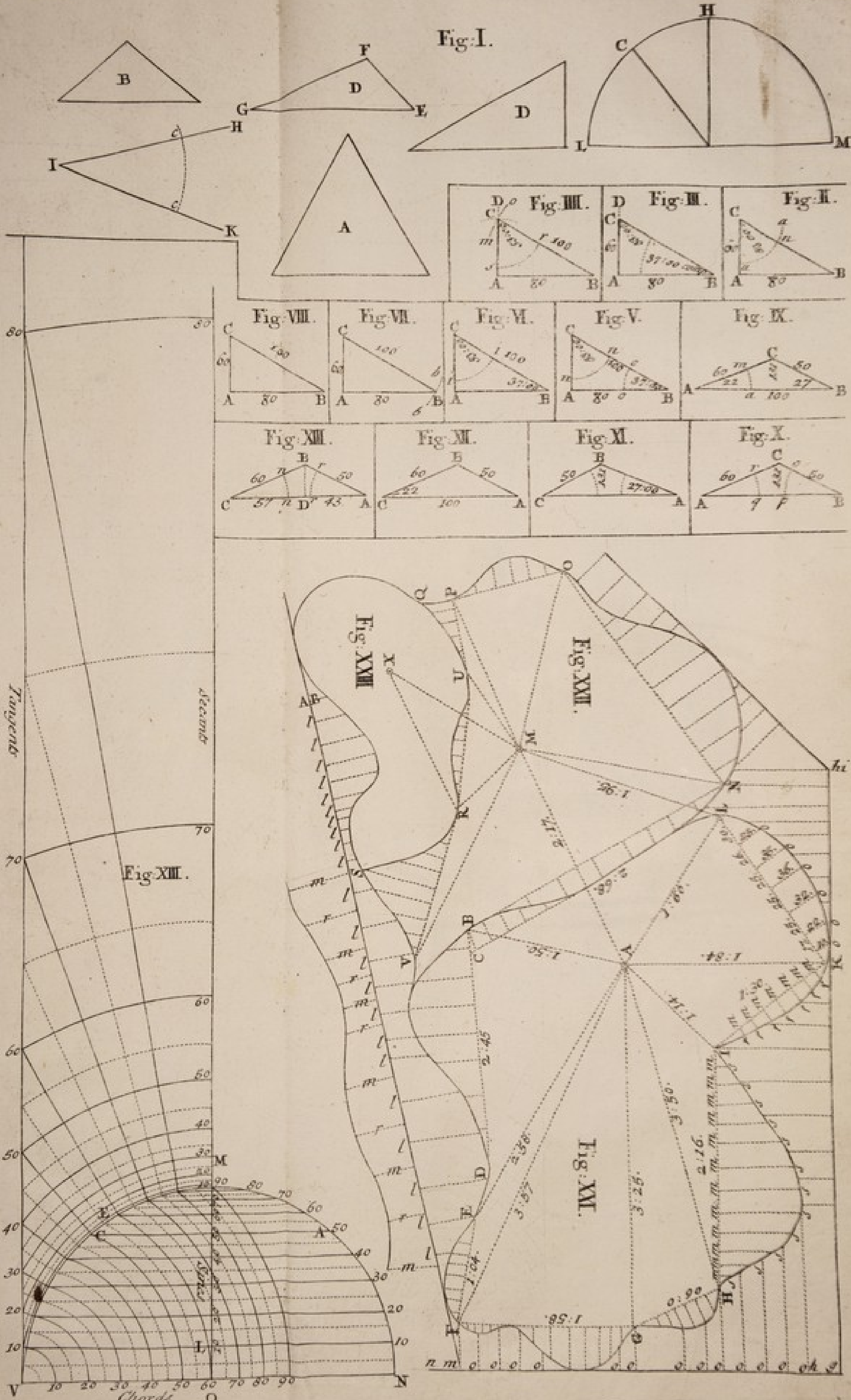


Fig: I.
Fig: II.
Fig: III.
Fig: IIII.
Fig: V.
Fig: VI.
Fig: VII.
Fig: VIII.
Fig: IX.
Fig: X.
Fig: XI.
Fig: XII.
Fig: XIII.
Fig: XIII.
Fig: XXI.
Fig: XXII.
Fig: XXIII.
Tangents
Secants
Sines
Chords

3. On any point of the centeral line as at O, draw the line P Q, at right angles infinitely, and at the parallel distance of P V (the breadth of the terrace) draw the line V K infinitely.

4. At the parallel distance of V O, draw the line O P, and divide that parallel distance with two other parallel lines in such proportion as the slope and verges are divided.

5. At the distance of O A draw A D infinitely, as also the line E H at the parallel distance of A E, and likewise the lines XX and YY, at such distances as their breadths contain. And thus have you, by those parallel lines, divided the several cross walks, &c. therein, in respect to their breadths. And to find their terminations, or intersections, proceed as follows.

1. On the lines A D and E H, from the points B C and F G, set off the measures B A, C D, E F, G H, and draw the lines A E and H D. Fig. XXIV.

2. The two parterres being thus enclosed, and their several parts being all parallel to each other, therefore measure the distances between the several lines contained therein, and draw every particular line parallel to the centeral line N O.

3. Give to every right line its particular length, and describe every circular line by the rules laid down in sect. II. part. I. and thereby you will complete the several parts therein contained. And as the other outer walks, slopes, verges, &c. are all parallel to the aforesaid, therefore at those parallel distances, describe every line, and thereby you will complete the whole draught, as required. And what is said of the delineation of this, the same is to be understood of all others of the like nature. And, indeed, he that is well acquainted with all the preceding problems, is enabled to make a plan of this or any other garden without any more directions. And therefore it being needless to treat any further thereon, I shall leave the ingenious student to the practice thereof. And for his exercise I have subjoin'd the plan of a wilderness, fig. XXV plate XIII. wherein are contain'd some few artinatural lines, that may be worthy of his consideration, and not a small help to invention in designing gardens after that rural manner; which are not entirely new, but far preferable to the most regular set forms hitherto practised (as I observ'd before) in most parts of *England,* to the great disadvantage of the proprietors, and shame of the pretended performers. And to demonstrate more plainly, that the laying out of gardens has no sort of recourse to the exterior figure, or

Dd bounds

bounds thereof, being regular, I have ſubjoined the plan, fig. XXVI. plate XII. wherein is delineated an artinatural walk, which demonſtrates that the moſt beautiful gardens are to be made in the moſt irregular forms or boundaries. Altho' the practice hitherto has been the reverſe. And thereby oftentimes to make a garden regular (*or rather totally ruin it*) the gentleman has been adviſed to purchaſe a part of his neighbours land at a very dear rate, purely for the ſake of regularity, which in all gardens ſhould be avoided, as may be ſeen in plate XIV. which is an entire garden according to the truth of deſigning, wherein you may behold art and nature in conjunction with each other, which in gardening is a general axiom to be obſerved, &c.

N B. To repreſent graſs you muſt uſe ſap-green, and gumbouge lightn'd for ſand or gravel.

Problem III.

Plate XV.

How to make the map of any eſtate, farm, lordſhip, mannor, &c. *Let it be required to make a map of the lands, fig.* XXVII.

1. By problem 7. ſect. I. part II. make a plan of the dwelling houſe B, and ſtable A.

2. By problem 5. ſect. I. part II. take the quantity of Fig. XXVII. the angle F, and draw the line F G.

3. Alſo take the quantity of the angle G, and draw the line G, *e*, equal to the meaſure taken, and by problem VII. ſect. I. part II. make the plan of the barn D and the ſtable E.

4. Take the angle H, and draw H I equal to its meaſure.

5. Take the angle I, and draw I N equal to its meaſure.

6. Meaſure the lines I, *o*, *o*, *o*, and *o*, N, and complete the trapezium I, *o*, *o*, N. So will *o*, *o*, be one end of the barn D E.

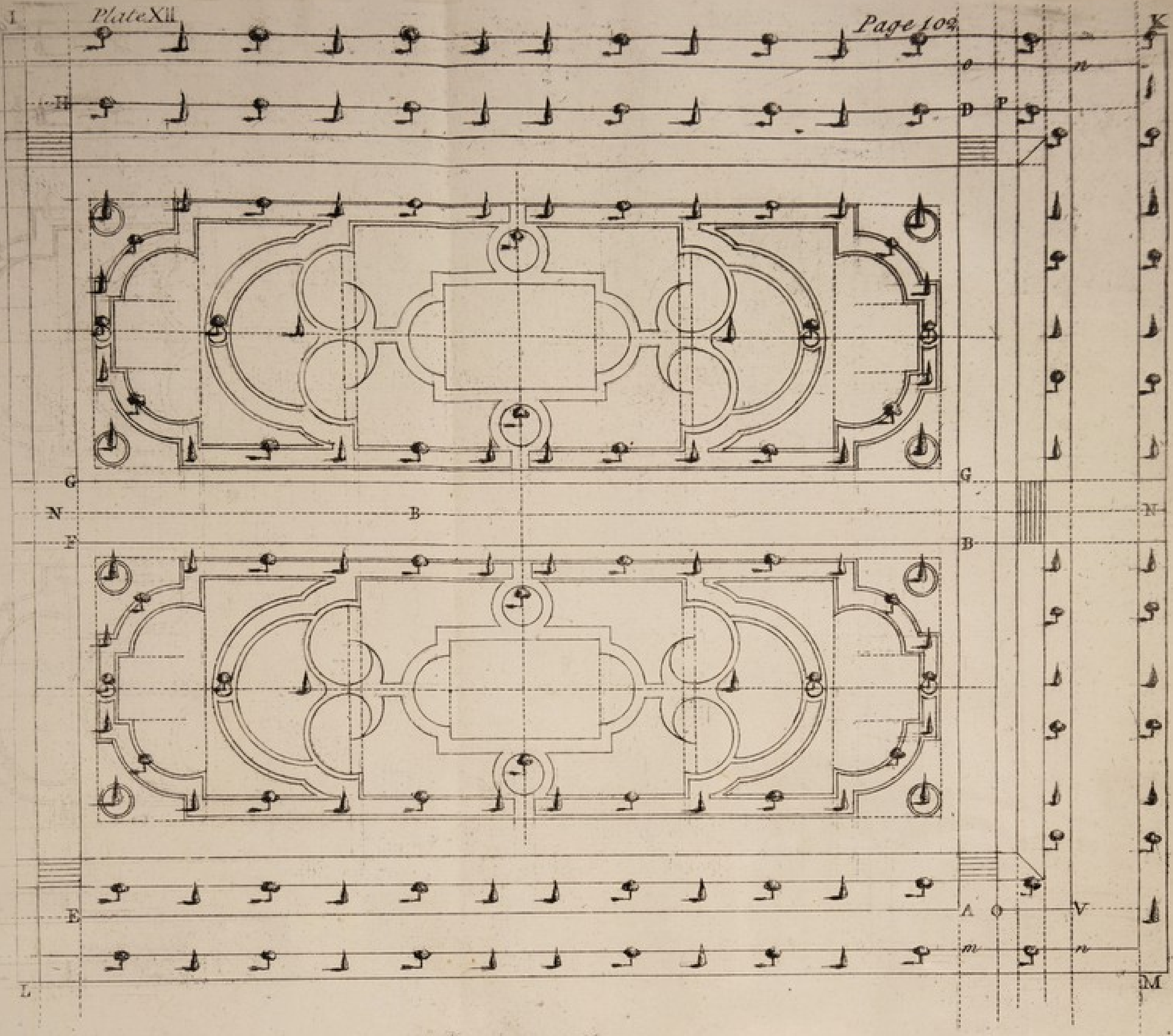
7. Meaſure either or both of the angles, *o*, and *o*, and complete the oblong plan of the barn D E, and alſo by the ſame rule complete the barn D I.

8. Meaſure the lines N K and L K, and delineate them. So ſhall you have completed the houſe, barns, ſtables, yards, &c.

9. In the field Z, in any convenient part, as at Z, drive down a ſtake for a ſtation.

10. Meaſure the lines V Z and T Z, and delineate them by the latter part of problem I. hereof.

11. Your



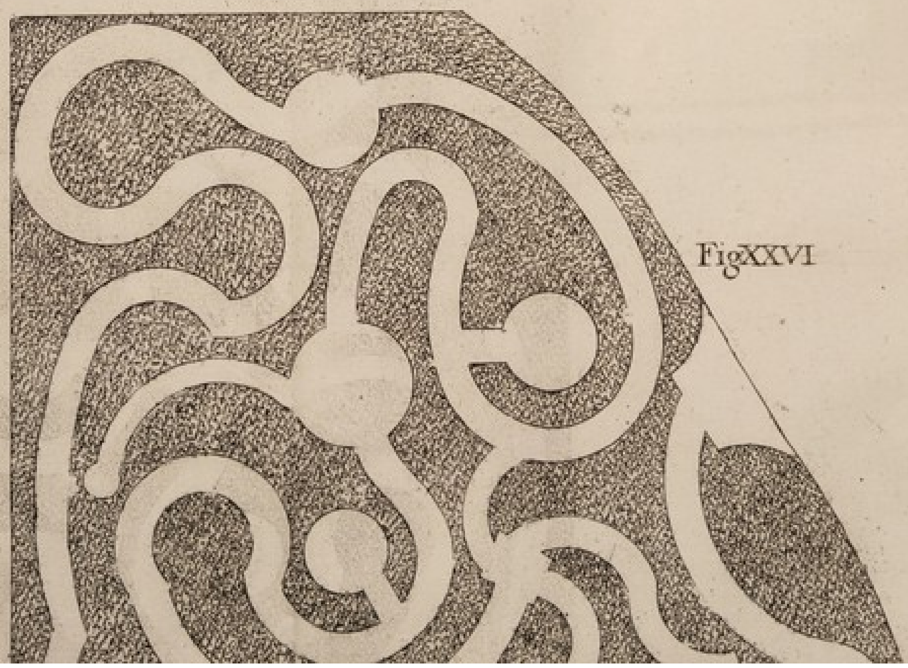
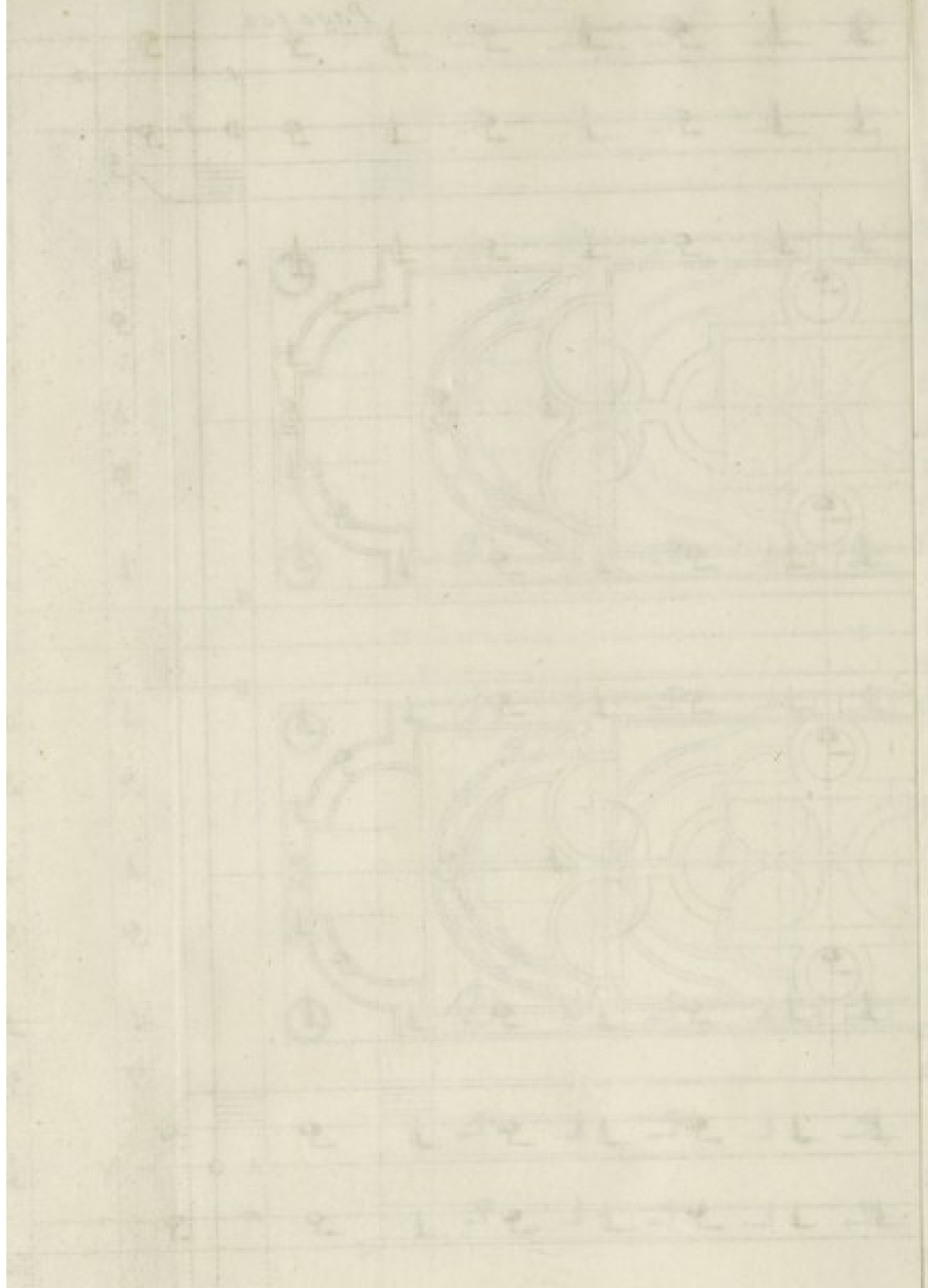


Fig XXVI



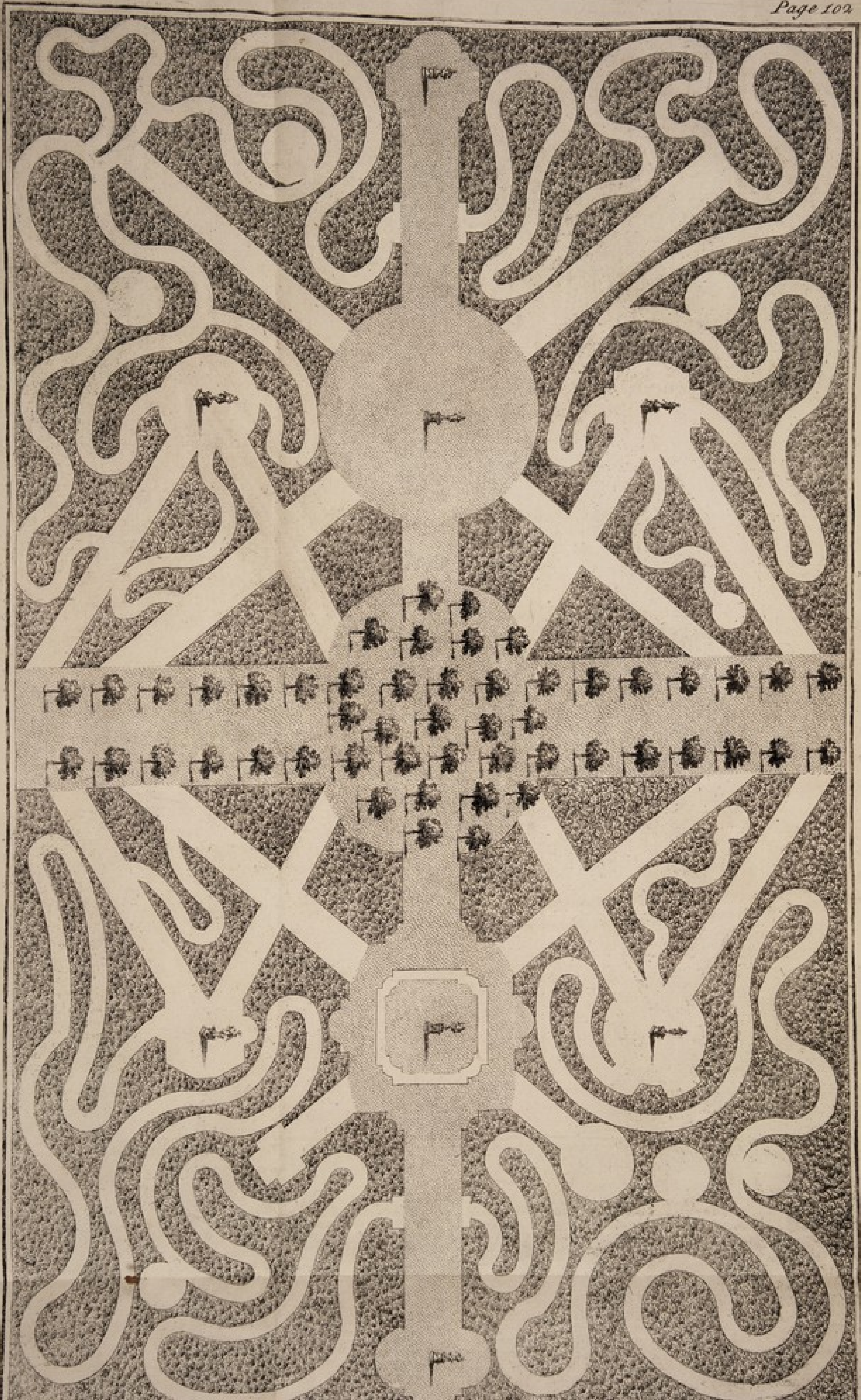
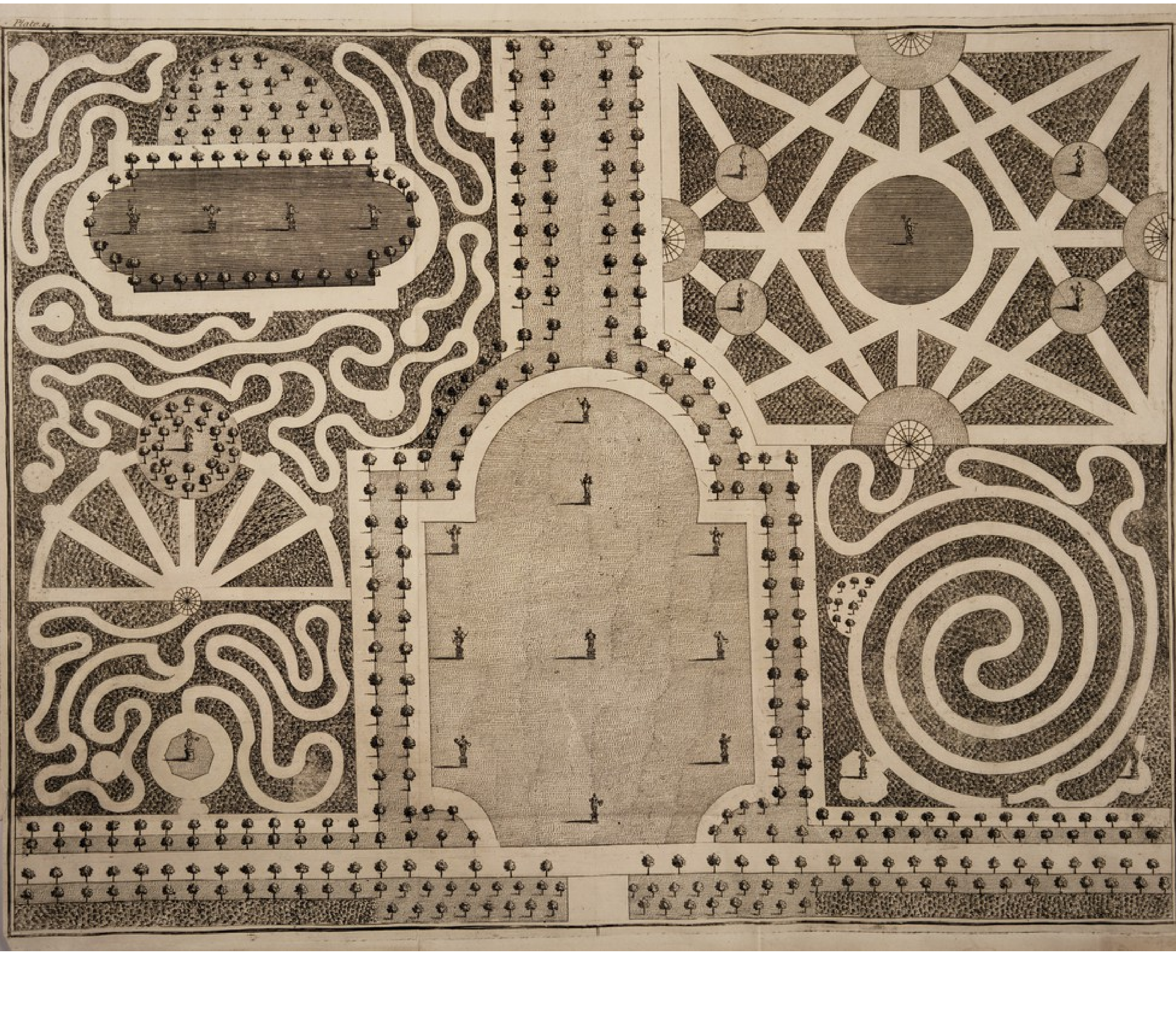


Plate 14.



11. Your station point being thus placed, measure from thence into every angle, or to such sudden turns in the hedges, as are remarkable, and then proceed in all respects as is laid down in problem I. hereof, and thereby you will exactly delineate a true map of the farm, as required.

Advertisement.

I do hereby advise every gentleman, that when they imploy a land surveyor to measure and map an estate, they cause him to describe every timber tree contain'd therein, and that the timber of every tree be measured, and the quantity of that measure written underneath each particular tree, with the first letter of the tree's name, as an E for elm, an O for oak, an A for ash, &c. and thereby the true value of an estate, both of land and timber, may be known at all times, without any sort of trouble. Also if a gentleman lets any land by lease, or otherwise, 'tis not in the power of his tenant to wrong him of any one tree of timber, contained in the lands to him demised, and many other excellent advantages too tedious here to mention.

Note, That when timber-trees stand so very thick (as in a wood) that the representation of every tree, with its measure, cannot be inserted, then at all such times the surveyor must represent the basis of every tree, by a point or period, with numerical figures to each, as 1, 2, 3, 4, 5, &c. Which numbers refer you to the very same numbers in a column placed on one side of the map, against which stands the true solid content of every tree, as each point, or figure represents. See L M of *Nuns* wood, with its tables of quantities, &c.

Problem IV.

Plate XVI.

How to increase or decrease any draught, at pleasure.

Let *a b c d e f g h i k l m n o p*, &c. be a small map of a farm, and 'tis required to increase the same four times its magnitude.

1. In any part of the same, as at A, make a point, and from that point, through all the several angles, draw right lines, and continue them infinitely. Fig. XXVIII.

2. Open your compasses from A, the given point, to *b*, and on the same line set that distance from *b* to B.

3. Make C *c* equal to A *c*, and draw the line B C.

4. Make D *d* equal to A *d*, and draw the line CD, and in the ſame manner, proceed 'till you have paſs'd through the whole, and thereby you'll encreaſe the map, as required.

Note, That by doubling the diſtance from the given point A to the ſeveral angles, you thereby (as aforeſaid) encreaſe the figure four times; therefore the double of that is eight times, and its half but two times, and conſequently its quarter but once. So that from theſe proportions you may increaſe, or decreaſe, any map to any proportion, as may be required.

PROBLEM V.

PLATE XVI.

How to deſcribe (and account for) the diminution of the breadths of long walks, avenues, viſto's, &c.

'Tis obſervable, that the breadth of long walks, avenues, &c. appears to be much narrower at the further end, than at that end where the perſon ſtands, notwithſtanding the ſides of the walk are actually parallel to each other. But what is the reaſon thereof, no gardener, or indeed any other, has yet accounted for it to the publick. It is occaſion'd as follows, Fig. XXX.

1. All objects that appear equal in height, or breadth, are ſeen under equal angles; but when objects appear unequal, and are equal, ſuch objects are ſeen under unequal angles.

Demonſtration.

1. Let the lines C E G and A D F, repreſent the hedge lines of a walk, &c.

2. Draw the centeral line B Z, and let the points C, E, G, F, D, A, be remarkable places in the hedge lines C E G and F D A, and let the line W X V be drawn at right angles to Z B, as alſo the lines D E and A C.

3. Make T B equal to T X, and draw the lines C B and A B, as alſo W T and V T, as alſo E B and D B, and G B and F B.

4. The objects C A and V W, being equal to each other, and they lying placed at equal diſtances therefrom, as at T and B, are ſeen under equal angles, and do appear to be equal to each other; but the objects D E and F G, appear both leſs than V W or A C, by reaſon the angle E B D and

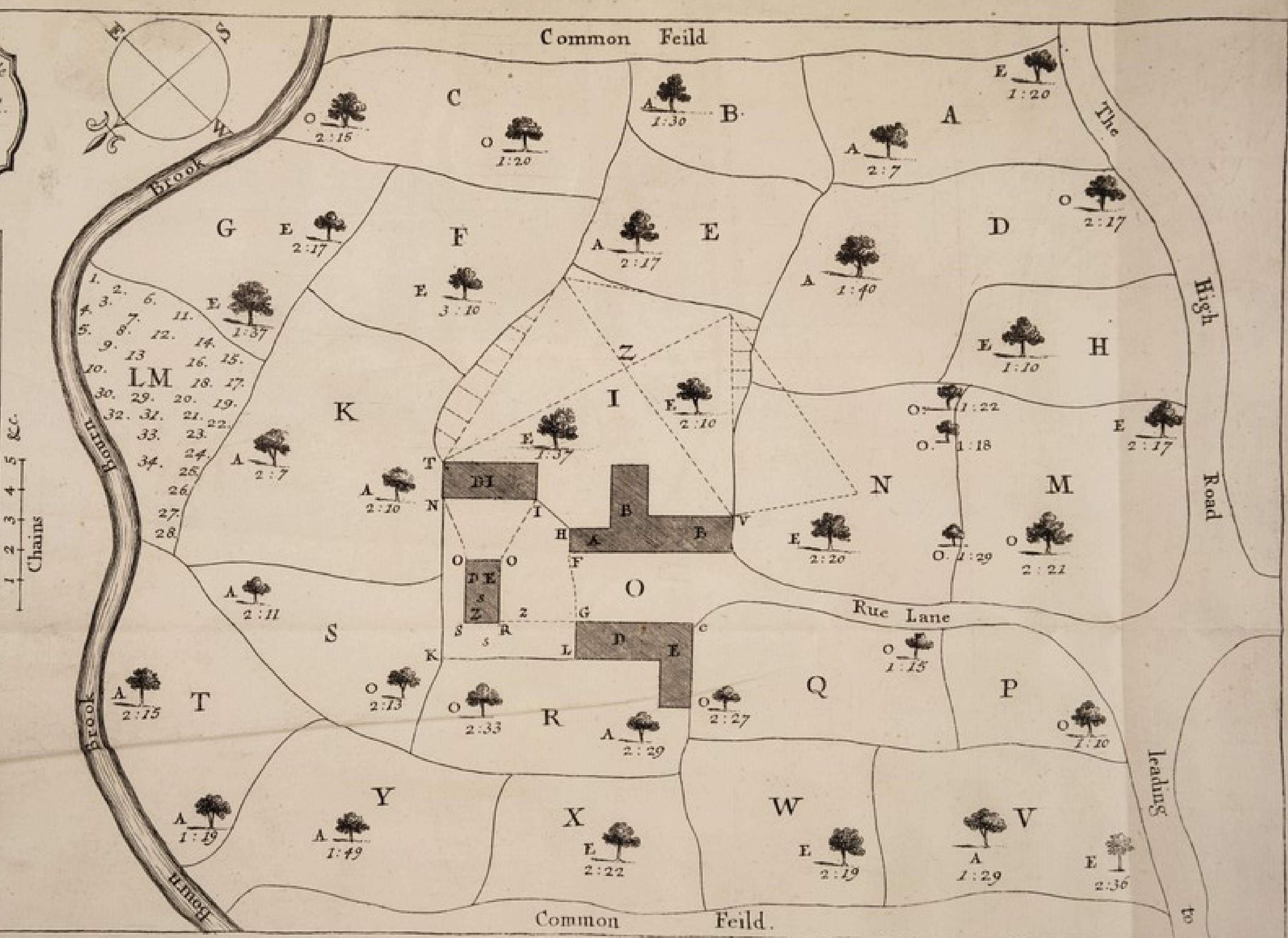
CREDON FARM
The Lands of y^e Honourable A.B.
Scituated in the Parish of T.
In the County of S.
Survey'd and Mapp'd
By
B.L.

Table of Contents

		Acre	Rood	Pole
A	Broom Feild	4	2	9
B	Calfs Plat	2	0	27
C	Stump Close	4	3	29
D	Fern Feild	7	2	11
E	Cow Close	3	0	7
F	Well Close	3	3	9
G	Marsh mead	4	1	15
H	Little eight	3	1	7
I	Barn Close	6	1	20
K	Nuns Close	6	3	21
LM.	Nuns Wood	3	2	9
M	Crums Feild	5	3	37
N	Home Close	5	3	31
OB.	House Yards &c.	2	1	20
P	Mutton Close	1	3	10
Q	Stacken Close	4	0	7
R	Sheep Pasture	4	1	9
S	Bun's Close	3	1	21
T	Brook mead	4	2	11
V	Plum bush Feild	4	1	2
W	Marvel hole	3	1	7
X	Marvel hill	2	3	10
Y	Bulls Meadow	3	3	17
Sum Totall				

Quantity of Timber in NUNS WOOD.

	L	F		L	F		L	F		L	F
1	1	7	10	0	20	19	1	7	28	2	10
2	0	40	11	0	49	20	1	20	29	1	7
3	2	7	12	1	20	21	1	17	30	0	29
4	2	10	13	1	33	22	0	10	31	1	17
5	2	1	14	2	9	23	1	41	32	2	11
6	1	31	15	2	2	24	2	3	33	2	5
7	1	9	16	1	31	25	2	15	34	3	18
8	2	11	17	0	47	26	3	5			
9	2	3	18	2	9	27	3	11	E: tot.	57	17



and G B D, are both lesser than the angle C B A, and from hence it appears, that the longer a walk is in looking from one end to the other, the more the visual rays are contracted, and thereby constitute a lesser angle, which is the real cause of the diminution of the walk, and is what was to be demonstrated.

Note, That if in small gardens where walks cannot be made of a great length, by contracting the further part to which a view is taking, 'twill make the walk appear to be of a greater length than it really is, and especially when the contracted part ascends the gentle ascent of a hill, and the hedges planted with such trees as produce leaves of a light green, as box, silver-holly, &c.

Problem VI.

How to describe (*and account for*) *the diminution of objects in a Land-skip.*

This problem is no other ways differing from the preceding, than that the objects therein (*viz.* the breadth of the walk in its several parts) were horizontal, and here they are perpendicular.

Let it be required to draw the diminution of the trees R B, SC, TH, VI, WK and XL, as they appear at the point (or place) A.

1. From the point A to the points B, C, H, I, K, L, draw right lines, as the lines A B, A C, H A, A I, AK and A L.

2. From the vertical points of the trees, as the points B, C, H, I, K, L, let fall the perpendiculars B R, C S, H T, I V, KW, LX.

3. At D, where the line (or visual ray) intersects B R, draw D M parallel to AX, so shall MS be the true diminishing height of C S. Fig. XXXI.

4. At E, where the line A H intersects BR, draw EN parallel to A X, so shall NT be the representing, or diminishing height of H T, and the same of I V, KW and LX, and all others whatsoever.

And what is here said in relation to the diminution of trees, the same is to be understood of buildings, animals, &c.

Problem VII.

How to give the exact height to any ſtatue placed on a building, that the ſame ſhall appear equal to the common height of a man ſtanding on the ground.

Let D C be the common height of a man (as five foot nine, or ten inches) and 'tis required to place a ſtatue on the building at I, ſhall that appear equal in height thereunto.

1. At any convenient place, as at A, upon the level of the building, place your ſtation, and draw the lines A C, A D and A I.

FigXXXII. 2. On the point A, with any diſtance, deſcribe the arch B E F G, and make F G equal to E B, and draw the line A G H.

3. Continue C I to H, ſo ſhall I H be the height of the object, required.

Demonſtration.

The angle E A B is equal to G A F, therefore ſince H I is ſeen under the very ſame angle, as D C, by problem V. hereof, H I is in appearance equal to D C, and is the true height of that object, which is what was to be demonſtrated.

THE

PRACTICE

OF

Architecture, Gardening, Menſuration, and *Land-Surveying,* Geometrically demonſtrated.

PART III.

Of Geometrical Axioms and Analogies, for the Menſuration of all Kind of Lines, ſuperficial Figures, and ſolid Bodies, &c.

Since the Menſuration of all Kind of Work is for the Generality perform'd by Croſs Multiplication, therefore I will firſt explain the ſame, and afterwards proceed to Menſuration in general.

SECT. I.

Of Croſs Multiplication.

LET it be required to multiply ſeven feet, three inches, ſix parts, by five feet, four inches, ſix parts.

	feet.inch.part.
Place the numbers thus	7 : 3 : 6 5 : 4 : 6
1. Multiply 5 feet by 7, and the product is	35 : 0 : 0
2. Multiply the feet into the inches, as 5 into 3, which is 15, 12 of which make one foot, which place under the feet, and the remaining 3 under the inches.	1 : 3 : 0
3. Multiply the 7 feet into 4 inches, and the product is 28, wherein is twice 12, and 4 remaining, which is 2 feet and 4 inches, which place under feet and inches.	2 : 4 : 0
4. Multiply the inches into themſelves and their product is 12, which is 1 inch, which place under inches.	0 : 1 : 0
5. Multiply the parts into the feet, as 6 times 7 is 42, wherein 12 is contain'd thrice, and 6 remaining, which is 3 inches and 6 parts, which write under inches and parts.	0 : 3 : 6
6. Multiply the 6 parts into the 5 feet, and the product is 30, or 2 inches ½, which alſo write down.	0 : 2 : 6
7. Multiply the parts into the inches, as 6 into 3, and the ſum is 18 parts, or 1 part and ½, which write down under parts, as thus.	0 : 0 : 1 ½
8. Multiply the 6 into 4, and the product is 24, or 2 parts, which alſo place under parts, thus.	0 : 0 : 2
Laſtly, Multiply the parts into themſelves, and their product is 36, of which 144 make 1 part, therefore 36 is	0 : 0 : 0 ¼
And the ſum is	39 : 2 : 3 ¾

SECT. II.

Of Geometrical Axioms for the Menſuration of Lines and ſuperficial Figures.

PLATE XVII.

PROBLEM I.

To meaſure the geometrical ſquare ABCD, *whoſe ſides are each equal to* 16 *foot* 6 *inches.*

Rule.

Multiply any one ſide, as AB, 16 foot 6 inches, by any other of the ſides, as B D, and the product will be 272 Fig. I. foot 36 inches, the ſuperficial content required.

PROBLEM II.

To meaſure the parallelogram AB C D, *whoſe longeſt ſide is equal to* 28 *foot* 9 *inches, and its ſhorteſt to* 6 *foot* 6 *inches.*

Rule.

Multiply the length 28 foot 9 inches, by the breadth Fig. II. 6 foot 6 inches, and the product is 186 $\frac{12}{144}$ the ſuperficial content required.

PROBLEM III.

To meaſure the triangle N M O, *whoſe longeſt ſide* NO *is equal to* 42 *foot, and the perpendicular* MA to 16 *foot.*

☞ That before any right lined triangle is meaſured, a perpendicular line is let fall upon the longeſt ſide (or baſe) from the oppoſite angle.

Rule.

Multiply half the perpendicular (*viz.* 8.) by 42, the Fig. III. length of the baſe NO, and the product 336 is the ſuperficial content required.

PROBLEM IV.

To meaſure the trapezium O M N V.

Rule.

Fig. IV. 1. Draw the line MV, and then the trapezium is divided into two triangles.

2. Meaſure each triangle ſeverally, and the ſums together, and the total will be the ſuperficial content required.

PROBLEM V.

To meaſure any irregular figure, as the figure L, O, V, R, S, N, M, I, D, E, W.

Rule.

1. Divide the figure into triangles, and meaſure each Fig. V. triangle ſeverally, and note its quantity.

2. Add all the triangles together, and the total will be the ſuperficial content of the figure required.

PROBLEM VI.

To meaſure any regular polygon, as a pentagon, hexagon, heptagon, octagon, nonagon, or decagon.

For the menſuration of all thoſe regular polygons, there is one general rule, *viz.*

Multiply half the circumference, as E, O, M, I, by Fig. VI. the radius or ſemidiameter AN, and the product will be equal to the ſuperficial content required. Or otherwiſe, you may divide the figure into triangles, and then meaſure each triangle, and add up the ſum total of the whole, and that ſhall be the ſuperficial content required.

PROBLEM VII.

The ſide of a pentagon, &c. *as* B A *given, to find the ſemidiameter of a circle inſcribed therein.*

Rule.

Fig. XV. As 182 is to 125, ſo is the ſide of the polygon (be it any whatſoever) to the radius of the circle inſcribed therein.

PROBLEM VIII.

To meaſure any circle, or ſection of a circle.

☞ The diameter of every circle hath ſuch proportion to its own circumference, as 7 hath to 22, or rather as 113 is to 355, therefore if any one be given, the other may thus befound.

Rule

Rule I.

The diameter being given, to find the circumference.

Practice.

Multiply the diameter given by 22, and the product divide by 7, the quotient is the circumference required.

Rule II.

The circumference being given, to find the diameter.

Practice.

Multiply the circumference given by 7, and divide the product by 22, and the quotient is the diameter required.

Rule III.

The diameter of a circle being given, to find the area.

Practice.

1. Multiply the diameter into itſelf, and that product multiply by 11.
2. Divide the laſt product by 14, and the quotient is the area required.

Rule IV.

The circumference of a circle being given, to find the area.

Practice.

1. Multiply the circumference given, by itſelf, and the product alſo multiply by 7.
2. Divide the laſt product by 88, and the quotient will be the area required.

Rule V.

The circumference and diameter of a circle being given, to find the area.

Practice.

Multiply half the circumference by half the diameter, and the product will be the area required.

Rule VI.

The area of any circle being given, to find the diameter.

Practice.

Practice.

Divide the area given by 11, and the quotient is the diameter required.

Or thus.

As 22, is to 28, ſo is the area to the diameter required.

Rule. VII.

The area of any circle being given, to find its circumference.

Practice.

As 7 is to 88,, ſo is the area to the ſquare of the circumference, whoſe root is the circumference required.

Rule VIII.

The area of any circle being given, to find the ſide of a ſquare equal thereunto.

Practice.

Extract the ſquare root of the area given, and the root ſhall be the ſide of the ſquare required.

Rule IX.

The diameter of any circle being given, to find the ſide of a ſquare, the content of which ſquare ſhall be equal to the ſuperficial content of the circle, whoſe diameter was given.

Practice.

As 7 is to 22, ſo is the ſquare of the radius to the area required.

Or thus.

As 113 is to 355, ſo is the ſquare of the radius to the area required.

Rule X.

The diameter and curve line of a ſemicircle being given, to find the content.

Practice.

Multiply $\frac{1}{2}$ the curve by the radius, and the product is the content required.

Rule

Rule XI.

The radius and curve line of a ſector of a circle being given, to find the content.

Practice.

Multiply the radius by $\frac{1}{2}$ the curve line, and the product is the content required.

Rule XII.

Any part, or ſegment, of a circle being given, as B C D L, *fig.* XVIII. *to find the area thereof.*

Practice.

1. By problem XI. ſect. II. part I. find the center E of the arch B C D, and draw the lines B E and D E, which will complete the quadrant E B C D.

2. By the laſt rule, meaſure the whole ſector E B D, and from it deduct the triangle EBD, and the remainder is the content of the ſegment required.

PROBLEM IX.

To meaſure any ellipſis or oval form.

Rule.

Multiply the longeſt diameter by the ſhorteſt, and extract the ſquare root of the product, which ſquare root ſhall be the diameter of a circle equal to the ellipſis, which being given, you may by the preceding problem find the area required.

PROBLEM X.

To meaſure the ſuperficies of a ſphere, or hemiſphere.

Rule.

The ſuperficies of a ſphere is equal to four great circles of that ſphere, therefore find the area of a circle, whoſe diameter is equal to the diameter of the ſphere given, and four times that area is the area of the ſphere required, and conſequently the half is the area of the hemiſphere alſo.

Or thus,

Multiply the diameter by the circumference, and the product ſhall be the ſuperficial content of the ſphere or globe. And if the axis only is given, the ſuperficial content may thus be found, *viz.* as 7 is to 22, ſo is the ſquare of the diameter to the content required.

PROBLEM XI.

To meaſure the ſuperficial content of any cone.

Practice.

1. Find the ſuperficial content of the baſe by problem VIII. hereof.

2. Multiply the length contained between the vertex and the circumference of the baſe, by $\frac{1}{2}$ the circumference of the baſe, and to the product add the content of the baſe, and the total is the content required.

PROBLEM XII.

To meaſure the ſuperficial content of any pyramis.

1. By the definition 33. ſect. I. part I. a pyramis is comprehended under divers flat ſuperficies, whoſe areas being found by the preceding problems and added together, their total will be the content required.

PROBLEM XIII.

To find the ſuperficial content of a cylinder.

Practice.

1. Find the area of both ends by problem VIII. hereof, as alſo its circumference, which multiplied into the length, and the product added to the areas of both ends, their total is the content required.

PROBLEM XIV.

To meaſure the ſuperficial content of any fragment or part of a globe, or ſphere.

Practice.

As the whole diameter of the globe is to the ſuperficial content of the globe, ſo is that part of the diameter belonging to the part, or fragment of the globe, to the ſuperficial content required. SECT.

Sect. III.

Plate XVII.

Of Geometrical Axioms for the Menſuration of ſolid Bodies.

Problem I.

To meaſure the ſolidity of a cube, as the cube ABCD, *whoſe ſide is equal to 3 foot.*

Proportion.

As 1 is to 3 the breadth, ſo is 3 to 9, and 9 to 27, the ſolidity required.

Or thus,

1. Multiply the ſide 3 by 3, the product is 9.
2. Multiply the laſt product 9 by 3 the depth, and the product will be 27, the ſolidity required.

☞ 'Tis to be obſerved that a parallelopipedon is but a long cube, and that the above rules, or proportions will meaſure the ſame, therefore an example is needleſs. See fig. X. Fig. IX.

Problem II.

To meaſure a pyramis, as the pyramis MAON, *whoſe baſe is a geometrical ſquare, having each of its ſides equal to 6, and its altitude to 12 foot.*

Rule.

1. Find the area of the baſe. Fig. XI.
2. Multiply the area by $\frac{1}{3}$ of the altitude, and the product will be the ſolidity required. And as this is the rule by which a cone is alſo meaſured (as the cone, fig. XII.) therefore 'tis needleſs to add an example.

Problem

PROBLEM III.

To measure the frustum of a cone, or pyramis, as the frustum A *and* B, *in figures* XIII, *and* XIV.

Rule.

1. Find the area of each end of the frustum.
2. Multiply one area by the other, and extract the square root of their product.
3. Add this square root to the sum of both areas, and their sum multiply by $\frac{1}{3}$ of the frustum's length, and that product shall be the true solidity required.

☞ If you find the areas in inches, you must divide the solidity so found, by 1728, the number of cubical inches in a cubical foot, and the quotient will be the content in feet.

☞ I do advise the young student to be perfect in this problem, for hereon depends the whole truth of timber measuring, which hitherto has been kept in the dark, to the great injury of all gentlemen, who have disposed of great quantities of timber according to the customary (tho' false and base) way of measuring.

PROBLEM IV.

To measure the solidity of a sphere, globe, or ball.

Suppose the diameter of a sphere, globe, &c. be 12 inches, what is the solidity thereof?

Proportion.

As 21 is to 11, so is the cube of the diameter to the solidity required.

Or thus.

Cube the diameter, multiply by 11, and divide by 21. See the operation.

Diameter

Diameter 12
12

Product 144
12

288
144

1728 The diameter cubed.

Multiply by 11

1728
1728

Divide by 21)19008(905, ſolidity required.
189..

108
105

$\frac{3}{21}$ remains.

PROBLEM V.

The ſolidity of a ſphere being given, to find its diameter or axis.

Practice.

As 22 is to 42, ſo is the ſolidity to the axis or diameter required.

PROBLEM VI.

A ſegment or portion of a ſphere being given, to find its axis.

Practice.

1. Multiply $\frac{1}{2}$ the chord of the ſegment, and divide the product by the height of the ſegment.
2. For the quotient add the height of the given portion, and the ſum is the axis required.

PROBLEM VII.

To meaſure the ſolidity of a cylinder.

Rule

1. Find the ſuperficial content of one end.
2. Multiply the area ſo found by the length, and the product is the content required.

PROBLEM VIII.

To measure the solidity of a prism.

1. Find the superficial content of one end.
2. Multiply the content so found, by the length, and the product is the solidity required.

Problem IX.

To measure the solidity of a mount, terrace walk, canal, &c.

Let A B C D E F represent the profile of a mount, terrace walk, &c. and 'tis required to measure the solidity thereof.

Rule.

1. The slopes A B E and C D F, are prisms, therefore measure those parts according to the last problem.
Fig. XVI. 2. The body, or midst B C E F, is a long cube. Therefore measure that part according to problem I. hereof.
3. Add both their quantities together, and the total shall be the solidity required.

☞ This kind of measure is always measured by the cubical yard (which by gardeners is called a load) and contains 27 cubical feet. Therefore if the dimensions be taken in feet, the solidity must be divided by 27, and the quotient will be the solidity in yards.

The profile fig. XVII. is a representation of the inside of a canal, fish-pond, &c. and is measured by the very same rule as the above. Therefore to repeat the same again is needless.

These three last sections being duly consider'd, and well understood (which may soon be done) the young student will thereby be enabled to measure the superficial or solid content of any figure or body whatsoever. And seeing that the most difficult part of the mensuration of building, land, &c. consists in the manner of taking the dimensions, therefore that shall be the work of the next section, to which I proceed.

SECT.

Sect. IV.

Of the ſeveral Meaſures that Artificers work is accounted by, and the Manner of taking their Dimenſions.

I. Of Carpenters work.

1. THE principal work of carpenters is flooring, partitioning, and roofing, all which are meaſured by the ſquare, or 100 feet produced by 10 feet ſquared or multiplied into itſelf.

2. When you are to take the dimenſions of the frame of any timber floor, you muſt allow for the length of the joiſt laid in the walls, which is generally 9 or 10 inches.

3. When you meaſure flooring, without joiſt, the dimenſions are to be taken to the extreams thereof, out of which you muſt deduct the well-holes of the ſtair-caſe, and the chimney ways.

4. When you meaſure partitioning, you muſt deduct doors and door-caſes, and windows alſo, provided they are not to be included.

5. When you meaſure roofs, meaſure the length of the rafters by the length of the roof, and afterwards the hypps ſingly (inſtead of the common way, by allowing one and ½ the ſuperficial content of the ground plot) without making any deductions for the holes of the chimney ſhafts, or vacancies, for ſky or lanthorn lights, except 'tis agreed on otherwiſe.

6. Doors, ſhop-windows, &c. are meaſured by the ſquare foot, and alſo ſaſh frames, &c. ſtairs and ſtair-caſes are accounted for by the ſtep, in proportion to the nature and goodneſs of the work.

7. There be divers ſorts of work meaſured by running meaſure, *viz.* in length only; ſuch as cornices in general, pent-houſes, timber fronts, rails and balaſters, guttering, lintelling, ſkirting boards, breſtſomers, benching, ſhelving, &c.

II. Of Glaziers work.

Glaziers work is meaſured by the ſquare foot, and the dimenſions are taken in feet, inches, and parts, and the moſt material things to be obſerved therein, are the following.

1. That in meaſuring of glazing in one building, there are many times windows of one magnitude, and at ſuch times you need meaſure but one, and thereby account for the others.

2. That ſemicircle, ovalar, &c. windows be meaſured, as ſquare windows, whoſe breadths, &c. are equal to their diameters; and the reaſon for ſo doing is, becauſe there is great waſte in cutting the glaſs, and much more time expended therein, than if the whole was a ſquare window.

III. Of Joiners work.

1. Joiners work is meaſured by the ſquare yard (of 9 feet) but their dimenſions are taken in feet and inches, and the product being divided by 9 (the ſquare feet in a yard) the quotient is yards.

2. In taking the dimenſions you muſt obſerve the following rules.

1. In taking the height of any corniſh, wainſcot, &c. that you meaſure with a line into, and about, every moulding, as is contained between the cieling and the floor, which you muſt call the height, or breadth, and the circumference of the room meaſured on the floor, the length, which being multiply'd as is taught in ſect. I. hereof, and divided by 9, the quotient is the content thereof.

2. When you meaſure window-ſhutters, doors, drawers, ſeats, or pews in churches, &c. you muſt account the meaſure $\frac{1}{2}$ as much more that it contains, in regard to its being worked on both ſides, and is what workmen call work and $\frac{1}{2}$ work.

3. That in meaſuring wainſcot you always deduct the doors, chimneys, and windows contained therein.

4. That you meaſure the window boards, ſaphetas, cheeks, skirt boards, &c. by themſelves. And,

Laſtly, When joiners make cornice and baſe, and ſubbaſe, &c. ſingly, they are meaſured by running meaſure, as alſo architrave and freize.

N. B. That chimney-pieces, frontiſpieces of doors, ornaments of windows, pediments, &c. are valued according to their goodneſs, at - - - *per* piece.

IV. Of Painters work.

1. Painters work is meaſured and taken as joiners, both in reſpect to girting about the moulding, as well as in meaſuring

meaſuring the length on the circumference of the floor, &c. and the deductions to be made are the ſame, but inſtead of accounting doors, window-ſhutters, &c. work and half work, they account it all whole work.

2. Window-lights, bars, caſements, &c. are done at - - - *per* piece, and oftentimes cantalivers, modillions, &c. and ornaments between them.

V. Of Plaſterers work.

Plaſterers works are principally of two kinds, *viz.* cieling work which is lathed and plaſtered, and rendering, which is alſo of two kinds, *viz.* rendering upon brickwalls free from quarters, &c. and rendering in partitions between quarters, which are all meaſured by yard meaſure, taken by feet and inches, and reduced into yards, as before delivered.

The principal things to be obſerved in taking the dimenſions are the following.

1. To deduct chimneys, windows, and doors.

2. To make no deductions (in rendering upon brick) for doors or windows, by reaſon the jaums and heads, generally exceed the dimenſions of the vacancies.

3. That ſuch ſommers and girders as lie below a cieling be deducted, if the workman find materials, otherwiſe not.

4. In rendering, when materials are found by the workman, to deduct $\frac{1}{4}$ for the quarters, but when workmanſhip only is found, no deduction muſt be made, for the workman could have rendered the whole as ſoon as if there had been no quarters there.

5. When you meaſure whiting and colouring between quarters, you muſt add a fourth or fifth part, for the returns or ſides of the quarters.

Laſtly, Ornaments in plaſter, as ornaments in cielings, capitals, architraves, freizes, cornices, &c. are meaſured by foot meaſure, in length only at - - - - *per* foot according to the goodneſs and nature of the work.

VI. Of Maſons work.

Maſons work is meaſured three different ways, as firſt, running meaſure, as the coping of walls, &c. Secondly, ſuperficial, as pavements, &c. And laſtly ſolid, as blocks of marble, &c. which ſeveral meaſures being all performed by the 3 firſt ſections hereof, I need ſay no more thereof, but that their dimenſions are taken in feet, inches and parts.

VII. Of Bricklayers work.

Of bricklayers work there are divers kinds, but the principal are walling, tyling, and paving.

1. Of walling, performed by the rod.

1. Of walls there are divers kinds, in respect to their length, height and thickness's, whose dimensions are always taken in feet and inch measure in respect to length and height, and by the length of a brick, &c. in respect to their thickness.

2. The measure by which brickwalls are accounted is a square rod or 16 feet 6 inches squared, whose product or quantity, is 272 feet square and 36 inches, or $\frac{36}{144}$, whose $\frac{1}{2}$ is 136 feet $\frac{18}{144}$ and quarter 68 feet $\frac{9}{144}$.

3. The manner of measuring brick walls is the very same as any other superficial measure, provided their thickness be exactly the standard thickness, *viz.* one brick and $\frac{1}{2}$ and the product of the dimensions divided by 272: 26, whereby the number of square rods contained therein may be known.

4. When the thickness of brickwalls exceeds or is less than the standard thickness of one brick and half, they must be reduced thereunto by this general rule.

Multiply the superficial content of the wall by the number of half bricks contained in the thickness, and divide the product by three (the number of $\frac{1}{2}$ bricks contained in the standard thickness of one brick and $\frac{1}{2}$) and the quotient shall be the true content of the wall, reduced to the standard thickness of one brick and half, as required.

5. When brickwalls are of divers thickness they must be severaly taken, and their several quantities being added together will be the content of the whole, as required. And here note, that whatsoever doors, windows, &c. are contained in the several thicknesses of such walls, that you deduct them out of the total product of the respective dimensions or thickness, wherein they are situate, and the remainder will be the true content of the work.

6. When you are to measure walls that meet, and constitute an angle, you must take the length of one wall to the out-side of the angle, and the other to the inside.

7. When you have any chimneys to measure, measure them as a solid, and deduct the vacancies, (as taught by *Venterus Mandey* in his appendix of *chimneys reformed* in his *Mellificium Mensionis*) and thereby you will have the

the true ſolidity; but if you practice the common way of girting chimneys, you never can have the true content, and will always remain in the dark, as many ſtubborn ignorant conceited fools now are.

2. Of walling, performed by foot meaſure.

1. This part of walling is that which is called ornament, ſuch as arches over doors, windows, &c. *Facio's*, architraves of doors, windows, &c. freizes, cornices, ruſtick cones, rubbed returns, &c. and in ſhort all kind of work performed in a rubbing houſe with ax and ſtone is ornamental work, and is always performed at ---- *per* foot.

2. When you have any of theſe ornaments to meaſure, that have unequal ſides, as the arch over a window, &c. you muſt take the dimenſion thereof in the middle and thereby 'twill be a mean. And beſides the aforeſaid ornaments which are performed by foot meaſure, there are divers other ornaments that are performed --*per* piece, and ſuch are peers, columns, pillaſters, architraves, freizes, cornices, grottos, caſcades, pediments, &c. which are valued according to the nature and goodneſs of the materials and workmanſhip.

3. Of tyling.

1. As carpenters meaſure their roofs by the ſquare of 10 feet (*viz.* 100) ſo alſo do bricklayers their tyling, whoſe dimenſions are always taken in feet and inch meaſure, and their products being divided by 100 (the number of ſquare feet in a ſquare) the quotient is the content required.

2. When you take the dimenſion of a roof, you muſt firſt meaſure the whole length, as far as the tiles are laid, for your length, and from the ridge to the eves for the depth, and thereby the quantity of tyling will exceed the quantity of roofing, by ſo much as the tyles go beyond the roof at each end, and over the eves board.

3. It often happens, that in ſome roofs there are many hips and valleys, which muſt be paid for, at ---- *per* foot running meaſure.

N. B. That what is here ſaid of tyling, the ſame is be underſtood of ſlating.

4. Of paving.

Since it often happens that cellars, kitchins, grottos, &c. are paved by bricklayers, therefore I thought it neceſſary to mention it here, at the concluſion hereof, wherein you are to understand, that the dimensions of such work are taken in feet and inch measure, and the content is always given in square yard measure, as plastering, rendering, &c.

Sect. V.

Of the Manner of casting up the Dimensions of Land Measure taken with Gunter's *Chain (which of all others is the best.)*

Problem I.

Suppose an oblong piece of land contain 15 *chains* 25 *links in length, and* 13 *chains* 75 *links in breadth, what is the content?*

Rule.

1. Multiply 15 : 25, by 13 : 75, according to the common way of vulgar multiplication, and the product will be 20,96875, from which cut off the five last figures towards the right hand, *viz.* 96875, and the remainder to the left, *viz.* 20, is the number of acres.

2. Multiply the five figures cut off by 4 (the number of roods in an acre) and the product will be 387500, from which cut off five figures, as before, and the remaining is roods.

3. Multiply those figures last cut off by 40 (the number of square poles in a rood) and the product is 3500000, from which cut off five figures, as before, and the remainder is poles.

Lastly, If any numbers remain in the last five figures cut off, multiply them by $272\frac{1}{4}$, and cut off five figures, as before, and the remainders to the left, shall be the odd feet, which in land measure is exact enough. See the operation.

Length

Length	15:25	
Breadth	13:75	
	7625	
	10675	
	4575	
	1525	
Acres	20)96875	Theſe five figures
Multiply by	4	The roods in an acre.
Rods	3)87500	Theſe five figures
Multiply by	40	The poles in a rod.
Poles	35)00000	

Problem II.

Plate XVII.

The plan of a piece of land with the area given, to find the ſcale by which it was plotted, ſuppoſing ſuch a ſcale was left.

Suppoſe A B, C D, to be a plan, equal in area to 34 acres 31 centeſims, I demand by what ſcale the figure was plan'd.

1. If you meaſure the ſide A B with a ſcale of 10 in an inch, the length A B will contain 38 chains and 12 centeſims, and the breadth A C 6 chains and 25 cente- Fig. VII.
ſims. The content will be found to be 23 acres and 82 parts. Wherefore if you divide the diſtance on the ſcale of logarithms between 23 : 82, and 34 : 31 into two equal parts, and ſetting one foot of your compaſſes upon 10, the imagin'd ſcale, the other will reach to 12, which is the ſcale required.

Problem III.

Of the menſuration of turf, with which graſs walks, plotts, &c. *are made. The turf uſed in theſe works, is the fineſt that can be had, from commons, heaths,* &c. *which are generally cut at one ſhilling per* 100, *every turf being one foot in breadth and three foot in length. Therefore to find what quantity of turf will cover any walk,* &c. *find how many ſquare feet are contain'd therein, and divide that number by* 3, *the number of feet in a turf, and the quotient will be the number of turf required. As for example,* There is a walk to be turf'd, whoſe length is 100 foot, and breadth 16 feet, how many three foot turf will cover the ſame, ſuppoſing no waſte to be made?

The length	100	
The breadth	16	
Product	1600	Which divide by 3, as follows.

$$
\begin{array}{r l}
3\,)\,1600\,(& 533\frac{1}{3} \text{ the number of turf required.} \\
15\cdot\cdot & \\
\hline
10 & \\
9 & \\
\hline
10 & \\
9 & \\
\hline
1 & \text{remains.}
\end{array}
$$

Note, That this calculation ſuppoſes no waſte to be made, which in laying them is impoſſible. Therefore the uſual allowance for waſte is as follows, *viz.* a hundred of turf, which contains 300 foot, is allowed to completely finiſh one rod of ground, which contains $272\frac{1}{4}$ feet.

Sect. VI.

Of divers Analogies, or Proportions, in Land Meaſure.

Proportion I.

Having the length and breadth of an oblong given in chains, to find the contents in acres.

As 10 is to the breadth in chains, ſo is the length in chains to the content in acres.

Proportion II.

Having the perpendicular and baſe of a triangle given in perches, to find the content in acres.

As 320 is to the perpendicular, ſo is the baſe to the content in acres.

Proportion

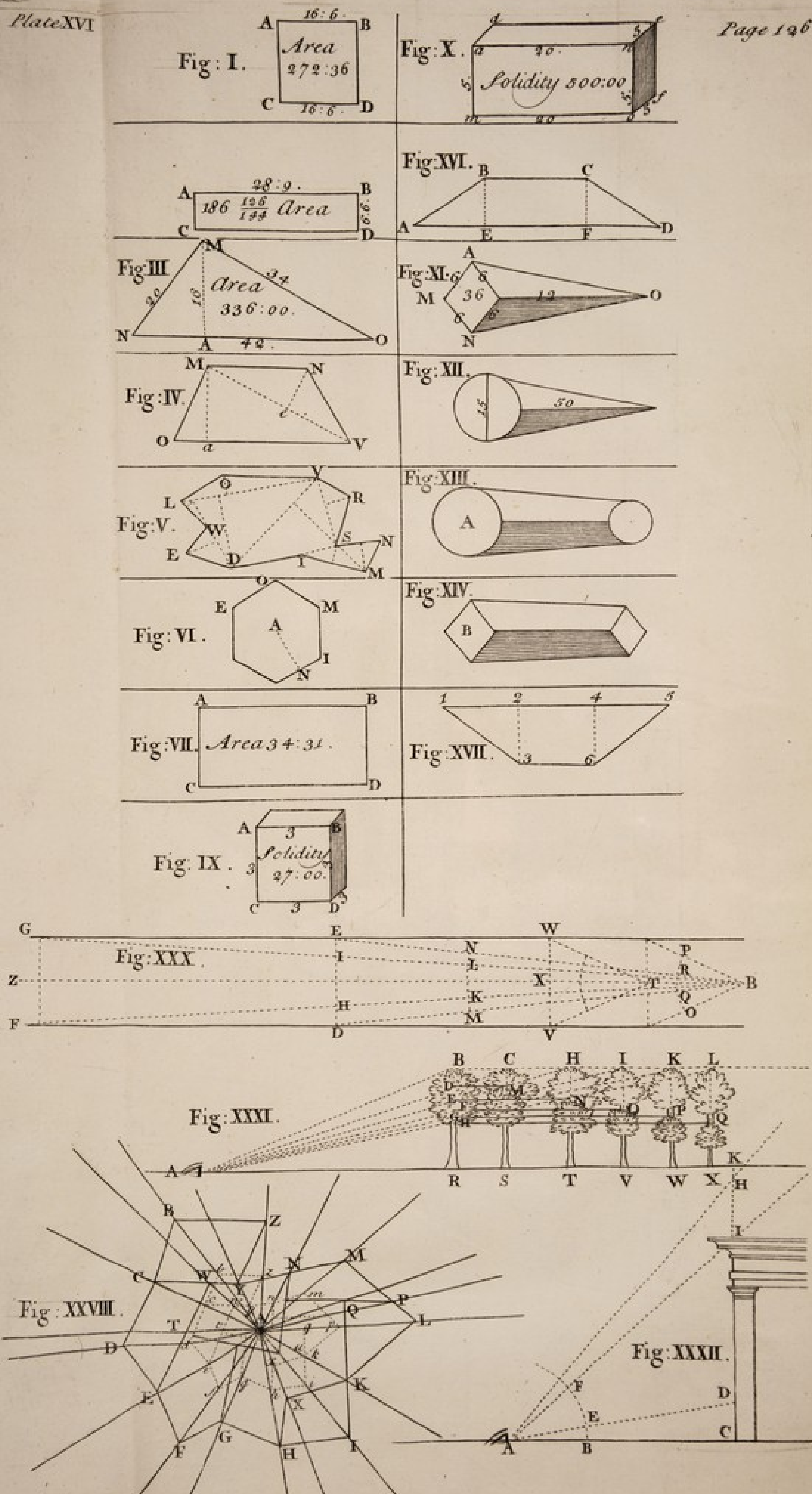


Fig: I.
Area 272:36
Fig: X.
Solidity 500:00
Fig: XVI.
186 $\frac{126}{144}$ Area
Fig: III
Area 336:00.
Fig: XI.
Fig: IV.
Fig: XII.
Fig: V.
Fig: XIII.
Fig: VI.
Fig: XIV.
Fig: VII.
Area 34:31.
Fig: XVII.
Fig: IX.
Solidity 27:00.
Fig: XXX.
Fig: XXXI.
Fig: XXVIII.
Fig: XXXII.

Proportion III.

Having the perpendicular and base of a triangle given in chains, to find the content in acres.

As 20 is to the perpendicular, so is the base to the content in acres.

Proportion IV.

Having the content of a superficies in one kind of measure, to find the content of the same superficies, according to any kind of perch measure.

As the length of the second perch is to the length of the first perch, so is the content in acres to a fourth number, and the fourth number to the content in acres required.

Proportion V.

Having the length and breadth of an oblong superficies given in perches, to find the content in acres.

As 160 is to the breadth in chains, so is the length in perches to the content in acres.

Proportion VI.

Having the length of a superficies in chains, to find the breadth of an acre.

As the length in chains is to ten, so is one acre to the breadth in chain measure.

THE

PRACTICE

OF

Architecture, *Gardening*, *Menſuration*, and *Land-Surveying*, Geometrically demonſtrated.

PART IV.

Containing divers excellent Tables of Menſuration, which ſhew, by inſpection, the true ſuperficial, or ſolid Content, of any Kind of Meaſure, according to any Dimenſions given.

SECT. I.

Of Engliſh *Meaſures uſed in Lands and Buildings.*

BEFORE I begin the tables, 'twill not be improper to inſert the following meaſures, *viz.* That

A ſquare foot	Contains	144 ſquare inches.
A cubical foot	Contains	1728 cubical inches.
A ſquare yard	Contains	9 ſquare feet.
A cubical yard	Contains	27 cubical feet.

A ſquare	Contains	100 ſquare feet, or 10 foot every way.
A load of timber		50 foot cubical.
A load of planks 2 inches thick.		300 ſquare feet.
A load of planks 3 inches thick.		200 ſquare feet.
A load of planks 4 inches thick.		150 ſquare feet.
A load of planks $1\frac{1}{2}$ inches thick.		400 ſquare feet.
A load of planks 1 inches thick.		600 ſquare feet.
A geometrical pace		5 feet in length.
A geometrical perch		10 feet in length.
A ſtatute pole or perch		16 feet $\frac{1}{2}$ in length.
A ſquare ſtatute perch		$272\frac{1}{4}$ ſquare feet.
A woodland pole or perch		18 foot in length.
A ſquare woodland pole		324 ſquare feet.
A forreſt pole or perch		21 foot in length.
A ſquare forreſt pole		441 ſquare feet.
4 ſtatute perches		One chain length.
10 chains length		A furlong or acre's length.
4 chains length		An acre's breadth.
40 ſquare perches		A rood or $\frac{1}{4}$ acre.
4 rood, or 160 perches		An acre.
A hide of land		100 acres

Bricks according to the ſtatute, ſhould be 9 inches in length, 4 inches $\frac{1}{2}$ in breadth, and 2 inches $\frac{1}{2}$ in thickneſs; 500 is a load. Plain tile, in length 10 inches $\frac{1}{2}$, breadth 6 inches $\frac{1}{4}$, and thickneſs $\frac{3}{4}$ inch; 1000 is a load. Gutter tile in length 10 inches $\frac{1}{2}$, the breadth and thickneſs in proportion. Roof tile in length 13 inches, thickneſs $\frac{1}{2}$ inch and $\frac{1}{2}$ quarter, the depth proportional. Lath 5 ſcore to the bundle, when 5 foot long; but when 4 foot in length, then 6 ſcore to the bundle. Deals and nails 120 to the hundred. Lime is ſold by the bag, which ſhould be a buſhel, 25 bags is called a hundred; 'tis in ſome places ſold by the load, which is about 40 buſhels. A tun of iron is 2240 pound weight; and a fodder of lead 19 hundred $\frac{1}{2}$, or 2184 pound.

Sect. II.

Of the Explication of the Inſpectional Tables of Menſuration.

Table I.

THis table is deſign'd for ſmall menſurations, as painting laid with leaf gold, which is generally done for 5*s.* *per* foot, if plain without carving; and if carved, double the price, by reaſon a great quantity of gold is waſted in gilding the broken parts of the ſame and glazing, &c. which is coſtly work, and ſeldom is in great quantity together.

The uſe of this table is as follows.

Suppoſe a piece of gilding, glazing marble, &c. *be* 11 *inches in breadth, what length muſt be taken for a ſquare foot?*

Practice.

1. In the firſt column (entitled the dimenſions breadth in inches) find 11 (the breadth of the work) and againſt it ſtands 1, 1, 1, which ſignifies one foot, one inch, and one tenth part of an inch, and is the length required to make one ſquare foot.

2. To find the content of the whole, open a pair of compaſſes to the extent of 1 foot, 1 inch, and $\frac{1}{10}$, and run that extent through the whole length of the dimenſions, and the number of thoſe extents ſhall be the number of feet required.

Example 2.

Suppoſe a ſlabe of marble is 13 *foot* 4 *inches and* $\frac{2}{10}$ *of an inch in length, and* 23 *inches wide at one end, and* 17 *at the other, what length muſt be taken for a ſquare foot, and how many doth it contain?*

Practice.

1. Add the ends together 23 and 17, and take a mean, *viz.* 20.

2. A-

2. Againſt 20 in the firſt column ſtands 0, 7, 2, *viz.* ſeven inches and $\frac{2}{10}$ of an inch, which is the length of a foot required.

And if the compaſſes be opened to that extent, 'twill paſs through the ſame exactly 22 times, which is the number of feet contain'd therein.

Note, That what is ſaid here in relation to the menſuration of marble, the ſame is to be underſtood in any other kind of meaſure.

Table II.

This table is calculated for any large menſurations of ſuperficial feet meaſure, and is divided into 21 columns. The firſt contains the dimenſions breadth in inches from 1 to 36. The other 20 columns, contains the dimenſions length in feet. Every of theſe columns is number'd at their heads from 1 to 20 feet, as 1 foot, 2 feet, &c. and under every of theſe numbers in each column, is placed the letters F P, which denote feet and part of feet. And here you are to obſerve, that every ſquare foot is divided into 100 equal parts, and thoſe parts, or numbers written under the letter P in every column, are ſo many parts of a hundred or foot. Therefore 25 of thoſe parts is a quarter, 50 a half, and 75 three quarters of a foot, and the like of any other centeſimal part.

Uſe.

Suppoſe a ſlabe of marble be 22 inches in breadth and 11 foot in length, what's the content?

In the angle of meeting of 22 (accounted from the ſide or firſt column,) and 11 (accounted from the head) is 20: 16, which is 20 ſquare foot and $\frac{16}{100}$ the content required.

Example 2.

There is a marble pavement 12 foot in breadth and 17 foot in length.

☞ When the breadth happens to be greater than 36 inches, as herein, you muſt firſt work, ſuppoſing the breadth was 36 inches only, and note that content.

2. As often as you can find 36 in the breadth, ſo many times add the firſt content (as in this example is 4 times) and if any part of the breadth remain, proceed as at firſt, and add that to the ſum of the ſeveral additions and the ſum ſhall be the content required. I need not add the operation, by reaſon 'tis ſo very eaſy and plain.

When meaſures happen unequal at each end, add them together and take a mean, as in table I.

Tables III, and IV.

Theſe two tables are both calculated for the menſuration of ſolids, as timber, ſtone, &c. as are truly ſquare at their ends.

Uſe of table I.

There is a piece of ſquare timber, whoſe ſides are each equal to 13 inches, what length muſt be taken for one ſolid foot?

Practice.

Againſt 13 in the firſt column, ſtands 0, 10, 2, *viz.* 10 inches and 2 tenths of an inch, which is the length required.

Table II.

Suppoſe a piece of timber be 16 inches ſquare at each end, and 37 foot in length, what is the content?

Note, That as this table is calculated but to ten foot in length, therefore find the quantity of 10 foot in length firſt, and then treble it, and afterwards find the quantity of 7 foot in length, and add that to the former, and the ſum ſhall be the ſolid content required.

Practice.

1. Againſt *16* in the firſt column, under 10 feet at the head, ſtands 17 : 78, which is 17 ſolid foot, and 78 parts of a hundred.

2. Ten being contain'd 3 times in 37, therefore treble 17 : 78, and the ſum will be 53 : 34.

3. For the quantity of the odd 7 foot, look under 7 foot at the head, againſt *16* of the ſide, and in that angle of meeting ſtands 12 : 44, which added to the former 53 : 34, is equal to *65* : 78, *viz.* *65* foot and 78 parts, which is $\frac{\;}{100}$ more than 3 quarters of a foot, and is the ſolid content required.

Note, That what is ſaid in this example, the ſame is to be underſtood in all others of this nature. And becauſe 'tis ſeldom that timber, or ſtone, happens exactly ſquare at their ends; therefore I have here ſubjoin'd a table of mean proportionals, by the help of which any unequal ſided timber may be meaſured by this table, as in the above example.

Table

Table V.

This table of mean proportionals, is calculated on purpoſe to reduce unequal ſided timber, &c. to exact ſquare meaſure, and thereby the laſt table is made capable to meaſure any kind of four ſided timber whatſoever.

Uſe.

Suppoſe one ſide of a piece of timber be 19 *inches, and the other* 7 *inches, what is the mean proportional, or what is the length of the ſide of a ſquare equal thereunto?*

Practice.

1. Againſt 7 in the firſt column ſtands 084509, and againſt 19 ſtands 127875.

2. Add thoſe 2 numbers of the ſecond column into one ſum, and 'twill be equal to 212384.

3. Divide this laſt number into 2 equal parts, then will the half be 106192.

4. Look for this number (or the neareſt to it) in the table which is 107918, againſt which ſtands 12, which is the length of the ſide of a ſquare equal thereunto, as required.

The ſide of the ſquare being thus found, enter the laſt table therewith, with any length aſſign'd, and proceed as therein directed (which is very plain and familiar, and the ſolid content will be found, as required. But to make it fully plain, take this example.

Let the length be 9 *foot.*

Firſt, Look for 12 inches in the firſt column, and under 9 foot (at the head of the table) ſtands 9 : 0, *viz.* 9 foot, 0 inches, which is the ſolid content required.

Table VI.

The abſolute reaſon of the conſtruction of this table, is to ſhew the great error and deceit as is contain'd in the cuſtomary way of meaſuring timber, and to prevent the practice thereof for the future.

The manner of uſing this table is exactly the ſame as the firſt and third. The column, wherein the words, the girt, &c. are inſerted, is numbered from 10 to 100. The other column contains the feet, inches, and tenth parts of an inch, as will make a ſolid foot in length at every circumference of the firſt column.

Example.

There is a piece of round timber that in the middle is 52 inches girt (or circumference) and 40 foot in the length, what's the ſolid content?

Practice.

1. In the firſt column find 52 the girt given, and againſt it ſtands 0, 8, 0, which is 0 feet, 8 inches, and 0 parts, and is the length of a ſolid foot, at that girt.

2. Take the diſtance of 8 inches in your compaſſes, and run them along the piece of timber in a right line, and as often as that diſtance is found therein, ſo many ſolid feet is contain'd in that piece of timber, which in this example is 60 times, and therefore the ſolidity is 60 foot, or one load and ten foot.

Now for a demonſtration of the aforeſaid error and deceit in the cuſtomary way of meaſuring, I'll meaſure the aforeſaid piece of timber, according to the common way, which is to double the ſtring by which the girt is taken 4 times, or to take $\frac{1}{4}$ of the girt for the ſide of a ſquare, and then meaſure the ſame as ſquare timber, as follows.

1. The aforeſaid girt is 52, one fourth thereof is 13. The ſide of a ſquare (which they ſuppoſe to be, or at leaſt ſay is true, tho' infinitely from it.)

2. The piece of timber being 40 long (and the fourth table hereof being calculated but to 10 foot length) therefore meaſure one fourth only, and quadruple it, ſo ſhall the mult be the content required. As for example.

Againſt 13, the ſide of the ſquare, and under 10 foot at the head of the table, ſtands 11 : 74, the ſolid content of 10 feet in length, which quadrupled is equal to 46 feet and 96 hundred parts, which is almoſt 47 feet.

From hence it appears, that the true content by the firſt (and true) way, is 60 feet complete, and by this way not quite 47 feet. Therefore 'tis 13 feet too little, or leſs than the true quantity.

Now ſuppoſe the aforeſaid piece of timber was oak, which is never ſold for leſs than one ſhilling per *foot, then will the aforeſaid loſs of 13 feet be 13 ſhillings at leaſt.* Therefore,

If in 60 foot there is but 47 foot accounted for, in 50 foot there is but $39\frac{1}{6}$ foot accounted for, and in every 50 foot, or load of timber, there is almoſt 11 foot of timber loſt, which, as before, is worth at leaſt eleven ſhillings.

Now if in one load of timber eleven shillings is lost, what in a hundred? Answer, 55 pound.

So that from what I have here delivered, 'tis evident, that all such gentlemen as have sold large quantities of timber, by the common way of measuring, have been actually cheated of $\frac{1}{5}$ of the same. But as I have taken the pains here, not only to demonstrate the same, but also to lay down easy plain rules and tables, 'tis hoped that the same will put a final end to all such impostors dealings.

Table VII.

This table is calculated as well for the use of the farmer, &c. to divide and lay out his corn-lands, meadows, &c. as for a gentleman to measure and let, dispose, purchase, &c. when a surveyor is not to be had easily, &c.

This table is of 4 parts, each part being divided into 5 columns, and every column into two others. That of the first, entituled, the breadth of the land, hath two rows of figures, those to the left are poles or perches, and those to the right hand are quarters or fourth parts of a pole or perch, and are distinguished at the head, by the words perch and $\frac{1}{4}$ parts.

The other columns have at their heads the words 1 rood, 2 rood, 3 rood and one acre, and underneath those words the letters P. pts. &c. the letter P in every column signifies perch, and the letters pts. hundred parts of a pole or perch.

☞ I do advise the practitioner to have a $\frac{1}{2}$ pole or pearch, divided into 5 equal parts, and one of those parts subdivided into ten equal parts, so will the whole be in effect divided into 50 parts, and will be answerable to the hundred parts of a perch, as is expres'd in the table. These divisions are best represented by broad-headed nails, with the number of the division engraved on the head of each nail.

The use of this table is as follows.

Suppose a piece of land be 7 poles in breadth, how much in length will make one rood, two rood, or an acre?

Practice.

Against 7 poles in the first column, stands in the second 5 perch 76 parts, the length of one rood, and in the second 11 perch 42 parts the length of two roods, and in the

the third 17 perches, 28 parts, and in the fourth 22 perches 85 parts, the length of an acre required. So also had the breadth of the land been 7 poles and 1 quarter, then would the several lengths be as follows, *viz.*

		Perch.	Parts.	
The length of	1 rood	5	52	And the like of any other breadth.
	2 rood	11	4	
	3 rood	16	56	
	Acre	22	8	

By the example last mention'd it appears, that as often as 22 perches and 8 hundred parts is contain'd in the length of any field, as is 7 poles and $\frac{1}{4}$ in breadth, so many acres is contain'd therein, and if at last any length is remaining as is less than an acre, measure off such a length, as that for 3 roods, 2 roods, or 1 rood, &c. as you find will be contain'd therein, and thereby you may have the true quantity to less than $\frac{1}{4}$ of an acre. And to find the true measure of the remaining part as is less than one rood, divide the space of 5 perch 52 parts, into 40 equal parts, and as many of those parts as are contain'd in the remaining part, is the number of odd perches, and thereby you have the whole content, in acres, rood, and perches, as land is generally measured.

A very little practice will make this very plain and familiar, and therefore I recommend you to the same, during which I shall imploy my pen in other important parts of architecture and gardening which I shall communicate in another treatise very speedily for publick benefit.

F I N I S.

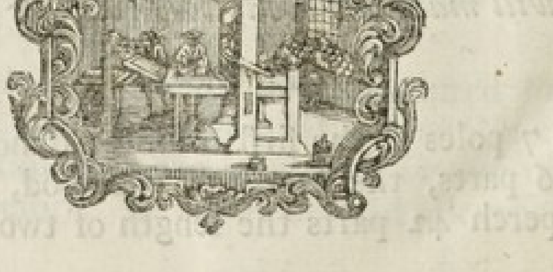


TABLE I.

An Inspectional Table for ye Mensuration of any Small Superficies, as Gilding, with Gold, Silver &c. or of Plank, Glazing, Paving &c.

The Dimensions Breadth in Inches.	Feet	Inches	10 parts
1	12	0	0
2	6	0	0
3	4	0	0
4	3	0	0
5	2	4	0
6	2	0	0
7	1	8	6
8	1	6	0
9	1	4	0
10	1	2	4
11	1	1	1
12	1	0	0
13	0	11	8
14	0	10	3
15	0	9	6
16	0	9	0
17	0	8	5
18	0	8	0
19	0	7	6
20	0	7	2
21	0	6	8
22	0	6	6
23	0	6	2
24	0	6	0
25	0	5	8
26	0	5	5
27	0	5	3
28	0	5	1
29	0	5	0
30	0	4	8
31	0	4	7
32	0	4	5
33	0	4	4
34	0	4	2
35	0	4	1
36	0	4	0

The Length of one Foot.

TABLE II.

An INSPECTIONAL TABLE for ye Mensuration of all Kinds of SUPERFICIAL Measure, as Painting, Wainscoting, Plastering, Paving, Flooring, Glazing &c. In square foot Measure.

The (Dimensions) Length in Feet.

The Dimensions Breadth in Inches.	1 Foot F. P.	2 Feet F. P.	3 Feet F. P.	4 Feet F. P.	5 Feet F. P.	6 Feet F. P.	7 Feet F. P.	8 Feet F. P.	9 Feet F. P.	10 Feet F. P.
1	0 8	0 16	0 25	0 32	0 40	0 50	0 58	0 66	0 75	0 84
2	0 7	0 34	0 50	0 68	0 85	1 0	1 16	1 36	1 50	1 70
3	0 25	0 56	0 75	1 0	1 25	1 50	1 75	2 0	2 25	2 50
4	0 33	0 66	1 0	1 32	1 68	2 0	2 32	2 65	3 0	3 30
5	0 42	0 84	1 25	1 68	2 10	2 50	2 90	3 36	3 75	4 20
6	0 50	1 0	1 50	2 0	2 50	3 0	3 50	4 0	4 50	5 0
7	0 58	1 16	1 75	2 32	2 90	3 50	4 6	4 65	5 25	5 80
8	0 67	1 34	2 0	2 68	3 36	4 0	4 69	5 36	6 0	6 70
9	0 75	1 50	2 25	3 0	3 85	4 50	5 25	6 0	6 75	7 50
10	0 82	1 66	2 50	3 32	4 15	5 0	5 81	6 65	7 50	8 30
11	0 92	1 84	2 75	3 68	4 60	5 50	6 44	7 36	8 25	9 20
12	1 0	2 0	3 0	4 0	5 0	6 0	7 0	8 0	9 0	10 0
13	1 8	2 16	3 25	4 32	5 40	6 50	7 56	8 65	9 75	10 80
14	1 17	2 34	3 50	4 68	5 85	7 0	8 19	9 36	10 50	11 70
15	1 25	2 50	3 75	5 0	6 25	7 50	8 75	10 0	11 25	12 50
16	1 33	2 66	4 0	5 32	6 65	8 0	9 31	10 65	12 0	13 30
17	1 42	2 84	4 25	5 68	7 10	8 50	9 94	11 36	12 75	14 20
18	1 50	3 0	4 50	6 0	7 50	9 0	10 50	12 0	13 50	15 0
19	1 58	3 16	4 75	6 82	7 90	9 50	11 6	12 65	14 25	15 80
20	1 67	3 34	5 0	6 68	8 35	10 0	11 69	13 36	15 0	16 70
21	1 75	3 50	5 25	7 0	8 85	10 50	12 25	14 0	15 75	17 50
22	1 83	3 66	5 50	7 32	9 15	11 0	12 81	14 65	16 50	18 30
23	1 92	3 84	5 75	7 68	9 60	11 50	13 44	15 36	17 25	19 20
24	2 0	4 0	6 0	8 0	10 0	12 0	14 0	16 0	18 0	20 0
25	2 8	4 16	6 25	8 32	10 40	12 50	14 56	16 65	18 75	20 80
26	2 17	4 34	6 50	8 68	10 85	13 0	15 16	17 36	19 50	21 70
27	2 25	4 50	6 75	9 0	11 25	13 50	15 75	18 0	20 25	22 50
28	2 33	4 66	7 0	9 32	11 65	14 0	16 31	18 65	21 0	23 30
29	2 42	4 84	7 25	9 68	12 10	14 50	16 94	19 36	21 75	24 20
30	2 50	5 0	7 50	10 0	12 50	15 0	17 50	20 0	22 50	25 0
31	2 58	5 16	7 75	10 82	12 90	15 50	18 6	20 65	23 25	25 80
32	2 67	5 34	8 0	10 68	13 36	16 0	18 69	21 36	24 0	26 70
33	2 75	5 50	8 25	11 0	13 85	16 50	19 25	22 0	24 75	27 50
34	2 83	5 66	8 50	11 32	14 15	17 0	19 81	22 65	25 50	28 30
35	2 92	5 84	8 75	11 68	14 60	17 50	20 44	23 36	26 25	29 30
36	3 0	6 0	9 0	12 0	15 0	18 0	21 0	24 0	27 0	30 0

The Dimensions Breadth in Inches.	11 Feet F. P.	12 Feet F. P.	13 Feet F. P.	14 Feet F. P.	15 Feet F. P.	16 Feet F. P.	17 Feet F. P.	18 Feet F. P.	19 Feet F. P.	20 Feet F. P.
1	0 92	1 0	1 8	1 16	1 25	1 33	1 42	1 50	1 58	1 66
2	1 84	2 0	2 16	2 33	2 50	2 66	2 84	3 0	3 16	3 32
3	2 75	3 0	3 25	3 49	3 75	4 0	4 26	4 50	4 74	5 0
4	3 66	4 0	4 33	4 65	5 0	5 33	5 65	6 0	6 32	6 66
5	4 58	5 0	5 42	5 81	6 25	7 66	7 10	7 50	7 90	8 32
6	5 50	6 0	6 50	7 0	7 50	8 0	8 50	9 0	9 50	10 0
7	6 42	7 0	7 58	8 16	8 75	9 33	9 92	10 50	11 8	11 66
8	7 33	8 0	8 66	9 33	10 0	10 66	11 34	12 0	12 56	13 32
9	8 25	9 0	9 75	10 49	11 25	12 0	12 76	13 50	14 24	15 0
10	9 16	10 0	10 84	11 65	12 50	13 33	14 18	15 0	15 82	16 66
11	10 8	11 0	11 92	12 81	13 75	14 66	15 60	16 50	17 40	18 32
12	11 0	12 0	13 0	14 0	15 0	16 0	17 0	18 0	19 0	20 0
13	11 92	13 0	14 8	15 16	16 25	17 33	18 42	19 50	20 53	21 66
14	12 84	14 0	15 16	16 33	17 50	18 66	19 84	21 0	22 16	23 32
15	13 75	15 0	16 25	17 49	18 75	20 0	21 26	22 50	23 74	25 0
16	14 66	16 0	17 33	18 65	20 0	21 33	22 68	24 0	25 32	26 66
17	15 58	17 0	18 42	20 81	21 25	22 66	24 10	25 50	26 90	28 32
18	16 50	18 0	19 50	21 0	22 50	24 0	25 50	27 0	28 48	30 0
19	17 42	19 0	20 58	23 16	23 75	25 33	26 92	28 50	30 6	31 66
20	18 33	20 0	21 66	24 33	25 0	26 66	28 34	30 0	31 64	33 32
21	19 25	21 0	22 75	25 49	26 25	28 0	29 76	31 50	33 22	35 0
22	20 16	22 0	23 84	26 65	27 50	29 33	31 18	33 0	34 80	36 66
23	21 8	23 0	24 92	27 81	28 75	30 66	32 60	34 50	36 38	38 32
24	22 0	24 0	26 0	29 0	30 0	32 0	34 0	36 0	38 0	40 0
25	22 92	25 0	27 8	30 16	31 25	33 33	35 42	37 50	39 58	41 66
26	23 84	26 0	28 16	31 33	32 50	34 66	36 84	39 0	41 16	43 32
27	24 75	27 0	29 25	32 49	33 75	36 0	38 26	40 50	42 74	45 0
28	25 66	28 0	30 33	33 65	35 0	37 33	39 68	42 0	44 32	46 66
29	26 58	29 0	31 42	34 81	36 25	38 66	39 10	43 50	45 90	48 32
30	27 50	30 0	32 50	36 0	37 50	40 0	41 50	45 0	47 48	50 0
31	28 42	31 0	33 58	37 16	38 75	41 33	43 92	46 50	49 6	51 66
32	29 33	32 0	34 66	38 33	40 0	42 66	44 34	48 0	50 64	53 32
33	30 25	33 0	35 75	39 49	41 25	44 0	45 76	49 50	52 22	55 0
34	31 16	34 0	36 81	40 65	42 50	45 33	47 18	51 0	53 80	56 66
35	32 8	35 0	37 92	41 81	43 75	46 66	48 60	52 50	55 38	58 32
36	33 0	36 0	39 0	42 0	45 0	48 0	51 0	54 0	57 0	60 0

TABLE III.

An Inspectional Table Shewing how much in Length will make a Solid foot of any True Squared Timber, Stone &c.

Inches square at ye end of ye Stone, Timber &c.	Feet	Inches	Parts
6	4	0	0
7	2	11	2
8	2	3	0
9	1	9	3
10	1	5	3
11	1	2	3
12	1	0	0
13	0	10	2
14	0	8	8
15	0	7	6
16	0	6	7
17	0	5	9
18	0	5	3
19	0	4	8
20	0	4	3
21	0	3	9
22	0	3	5
23	0	3	2
24	0	3	0
25	0	2	8
26	0	2	6
27	0	2	3
28	0	2	2
29	0	2	1
30	0	1	9
31	0	1	8
32	0	1	7
33	0	1	6
34	0	1	5
35	0	1	4
36	0	1	3

The Length of a Solid Foot.

TABLE IV.

An INSPECTIONAL TABLE for the Mensuration of Timber, Stone &c. as is Exactly Square at each end Calculated from 1 Inch Square, to 36, and for any length required.

The Length of the Timber, Stone &c.

Inch's square at ye end of ye Stone, Timber &c.	1 Feet F. P.	2 Feet F. P.	3 Feet F. P.	4 Feet F. P.	5 Feet F. P.	6 Feet F. P.	7 Feet F. P.	8 Feet F. P.	9 Feet F. P.	10 Feet F. P.
1	0 1	0 1	0 2	0 3	0 3	0 4	0 5	0 5	0 6	0 7
2	0 3	0 5	0 8	0 11	0 14	0 17	0 19	0 22	0 25	0 28
3	0 6	0 12	0 18	0 25	0 31	0 37	0 43	0 49	0 56	0 62
4	0 11	0 22	0 33	0 44	0 55	0 66	0 78	0 89	1 0	1 11
5	0 17	0 35	0 52	0 69	0 87	1 4	1 22	1 39	1 56	1 74
6	0 25	0 50	0 75	1 0	1 25	1 50	1 55	2 0	2 25	2 50
7	0 34	0 68	1 2	1 36	1 70	2 4	2 38	2 72	3 6	3 40
8	0 44	0 89	1 33	1 77	2 22	2 66	3 11	3 55	4 0	4 44
9	0 50	1 12	1 68	2 25	2 81	3 37	3 93	4 49	5 5	5 62
10	0 69	1 39	2 8	2 77	3 47	4 16	4 86	5 55	6 24	6 94
11	0 84	1 68	2 52	3 36	4 20	5 4	5 88	6 72	7 56	8 40
12	1 0	2 0	3 0	4 0	5 0	6 0	7 0	8 0	9 0	10 0
13	1 18	2 35	3 52	4 69	5 87	7 4	8 22	9 39	10 55	11 74
14	1 36	2 72	4 8	5 44	6 80	8 16	9 53	10 89	12 25	13 61
15	1 56	3 12	4 68	6 25	7 81	9 37	10 93	12 49	14 6	15 62
16	1 78	3 55	5 33	7 11	8 89	10 67	12 44	14 22	16 0	17 78
17	2 1	4 10	6 2	8 3	10 3	12 4	14 5	16 5	18 6	20 7
18	2 25	4 50	6 75	9 0	11 25	13 56	15 75	19 0	20 25	22 50
19	2 51	5 1	7 52	10 3	12 53	15 4	17 55	20 5	22 56	25 7
20	2 78	5 55	8 33	11 11	13 89	16 67	19 40	22 22	25 0	27 78
21	3 6	6 13	9 18	12 25	15 31	18 37	21 43	24 49	27 56	30 62
22	3 36	6 72	10 8	13 44	16 80	20 16	23 53	26 89	30 25	33 61
23	3 67	7 34	11 3	14 69	18 36	22 4	25 71	29 38	33 6	36 73
24	4 0	8 0	12 0	16 0	20 0	24 0	28 0	32 0	36 0	40 0
25	4 34	8 68	13 2	17 36	21 70	26 4	30 38	34 76	39 2	43 40
26	4 69	9 39	14 8	18 77	23 47	28 16	32 66	37 55	42 24	47 0
27	5 6	10 12	15 19	20 25	25 31	30 38	35 44	40 50	45 57	50 63
28	5 44	10 89	16 33	21 78	27 22	32 67	38 11	43 56	49 0	54 45
29	5 84	11 68	17 52	23 36	29 20	35 4	40 88	46 72	52 56	58 40
30	6 25	12 50	18 75	25 0	31 25	37 60	43 75	50 0	56 25	62 50
31	6 67	13 34	20 2	27 0	33 36	40 4	46 71	53 38	60 6	66 73
32	7 11	14 22	21 33	28 44	35 55	42 66	49 78	56 89	64 0	71 11
33	7 56	15 15	22 68	30 24	37 81	45 37	52 93	60 49	68 6	75 62
34	8 3	16 5	24 8	32 11	40 14	48 17	56 19	64 22	72 25	80 28
35	8 50	17 1	25 52	34 3	42 53	51 4	59 55	68 5	76 56	85 7
36	9 0	18 0	27 0	36 0	46 0	54 0	63 0	72 0	81 0	90 0

TABLE V.

A TABLE OF MEAN PROPORTIONALS for reducing unequall sided Timber (as most is) Stone &c. to true Square Measure. as Table IV.

Sides of the Square in Inches.		Sides of the Square in Inches.		Sides of the Square in Inches.	
1	000000	34	153147	67	182607
2	030103	35	154406	68	183250
3	047712	36	155630	69	183885
4	060206	37	156820	70	184509
5	069897	38	157978	71	185125
6	077815	39	159106	72	185733
7	084509	40	160205	73	186332
8	090308	41	161278	74	186923
9	095424	42	162325	75	187506
10	100000	43	163346	76	188081
11	104139	44	164345	77	188649
12	107918	45	165321	78	189209
13	111394	46	166276	79	189762
14	114612	47	167209	80	190309
15	117609	48	168124	81	190848
16	120411	49	169019	82	191381
17	123044	50	169897	83	191907
18	125527	51	170757	84	192428
19	127875	52	171600	85	192941
20	130102	53	172427	86	193449
21	132221	54	173239	87	193952
22	134242	55	174036	88	194448
23	136172	56	174818	89	194939
24	138021	57	175587	90	195424
25	139794	58	176342	91	195904
26	141497	59	177085	92	196378
27	143136	60	177815	93	196848
28	144715	61	178533	94	197312
29	146239	62	179239	95	197772
30	147712	63	179934	96	198227
31	149136	64	180618	97	198677
32	150515	65	181291	98	199122
33	151851	66	181954	99	199563
				100	200000

TABLE VI.

An Inspectional Table. Shewing how much in Length will make a Solid Foot of any round Timber Stone &c. according to any Girt or Circumference given in Inches.

The Girt. Inches	Feet	Inches	Parts	The Girt. Inches	Feet	Inches	Parts	The Girt. Inches	Inches	Parts
10	18	11	2	40	1	1	6	70	4	4
11	14	11	5	41	1	0	9	71	4	3
12	12	6	8	42	1	0	3	72	4	2
13	10	8	5	43	0	11	7	73	4	1
14	9	2	7	44	0	11	1	74	3	9
15	7	10	3	45	0	10	7	75	3	8
16	7	0	8	46	0	10	2	76	3	7
17	6	3	0	47	0	9	9	77	3	6
18	5	7	0	48	0	9	4	78	3	6
19	5	0	2	49	0	9	0	79	3	5
20	4	6	3	50	0	8	7	80	3	4
21	4	1	2	51	0	8	3	81	3	4
22	3	8	9	52	0	8	0	82	3	3
23	3	4	9	53	0	7	8	83	3	2
24	3	1	4	54	0	7	4	84	3	2
25	2	10	7	55	0	7	2	85	3	0
26	2	8	1	56	0	6	9	86	2	9
27	2	5	8	57	0	6	7	87	2	8
28	2	3	7	58	0	6	4	88	2	8
29	2	1	8	59	0	6	2	89	2	7
30	2	0	1	60	0	6	0	90	2	7
31	1	10	6	61	0	5	8	91	2	6
32	1	9	2	62	0	5	6	92	2	6
33	1	7	9	63	0	5	5	93	2	5
34	1	6	8	64	0	5	2	94	2	5
35	1	5	7	65	0	5	1	95	2	4
36	1	4	7	66	0	4	9	96	2	4
37	1	3	8	67	0	4	8	97	2	3
38	1	3	0	68	0	4	7	98	2	3
39	1	2	3	69	0	4	6	99	2	3
								100	2	2

The Length of a Foot.

TABLE VII.

An INSPECTIONAL TABLE of LAND MEASURE Shewing the Superficial Content of any quantity of Land. As also How to Divide Lands in Common Feilds or Inclosures. According to any Proportion Assigned.

The Breadth of the Land. — The Length of

		1 Rood P.	pts	2 Rood P.	pts	3 Rood P.	pts	One Acre P.	pts
1	0	40	0	80	0	120	0	160	0
	1	36	0	64	0	96	0	128	0
	2	26	66	52	50	78	75	105	0
	3	22	86	44	22	68	58	88	44
2	0	20	0	40	0	60	0	80	0
	1	17	62	35	64	53	46	71	28
	2	16	0	32	0	48	0	64	0
	3	14	54	29	8	43	62	58	16
3	0	13	33	26	66	30	0	53	33
	1	12	33	24	66	37	0	49	32
	2	11	43	22	86	34	29	45	72
	3	10	66	21	32	31	98	42	64
4	0	10	0	20	0	30	0	40	0
	1	9	41	18	82	28	23	37	64
	2	8	48	17	76	26	64	35	52
	3	8	42	16	84	25	26	33	68
5	0	8	0	16	0	24	0	32	0
	1	7	62	15	24	22	86	30	48
	2	7	27	14	54	21	81	29	8
	3	6	95	13	90	20	81	27	80
6	0	6	66	13	33	19	98	26	66
	1	6	40	12	80	19	20	25	60
	2	6	16	12	32	18	48	24	64
	3	5	92	11	84	17	76	23	68
7	0	5	76	11	42	17	28	22	85
	1	5	52	11	4	16	56	22	8
	2	5	33	10	61	16	0	21	32
	3	5	16	10	32	15	48	20	64
8	0	5	0	10	0	15	0	20	0
	1	4	85	9	70	14	55	19	40
	2	4	70	9	40	14	10	18	80
	3	4	57	8	14	13	71	16	28
9	0	4	44	8	88	13	32	17	77
	1	4	32	8	64	12	96	17	28
	2	4	21	8	42	12	63	16	84
	3	4	10	8	20	12	30	16	40
10	0	4	0	8	0	12	0	16	0
	1	3	89	7	78	11	67	15	56
	2	3	81	7	67	11	43	15	24
	3	3	72	7	44	11	16	14	88

		1 Rood P.	pts	2 Rood P.	pts	3 Rood P.	pts	One Acre P.	pts
11	0	3	63	7	27	10	89	14	54
	1	3	55	7	10	10	65	14	20
	2	3	47	6	94	10	41	13	88
	3	3	40	6	80	10	20	13	60
12	0	3	33	6	66	10	0	13	33
	1	3	26	6	52	9	76	13	4
	2	3	20	6	40	9	60	12	80
	3	3	13	6	26	9	39	12	52
13	0	3	8	6	15	9	24	12	31
	1	3	2	6	4	9	6	12	8
	2	2	96	5	92	8	88	11	84
	3	2	90	5	80	8	70	11	60
14	0	2	85	5	70	8	55	11	42
	1	2	80	5	60	8	40	11	20
	2	2	75	5	50	8	25	11	0
	3	2	71	5	42	8	13	10	84
15	0	2	66	5	33	7	98	10	66
	1	2	62	5	24	7	86	10	48
	2	2	58	5	16	7	74	10	32
	3	2	54	5	8	7	62	10	16
16	0	2	50	5	0	7	50	10	0
	1	2	46	4	92	7	38	9	84
	2	2	42	4	84	7	26	9	68
	3	2	38	4	76	7	14	9	52
17	0	2	35	4	72	7	5	9	42
	1	2	32	4	64	6	96	9	28
	2	2	28	4	56	6	84	9	12
	3	2	25	4	50	6	75	9	0
18	0	2	22	4	45	6	66	8	89
	1	2	19	4	39	6	57	8	78
	2	2	16	4	32	6	48	8	64
	3	2	13	4	26	6	89	8	52
19	0	2	10	4	21	6	30	8	42
	1	2	8	4	16	6	24	8	32
	2	2	5	4	16	6	15	8	20
	3	2	3	4	6	6	9	8	12
20	0	2	0	4	0	6	0	8	0
	1	1	97	3	94	5	91	7	88
	2	1	94	3	88	5	82	7	76
	3	1	92	3	84	5	76	7	68

		1 Rood P.	pts	2 Rood P.	pts	3 Rood P.	pts	One Acre P.	pts
21	0	1	90	3	81	5	70	7	62
	1	1	95	3	76	5	64	7	52
	2	1	86	3	72	5	58	7	44
	3	1	83	3	66	5	49	7	32
22	0	1	82	3	63	5	46	7	27
	1	1	79	3	58	5	37	7	16
	2	1	77	3	54	5	31	7	8
	3	1	75	3	50	5	25	7	0
23	0	1	73	3	46	5	19	6	95
	1	1	71	3	43	5	13	6	86
	2	1	70	3	40	5	10	6	80
	3	1	68	3	36	5	4	6	72
24	0	1	66	3	33	4	98	6	66
	1	1	64	3	28	4	92	6	56
	2	1	63	3	26	4	89	6	52
	3	1	61	3	22	4	83	6	44
25	0	1	60	3	20	4	80	6	40
	1	1	58	3	16	4	74	6	32
	2	1	56	3	12	4	68	6	24
	3	1	54	3	8	4	62	6	16
26	0	1	53	3	7	4	59	6	12
	1	1	52	3	4	4	56	6	8
	2	1	51	3	2	4	53	6	4
	3	1	49	2	98	4	47	5	96
27	0	1	47	2	94	4	41	5	92
	1	1	46	2	92	4	38	5	84
	2	1	45	2	90	4	35	5	80
	3	1	43	2	86	4	29	5	72
28	0	1	42	2	84	4	26	5	71
	1	1	41	2	82	4	23	5	64
	2	1	40	2	80	4	20	5	60
	3	1	39	2	78	4	17	5	56
29	0	1	38	2	76	4	14	5	52
	1	1	37	2	73	4	11	5	46
	2	1	35	2	70	4	5	5	40
	3	1	34	2	68	4	2	5	36
30	0	1	33	2	66	4	0	5	33
	1	1	32	2	64	3	96	5	28
	2	1	31	2	62	3	93	5	24
	3	1	30	2	60	3	90	5	20

		1 Rood P.	pts	2 Rood P.	pts	3 Rood P.	pts	One Acre P.	pts
31	0	1	29	2	57	3	87	5	16
	1	1	28	2	56	3	84	5	12
	2	1	27	2	54	3	81	5	8
	3	1	26	2	52	3	78	5	4
32	0	1	25	2	50	3	75	5	0
	1	1	24	2	48	3	72	4	96
	2	1	23	2	46	3	69	4	92
	3	1	22	2	44	3	66	4	88
33	0	1	21	2	42	3	63	4	85
	1	1	20	2	40	3	60	4	80
	2	1	19	2	38	3	57	4	76
	3	1	18	2	36	3	54	4	72
34	0	1	17	2	35	3	52	4	70
	1	1	17	2	34	3	50	4	68
	2	1	16	2	33	3	49	4	66
	3	1	16	2	32	3	48	4	64
35	0	1	15	2	30	3	45	4	60
	1	1	14	2	28	3	42	4	56
	2	1	12	2	24	3	36	4	48
	3	1	11	2	22	3	33	4	44
36	0	1	10	2	21	3	31	4	42
	1	1	10	2	20	3	30	4	40
	2	1	9	2	19	3	27	4	38
	3	1	9	2	18	3	25	4	36
37	0	1	8	2	16	3	24	4	32
	1	1	7	2	14	3	21	4	30
	2	1	6	2	12	3	18	4	28
	3	1	5	2	10	3	15	4	24
38	0	1	5	2	10	3	15	4	21
	1	1	4	2	9	3	12	4	18
	2	1	4	2	8	3	12	4	15
	3	1	3	2	6	3	9	4	12
39	0	1	2	2	4	3	6	4	8
	1	1	1	2	2	3	4	4	4
	2	1	0	2	2	3	3	4	3
	3	1	0	2	1	3	2	4	1
40	0	1	0	2	0	3	0	4	0

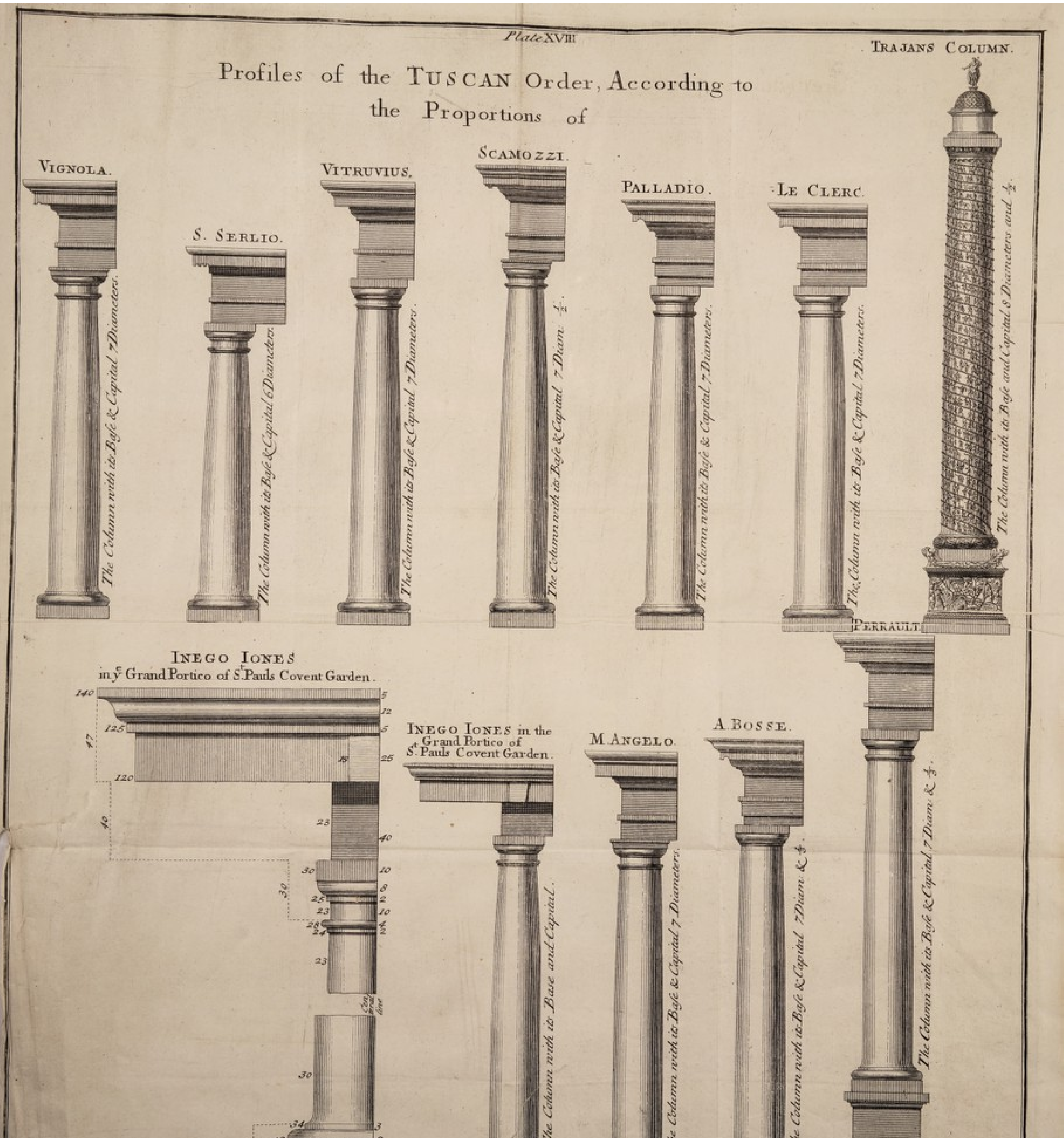
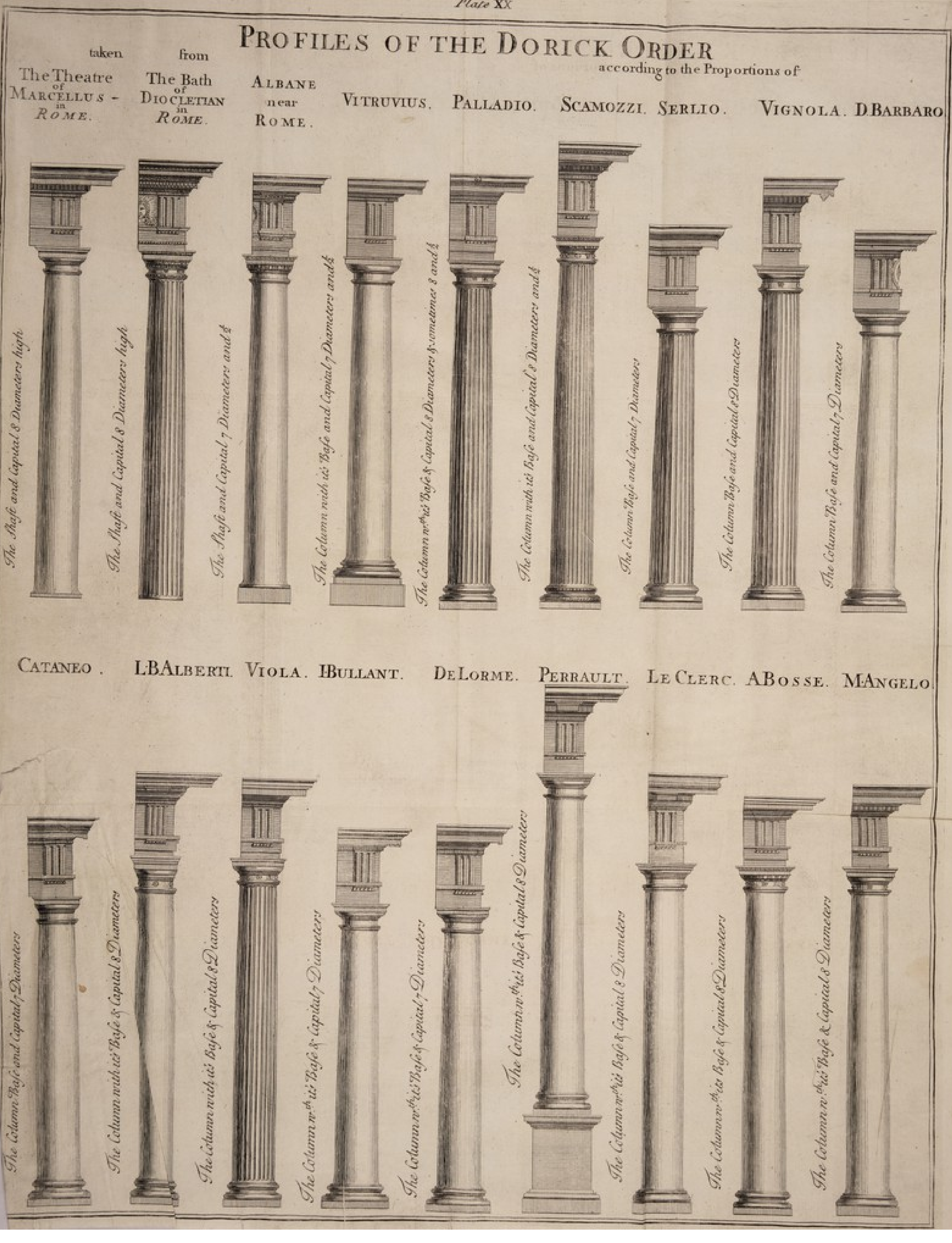


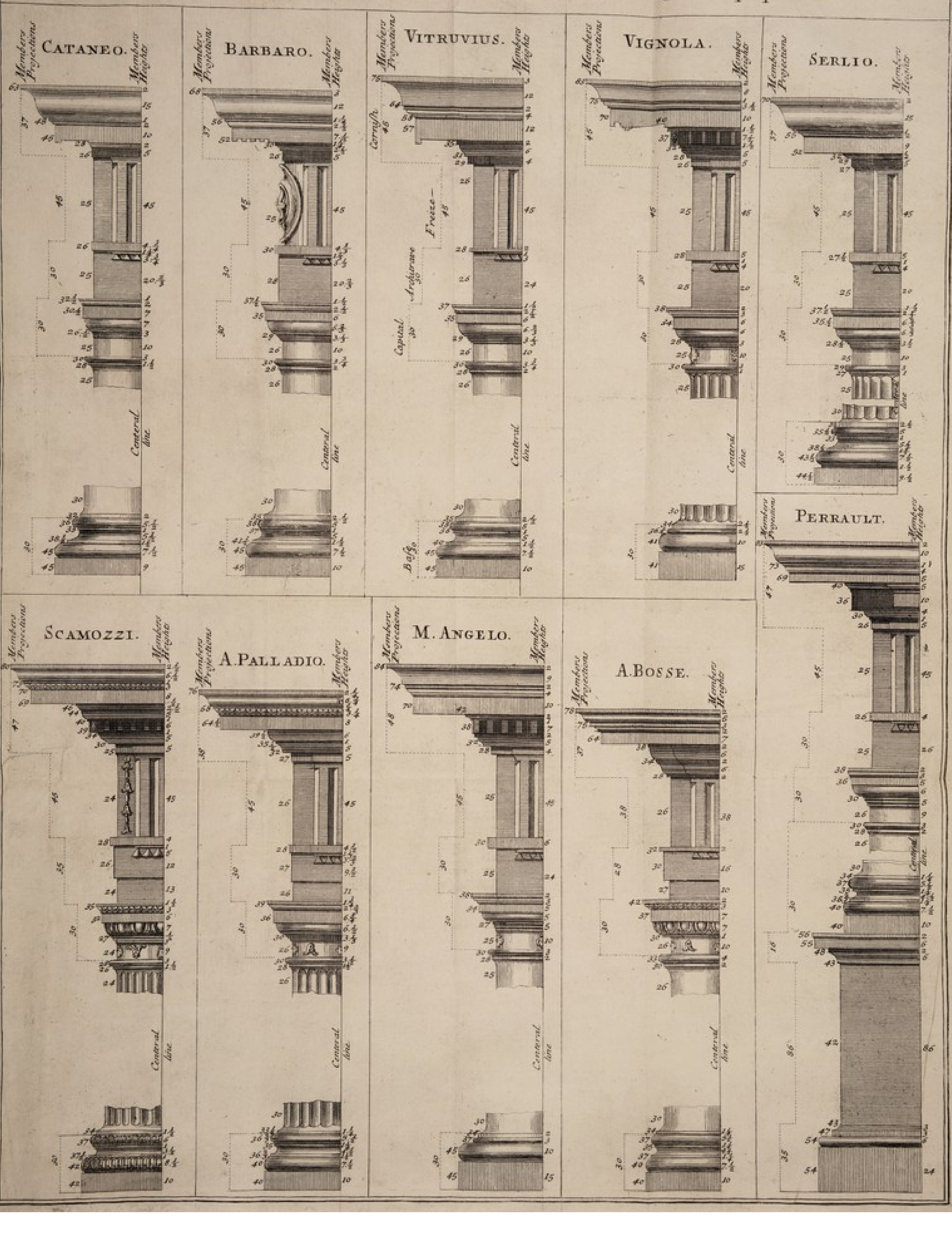
Plate XVIII
Profiles of the TUSCAN Order, According to the Proportions of
TRAJANS COLUMN.
The Column with its Base and Capital 8 Diameters and 1/2.
VIGNOLA.
The Column with its Base & Capital 7 Diameters.
S. SERLIO.
The Column with its Base & Capital 6 Diameters.
VITRUVIUS,
The Column with its Base & Capital 7 Diameters.
SCAMOZZI.
The Column with its Base & Capital 7 Diam. 1/2.
PALLADIO.
The Column with its Base & Capital 7 Diameters.
LE CLERC.
The Column with its Base & Capital 7 Diameters.
PERRAULT.
The Column with its Base & Capital 7 Diam. & 1/3.
INEGO IONES in ye Grand Portico of St Pauls Covent Garden.
INEGO IONES in the Grand Portico of St Pauls Covent Garden.
The Column with its Base and Capital.
M. ANGELO.
The Column with its Base & Capital 7 Diameters.
A. BOSSE.
The Column with its Base & Capital 7 Diam. & 1/4.

Plate XIX

Geometrical Elevations of ye TUSCAN Base, Capital and Entablature According to the Proportions of


PROFILES OF THE DORICK ORDER
taken from
The Theatre of Marcellus in Rome.
The Bath of Diocletian in Rome.
Albane near Rome.
according to the Proportions of
Vitruvius.
Palladio.
Scamozzi.
Serlio.
Vignola.
D.Barbaro
The Shaft and Capital 8 Diameters high
The Shaft and Capital 8 Diameters high
The Shaft and Capital 7 Diameters and ½
The Column with its Base and Capital 7 Diameters and ½
The Column wth its Base & Capital 8 Diameters & sometimes 8 and ½
The Column with its Base and Capital 8 Diameters and ½
The Column Base and Capital 7 Diameters
The Column Base and Capital 8 Diameters
The Column Base and Capital 7 Diameters
Cataneo.
L.B.Alberti.
Viola.
I.Bullant.
De Lorme.
Perrault.
Le Clerc.
A.Bosse.
M.Angelo.
The Column Base and Capital 7 Diameters
The Column with its Base & Capital 8 Diameters
The Column with its Base & Capital 8 Diameters
The Column wth its Base & Capital 7 Diameters
The Column wth its Base & Capital 7 Diameters
The Column wth its Base & Capital 8 Diameters
The Column wth its Base & Capital 8 Diameters
The Column wth its Base & Capital 8 Diameters
The Column wth its Base & Capital 8 Diameters

Geometrical Elevations of ye Dorick Base, Capitals, and Entablatures according to the proportions of



Geometrical Elevations of the *DORICK* Entablature, Capital & Base according to the Proportions, of

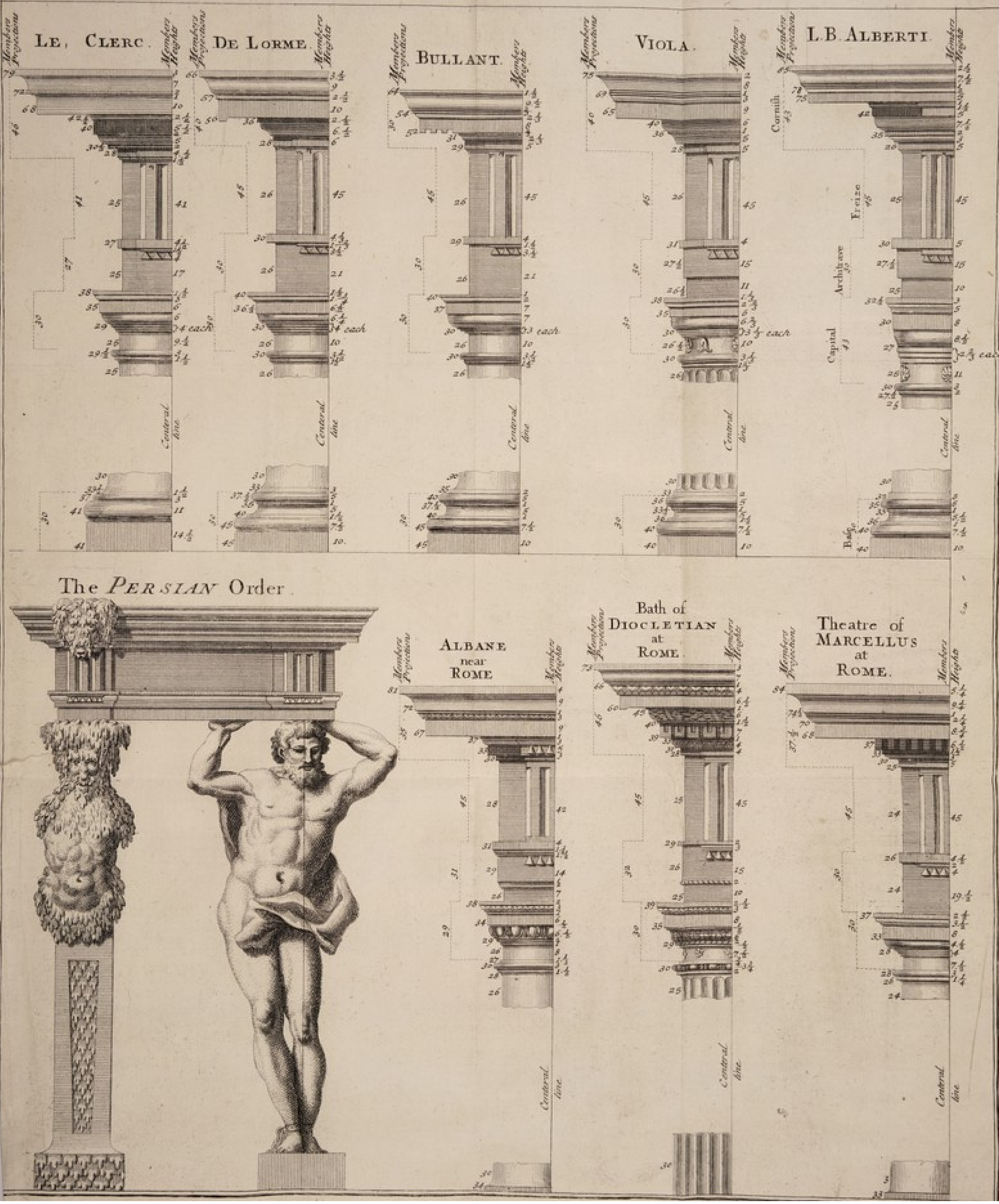
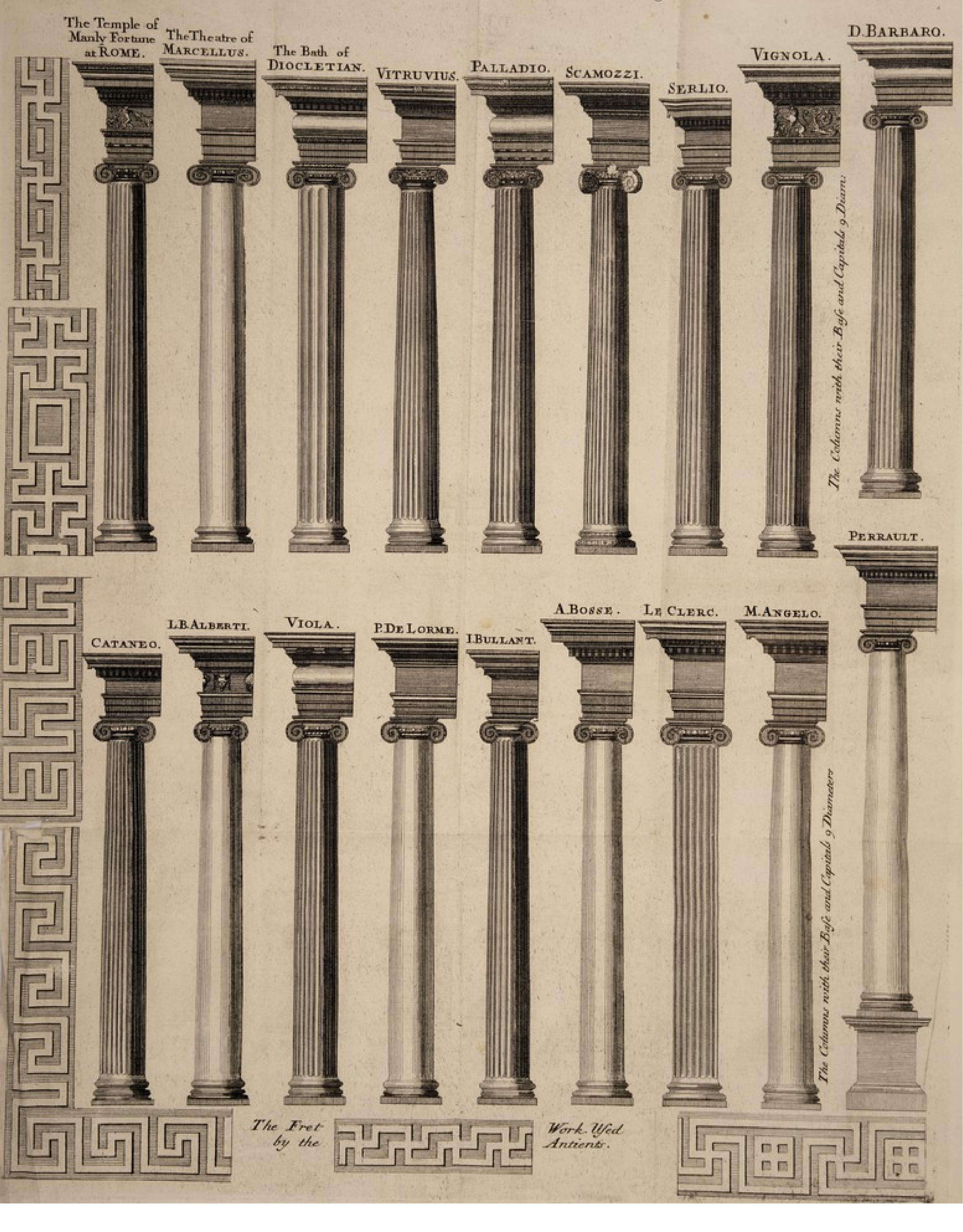
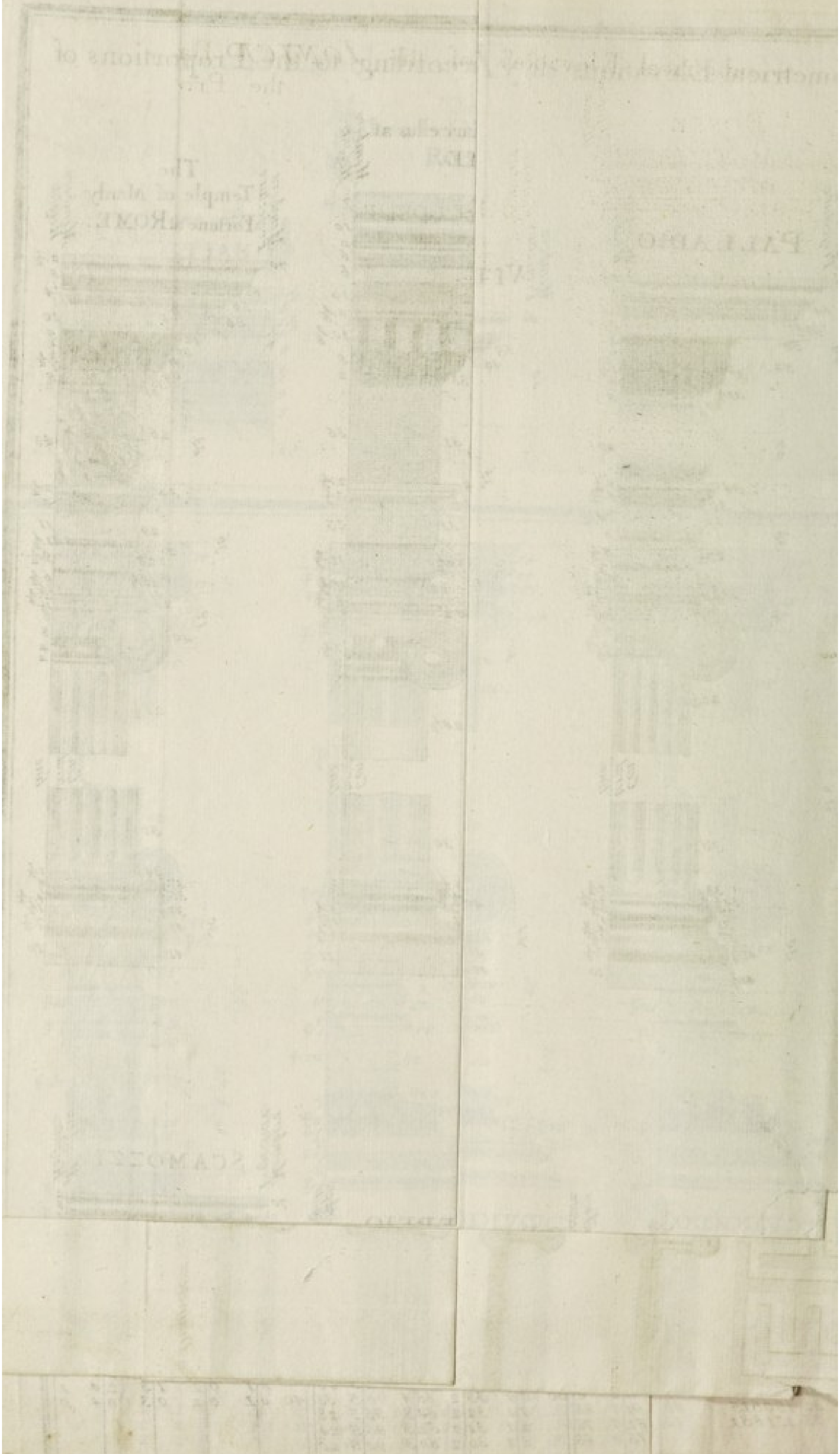


Plate XXIII

Profiles of the *IONICK* Order, According to



Geometrical Elevations of ye IONICK Base, Capitals, and Entablatures according to the Proportions of



The Temple of Manly Fortune at ROME
PALLADIO
SCAMOZZI

Geometrical Elevations of the *IONICK* Base, Capitals, and Entablatures according to the Proportions of

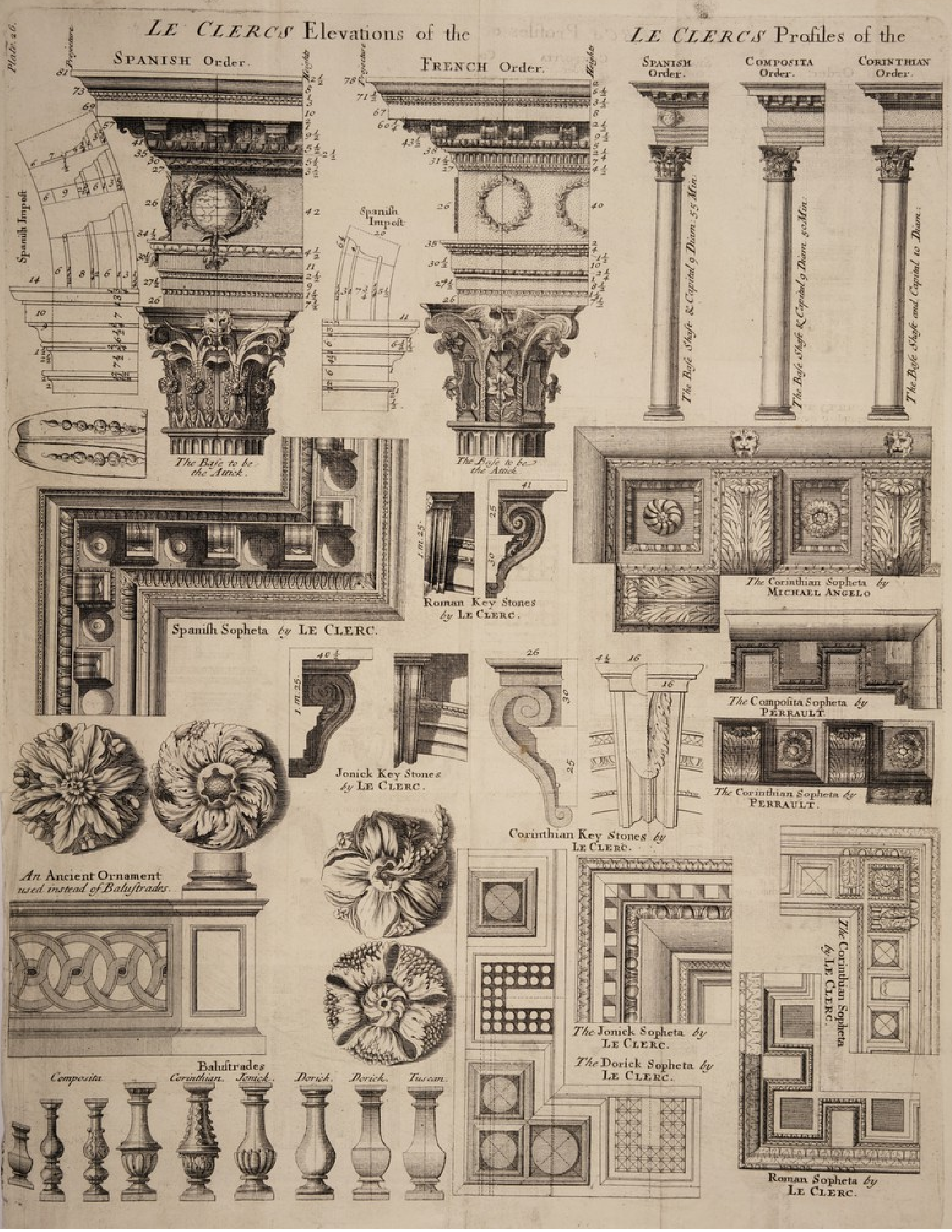
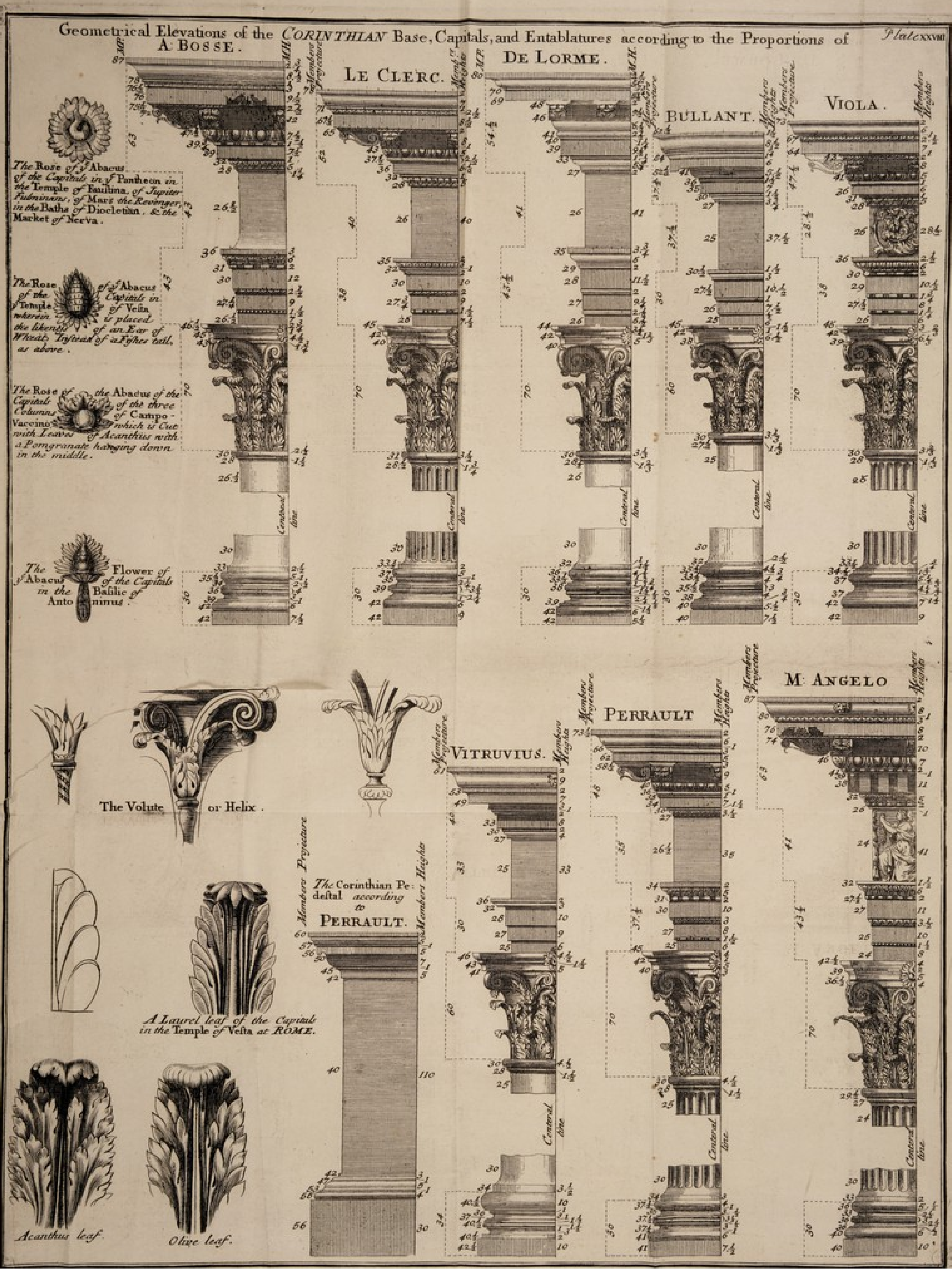


Plate 26.
LE CLERC'S Elevations of the
SPANISH Order.
FRENCH Order.
LE CLERC'S Profiles of the
SPANISH Order.
COMPOSITA Order.
CORINTHIAN Order.
Projecture
Heights
Spanish Impost
Spanish Impost
The Base to be the Attick.
The Base to be the Attick.
The Base Shaft & Capital 9 Diam: 55 Min:
The Base Shaft & Capital 9 Diam. 50 Min:
The Base Shaft and Capital 10 Diam:
Spanish Sopheta by LE CLERC.
Roman Key Stones by LE CLERC.
The Corinthian Sopheta by MICHAEL ANGELO
The Composita Sopheta by PERRAULT.
The Corinthian Sopheta by PERRAULT.
Jonick Key Stones by LE CLERC.
Corinthian Key Stones by LE CLERC.
An Ancient Ornament used instead of Balustrades.
Balustrades
Composita.
Corinthian.
Jonick.
Dorick.
Dorick.
Tuscan.
The Jonick Sopheta by LE CLERC.
The Dorick Sopheta by LE CLERC.
The Corinthian Sopheta by LE CLERC.
Roman Sopheta by LE CLERC.

Plate XXVII

Geometrical Elevations of the *CORINTHIAN* Base, Capitals and Entablatures according to y^e Proportions of.

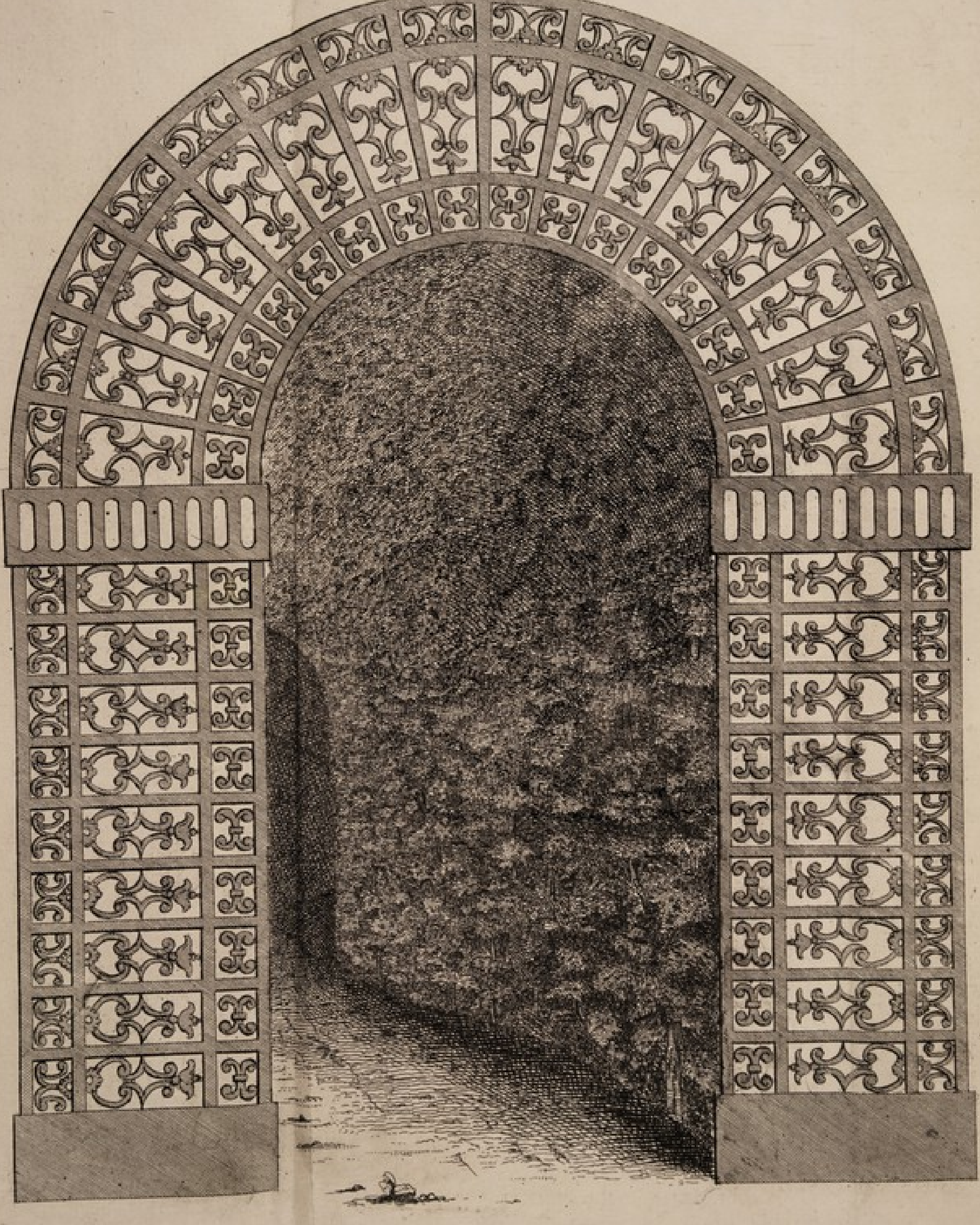

Geometrical Elevations of the CORINTHIAN Base, Capitals, and Entablatures according to the Proportions of
Plate XXVIII
A. BOSSE.
LE CLERC.
DE LORME.
BULLANT.
VIOLA.
The Rose of ye Abacus of the Capitals in ye Pantheon in the Temple of Faustina, of Jupiter Fulminans, of Mars the Revenger, in the Baths of Diocletian, & the Market of Nerva.
The Rose of ye Abacus of the Capitals in ye Temple of Vesta wherein is placed the likeness of an Ear of Wheat, Instead of a Fishes tail, as above.
The Rose of the Abacus of the Capitals of the three Columns of Campo-Vaccino which is Cut with Leaves of Acanthus with a Pomgranate hanging down in the middle.
The Flower of ye Abacus of the Capitals in the Basilic of Antoninus.
Central line
Members Projecture
Members Heights
The Volute or Helix.
The Corinthian Pedestal according to PERRAULT.
VITRUVIUS.
PERRAULT
M. ANGELO
A Laurel leaf of the Capitals in the Temple of Vesta at ROME.
Acanthus leaf.
Olive leaf.

Geometrical Elevations of the *COMPOSITA* Base, Capitals and Entablatures according to the Proportions of

Plate XXIX

30

Plate XXXI.



The Frontispiece of an Enterance into a Shady or Artinatural Walk

Plate XXXII

An Amphitheatrical mount of ever Greens
for y^e. Termination of a grand Walk.

Geometrical Elevations for Entrances into Grotto's and Caves.

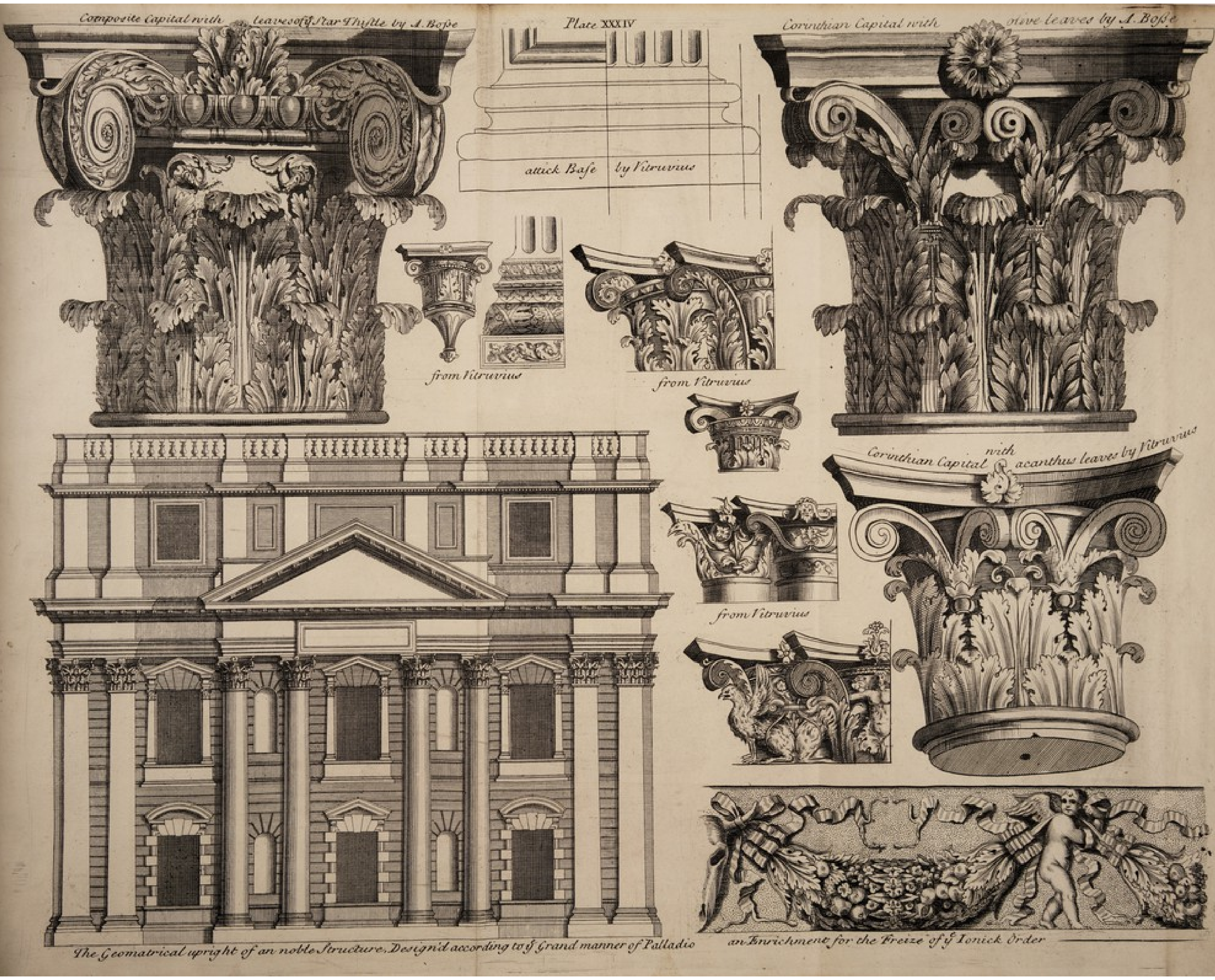
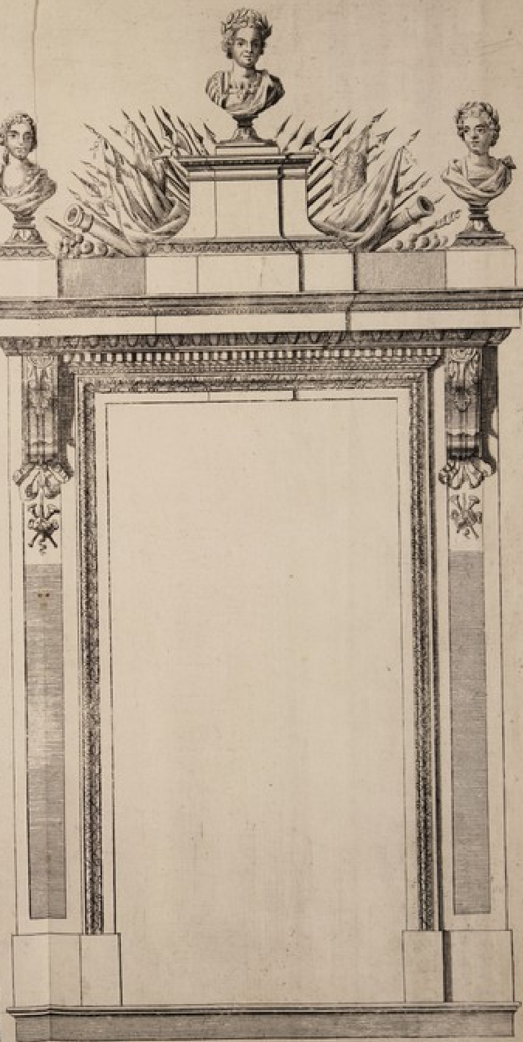

Composite Capital with leaves of ye Star Thistle by A. Bosse
Plate XXXIV
Corinthian Capital with olive leaves by A. Bosse
attick Base by Vitruvius
from Vitruvius
from Vitruvius
Corinthian Capital with acanthus leaves by Vitruvius
from Vitruvius
The Geomatrical upright of an noble Structure, Design'd according to ye Grand manner of Palladio
an Enrichment for the Freize of ye Ionick Order

Plate XXXV

Geometrical Entrance according to the Tuscan Order of the Antients.

Composite Soffeta



A Composite Door according to the Antients.

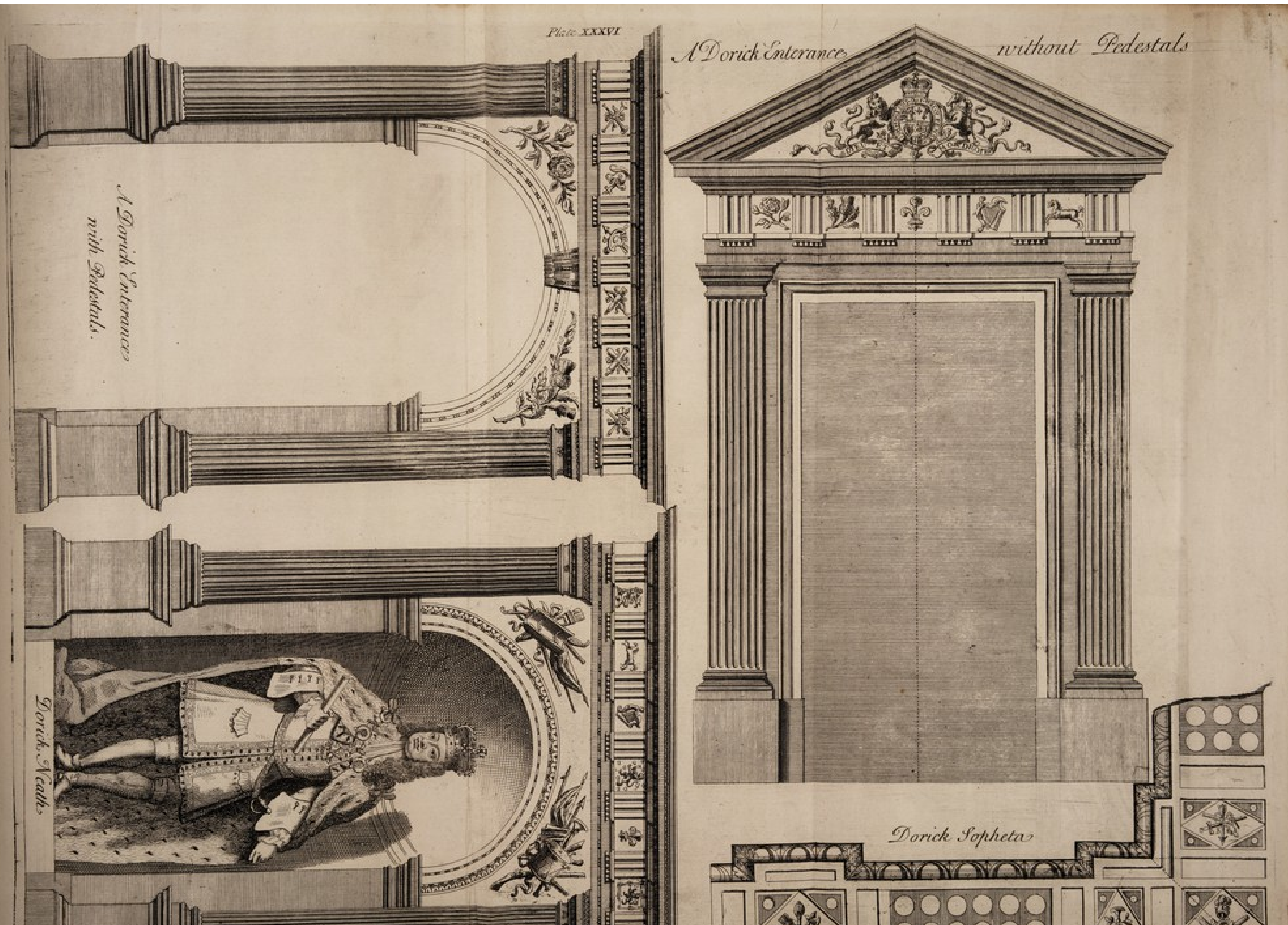


Plate XXXVI
A Dorick Enterance without Pedestals
A Dorick Enterance with Pedestals.
Dorick Niche
Dorick Sopheta

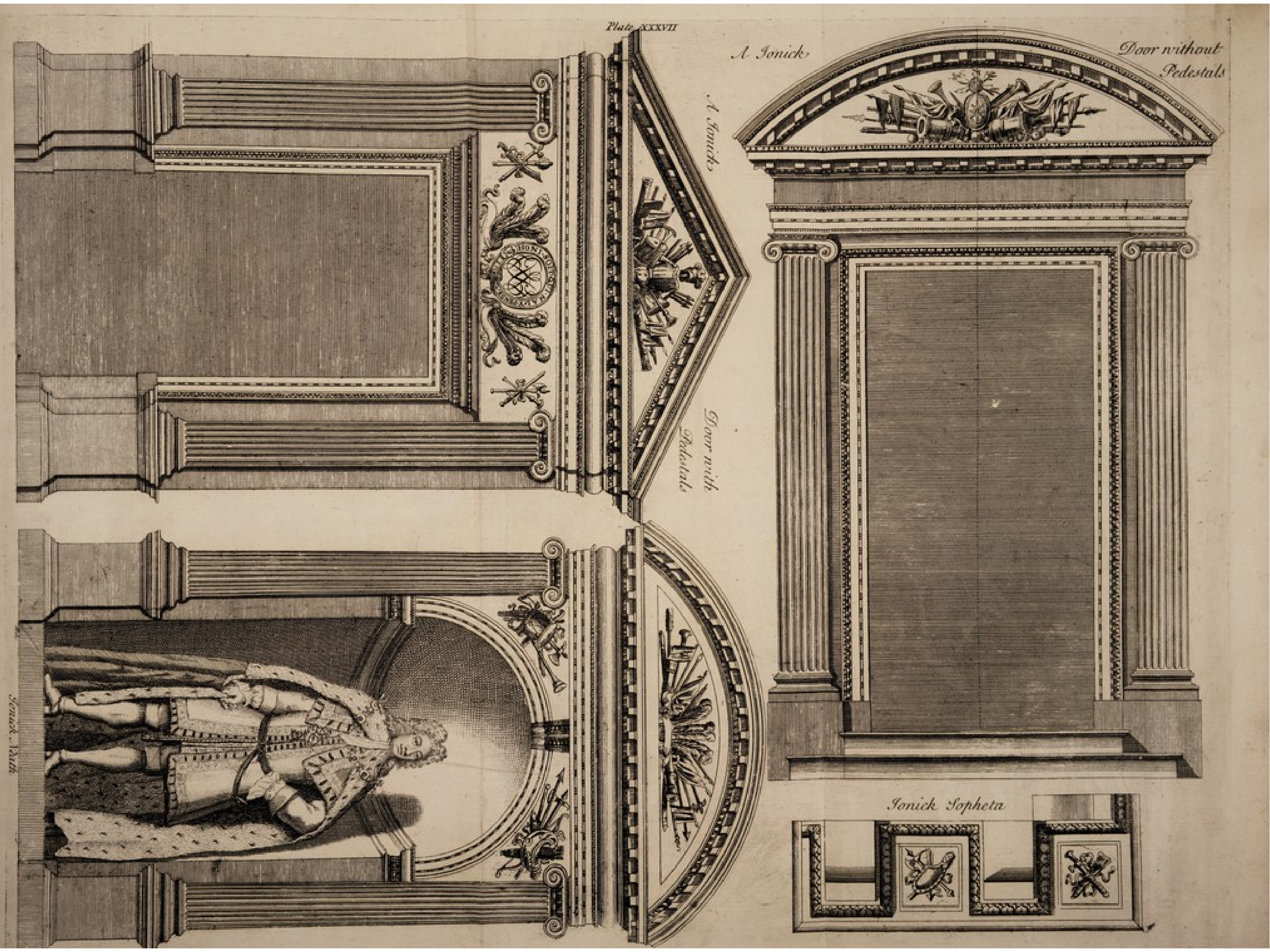


Plate XXXVII
A Ionick
Door with
Pedestals
A Ionick
Door without
Pedestals
Ionick Sopheta
Ionick Nich

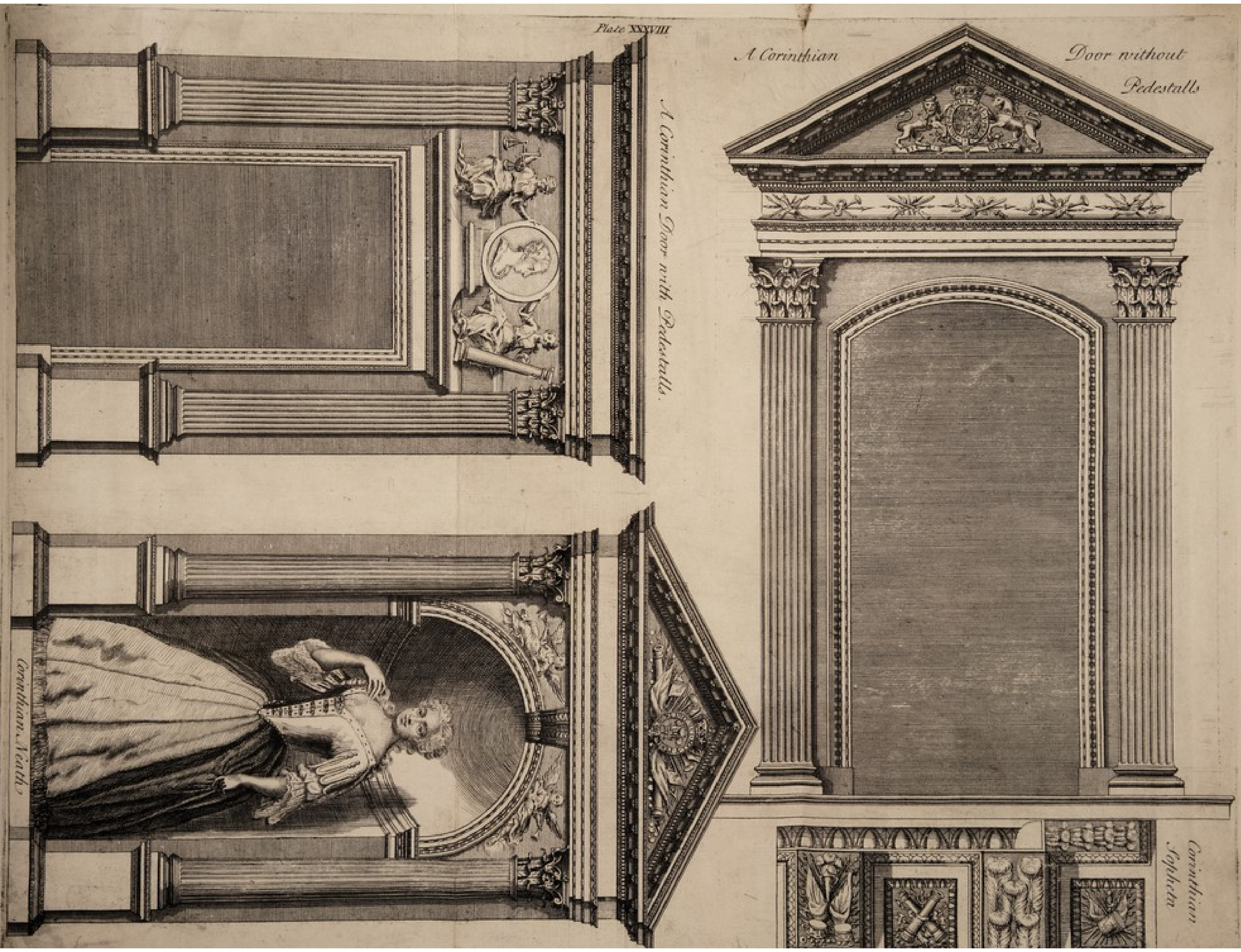


Plate XXXVIII
A Corinthian Door with Pedestalls.
A Corinthian Door without Pedestalls
Corinthian Niech
Corinthian Sophita

Plate XXXIX


An Enrichment for the Ionick Freize
An Enrichment for ye Corinthian Frieze

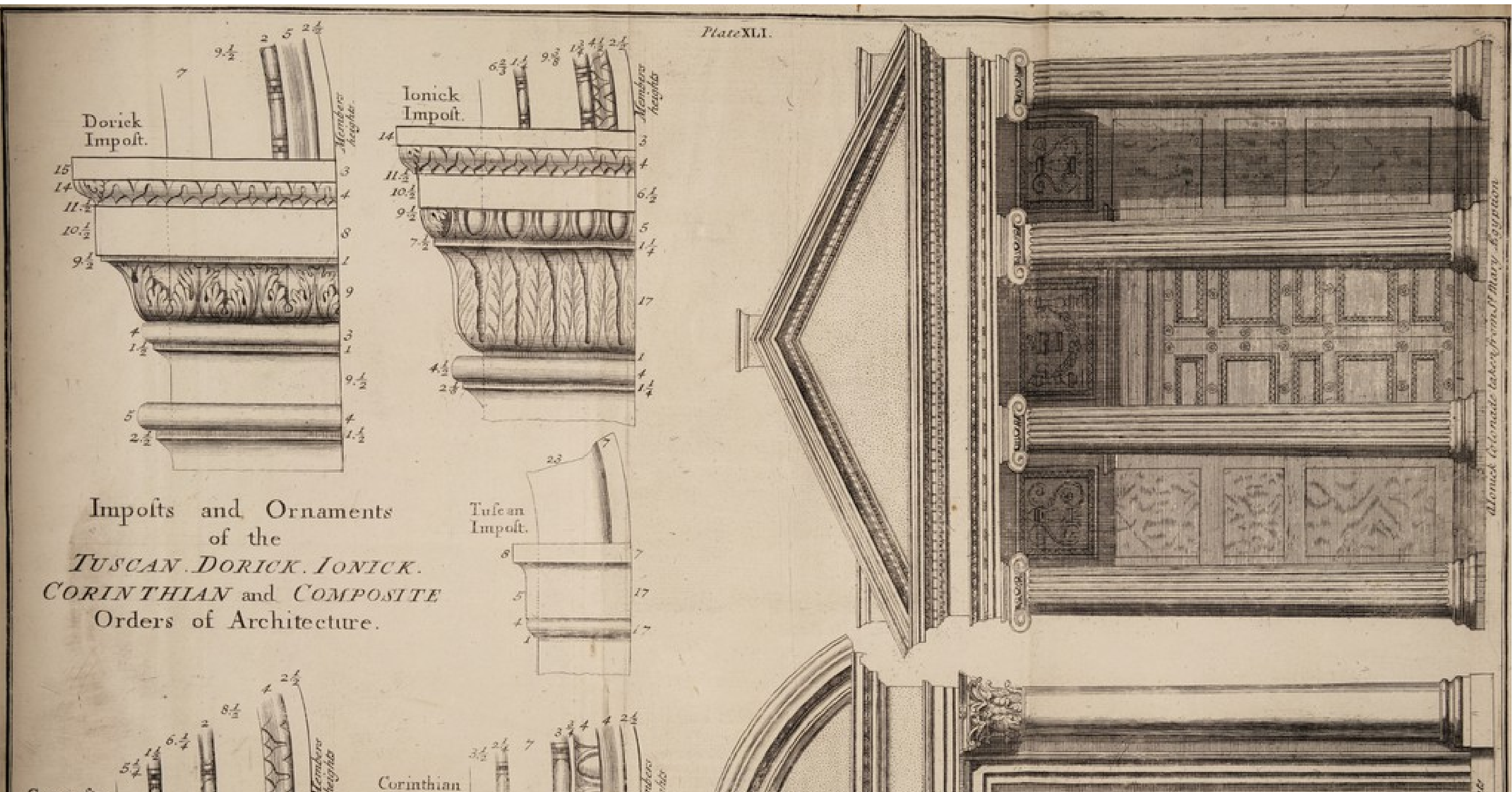


Plate XLI.
Dorick Impost.
Ionick Impost.
Members heights
Tuscan Impost.
Imposts and Ornaments of the
TUSCAN. DORICK. IONICK.
CORINTHIAN and COMPOSITE
Orders of Architecture.
Composite Impost.
Corinthian Impost.
A Ionick Colonade taken from St. Mary Egyptian
A Corinthian Door from the Ancients