

I. *A new Plotting-Table for taking Plans and Maps, in Surveying: Invented in the Year 1721. by Henry Beighton, F. R. S. Inscribed to the ROYAL SOCIETY.*

THE principal End and Design of Writing or Publishing, should be to convey down some useful Knowledge to the rest of Mankind, since it is what we are indebted, to communicate our Talents, in return for those Helps we have received from others.

Whoever writes on any of the practical Parts of the Mathematics, his chief End and Aim should be, at one or both of these Two Things, Certainty and Expedition, wherein consists the very Life and Beauty of a Science.

That Time and Observation have produced better Instruments or Improvements, is a Truth not to be denied; but at the same time that there may be new Instruments, and yet worse, is equally true: The eager Thirst after, and Humour for Things new, and in Vogue, have sometimes been the Occasion of rejecting some old Inventions, much superior to the new ones in Practice.

What I have to say on the Subject, and to make good what I have been aiming at, shall be in the practical Part of Surveying, *viz.* The taking of Plans or Maps. And here, perhaps, I may be thought to need an Apology, in seeming to propose a new Instrument, whilst I am blaming others for the same thing. But when I tell you mine is an old Instru-

s E

ment

ment improved; where I have obviated all the Difficulties that hitherto attended it; and made it to answer all the Objections that have been raised against it; and demonstrate that it is subservient to all Parts of the Art, for which such Instruments are designed; I may in some measure seem to be justified.

The Instrument is (what has been hitherto called) the *Plain Table*. One of the chief Objections against it was, the Difficulty in shifting of Papers; for you were almost necessitated, when you were at work on a Sheet in the Table, to put in all the Work that is to be contained thereon, (because it is very impracticable to put it on the Table in the same precise Position again) and this although it were with the utmost Inconveniency, in pursuing some grand Station, on circumscribing the Whole. This is entirely obviated; and I have remedied all the other Objections against it (as may be seen hereafter), in a very simple and easy Manner, which I contrived in the Year 1721. for making a correct Map of the County of *Warwick*; by which, with good Success and Expedition, I completed and published the same in the Year 1728. and call the Instrument *The Plotting-Table*.

Griff, July 14. 1739.

Henry Beighton.

A Description of the Plotting-Table.

IT is a plain smooth Board, about 18 Inches square, and Three-quarters of an Inch thick, as TAB. I. Fig. 1. *ABCD*, made of *Mahogany*, *Walnut*, *Pear-tree*, or *Norway Oak*, well clamped at the Ends,
or

or a brass Frame round it, to prevent its warping, and, as much as possible, shrinking and swelling.

Within Six-tenths of an Inch of Two of its opposite Sides (and parallel to them and one another) are Two Grooves *EF*, *GH*, cut on the Face half an Inch deep, to let in Two brass Holders in the Shape of *NO*, Fig. 2. which are each of one Piece of cast Brass, like Two brass Rulers, joined together at Right Angles. The perpendicular Part is One-tenth and Three hundredth Parts of an Inch thick, as at *d*, half an Inch deep, and a little shorter at each End than the upper Part, which is 17 Inches long, Three-tenths broad, and about Eight Parts of an hundredth of an Inch thick; about Two Inches and an half from each End of the Holder, are thick Parts or Bosses in the upright Piece, as at *P* and *Q*, through which are Holes tapped, to receive the Screws *PS*, *QR*, which Screws go each through a brass Plate as *T* and *V*, fixed by Rivets on the under Side of the Table, and little round Nuts (as at *a* and *b*) put on them, to confine them to their Shoulders in turning in the Plates, that they neither rise nor fall; these Holders must go easy in the Grooves, to sink easy and even with the upper Surface of the Table. Then, when the Screws enter the Holes of the Holders, by turning *R* and *S* at the same time forward, the Holders will fall, and pinch down any Papers, &c. that are under them; and, turning backward, will rise and release them. In the Middle of one End of the Table is a Groove to receive the Brass *W*, which has the same sort of Screw and Fixing as the other, to raise or fall it. But the Groove is quadrantal, that the Holder *W* may on Occasion be turned so as to lie all on the outside the

Line *EH*, and to cross it, in case of high Winds, for securing the Papers down, on Three Sides; and a Fourth might be added, but there is seldom any Occasion for it.

To the Centre of the Table underneath, is fixed a brass Socket, so truly made, that the Table may, when set, turn round truly horizontally: And a Machine, cased with Glass, in which a Plumbet hangs, to set the Table level; or the parallel Plates, and glass Tubes of Spirit of Wine, may be used, to set it horizontal, as any one sees Occasion to fancy them.

To any one of the Four Edges underneath, is screwed a Box and Needle, set to the Variation.

There belongs to this Instrument, a strong Three-legged Staff, and an Index with plain or telescopical Sights, near Two Feet long.

The Papers, or Charts, for this Table, are to be either a thin fine Pastboard, fine Paper pasted on Cartridge-paper, or Two Papers pasted together; cut as exactly square as is possible, each Side being nearly 16 Inches and an half long, just as they may slide in easily between the upright Part and under the flat Part of the Holders.

Any one of these Charts will be put in the Table any of the Four ways, be fixed, taken out, and changed at Pleasure: Any Two of them may be joined together true on the Table, if you make each of them meet exact at the Line *LM*, whilst near one half of each will hang over the Sides of the Table; or by creasing and doubling each, the Whole of them will be within the Table. And if Occasion should happen, as seldom it does, by creasing each Paper both Ways through the Middle; Four of them may
be

be put on at one time, meeting in the Centre of the Table.

Each Chart is always crossed by Right Angles through the Middle, for the Purpose above, and to make any of them answer to the Guide-Lines on the Table, Fig. 1. *IK, LM*, drawn quite through the Centre, and the whole Table.—So the grand Objection of shifting Papers is obviated.

Its Facility and Dispatch,

As also its Certainty, compared with any of the most celebrated Instruments, I shall now briefly set forth.

But, in order thereto, it may not be improper to to premise, or lay down, as *Lemmata*, these Three Things:

1. *The essential Business or Aim in surveying of Lands or Countries, is either to have an exact Plan, or to find the Area in some known Measure.*
2. *Every thing that is superfluous or foreign to such Design, is better omitted than taken.*
3. *If a true Survey, and exact Plan be made, every Part will have its just Proportion, and every Angle its true Opening or Quantity.*

Then what need have we of Degrees, Minutes, &c.? They are never made any Use of in the Practice of casting up, or any thing related thereto: For, if from a Station Two Lines be drawn by a good Index to Two distant Objects, will it not be
the

the very Angle, and identically the same, as if it had been taken by the most celebrated Instrument, in Degrees and Minutes, and laid down by a Protractor?

The first is much more expeditious, easy and certain, than the other. More expeditious, because those Two Lines are sooner drawn than an Angle can be taken, which done, Two thirds of the Work is behind, *viz.* Writing down and Plotting. More easy, as done with One-fourth of the Trouble. More certain, because one may be liable to Mistakes in taking the Degrees or Minutes; in setting down, and in protracting. And if it should so happen, that one numerical Angle should be taken, set down, or plotted to the wrong Coast, (where they depend on one another) so great an Error would ensue, that could not be retrievable, but by going on the Spot, and performing the Operation anew. Now the Plotting-Table, after Two Stations, proves every thing on the Spot; for, from every Station you are upon, the Index must point at the same time to any Station on your Map, and its corresponding Object in the Field; which is a demonstrative Proof, for nothing but Truth will agree.

In several Branches of the Mathematics, it is absolutely necessary to take Angles in Degrees, Minutes, and their Subdivisions, as Astronomy, Trigonometry, Navigation, Longimetry, inaccessible Heights and Distances, &c. and also in taking large Plans, to calculate and prove Things by Trigonometry; which would not only be a Work of Curiosity, but very commendable. But where the Nature of the Thing will admit of as good Proof, with One-tenth-part of the Trouble and Time; it would be like running the
So-

Solution of an easy Question into a long Process of Algebra or Fluxions, when the plain Rule of Proportion would justly answer the same.

It is objected, That, in surveying by the Plotting-Table, the shrinking or swelling of the Papers, are a great Inconveniency.

In Answer to this, it may be said, The same Inconveniency attends the surveying by any other Instrument, so soon as it is plotted; for both Velumn and Paper will shrink and swell in the House on the Alteration of Weather (as well as all Bodies); for a Line of 48 Chains, plotted by a Scale of 3.2 *per* Inch, in a hazy Morning, in a clear Afternoon the same Day, measured but 47 and an half: And there are various Shrinkings and Swellings, according to the Weather, and Difference of Paper, &c.

In the Plotting-Table this Inconveniency is in a great measure remedied. For in what State soever of the Weather you put Lines on the Chart, the Holders give Marks on the Chart as it then stood; if it was moist and swelled up in the middle Part, you may, when you either cast up or measure Lines, by laying it on a damp Floor, put it in the same Condition as it was when you plotted the Lines. If you plotted in dry hot Weather, and are casting up in damp or moist, a little heating by the Fire will reduce it to the same State again. Another Remedy I have long used is, to plot and measure by Scales of the same Paper, which will shrink or swell in proportion as your Map does.

But it will be well to observe here, that the Shrinking and Swelling alters the Lines only; and not at all the Angles: For, let a Polygon be never so much
uni-

uniformly extended or contracted, each Angle must contain the same Number of Degrees and Minutes as before. Hence this Objection falls no harder on the Table, than on all other Instruments.

And here I intended to have ended this Discourse: But as I have some other small Improvements, not only in the Instrumental Part, but in a new Method of disposing the Maps, and better adapting them to all subservient Uses; I proceed.

I should have said before, that each Chart has a *Flower de Lys* on its North Edge; and, as the Needle is moveable to any Side, Care must be taken, that the North End of the Needle, when it stands, should point the same Way as the *Flower de Lys* on the Charts.

I use a Needle about Five Inches long, placed in an oblong wooden Box, but just so wide as the Needle may play double the Degrees of the Variation West, viz. 30° . In the Middle of one End is the *Flower de Lys*, and the Box is by Studs and Holes always put on the Table oblique to the Quantity of the Magnetical Variation. I make no other Use of the Needle, than to set the Table in the Meridian, and to prevent any great Mistakes, in joining or placing the Charts wrong.

I have no more than half an Inch of the Needle that appears from under the Table, for the Reason it should not be in the Way, or so subject to be damaged: The making the Box so narrow, is to check its playing, that it may sooner hang still over the *Flower de Lys*. The wooden Box, lined with Paper, I find preferable to a large brass Box, and large Glass, which
in

in cold and hazy Weather, condenses the Vapour and Air so much, as to make the Needle very languid and dull.

Farther Uses, by taking a Survey in the new Method by the Plotting-Table.

The Charts, thus taken, are more readily laid together by Numbers on their Edges, which tally, and make up the whole Map in one Plan, or View, and are, in these Squares, more portable.

In the second Place, they are more readily copied, extended, or contracted. For, by having a Frame of Wood that just encompasses a Chart, divided by 19 Threads at equal Distances, and the same at Right Angles, the other Way; each Five or Ten, &c. being distinguished by Silk of a different Colour; a Rect is made of 400 Geometrical Squares, from which, having a Velumn or Paper so divided by lesser or greater Squares; then drawing or copying by Help of the Lines into those new Squares, you have your true Map contracted or extended.

Large Maps of Lordships are not any ways convenient, or portable, to have recourse to on the Spot or Place they represent; being subject to Damages; unfit to be opened in rainy Weather, very troublesome in the Wind, and very difficult to find out the Part you want. To remedy all these Inconveniences, some Years ago I contrived a new Method of disposing them, in such Manner as makes them more sure, safe, ready, convenient, durable, and portable, than any other Method.

And this is done by imitating the Geography of the World, which first gives the Whole, then the severall Kingdoms, Countries, Provinces, and minuter Parts and Divisions, severally and more at large.

First, It will be highly necessary, that a *General Map* of the whole Lordship (Country, &c.) be drawn in one Sheet of Paper or Velumn, to give the Form, Idea, and Proportion, that the Parts bear to the Whole, and one another; by which Situations, Bearings of the Towns, Villages, Roads, and remarkable Places, will be seen at one View: And this must be reduced to so small a Scale, as the intended Sheet may comprehend the Whole. A Scale of about 11 or 12 Chains in an Inch, will plot a Lordship of more than 2000 Acres, in the Compass of 16 Inches and One quarter Square; which may be a convenient Size to make Two Leaves, and open in a Folio Book. This Map may express the Roads, Rivers, Streets, Boundaries, Inclosures, and common Field Lands singly, in case they be not less than 40 or 50 Links in Breadth: The Pieces that contain not less than about 10 Acres, will admit of Room to write the Owners Names and Quantities in Statute Measure, as in Fig. 4. But for all the small Parts, there will not be room to explain them: Therefore—

I divide the general Map into as many Geometrical Squares, as it took Charts in surveying by the Table, by red Lines, as in Fig. 3. horizontally and perpendicularly, as noted by 0,0,0,0, &c. which, by a Scale of 32 *per* Inch, may take about 15 Charts in Number: In the openest Place near the Middle of each Square, in a small Circle, I number them with red Figures 1, 2, 3, &c. corresponding to the original Charts:

Charts: And in the Middle of each of their Sides, Numerical Letters, shewing how the particular Maps are to join to each other.

The particular Maps are each as large as the general, and numbered at the Top I. II. III. &c. corresponding to the Squares in General, as Fig. 4. where, in the Right Hand Margin, is put V. and at the Bottom IX. shewing the Fifth Map tallies to the Side, and the Ninth to the Bottom, or South Part: The general Map being an Index, shewing how they join to each other.

By these particular Maps may be shewn all the lesser Quantities, with their Tenure, Owners Names, and Contents; and, by the Scale, are capable of shewing the Lengths of any Lines, and the Dimensions, so as to discover any Encroachments, and record their Shape and Extents to Posterity: A most valuable Use of a Survey and Map.

All these Maps are bound up in Order, in a Folio Book, to open freely, which will be not only very portable, but useful to have recourse to on any Occasion; secure from Damages of Weather, as well as more durable and ornamental.

The Terriers to these Maps are made in the following Manner; either bound in a Book of a Pocket Size by themselves, or along with the Maps.

The Names of the Freeholders, Copyholders, Cottagers, Tenants, &c. are put in an Alphabetical Order.

The Power.

Refer. to the Map.	The Names of the Lands, their Situations and Boun- daries.	Tenure	Free- hold			Copy- hold		
			a	r	p			
IV. f. 4.	<i>Calmer-Close</i> in the Village of <i>B.</i> —the Parish of <i>Guine</i> <i>W. Townsend</i> E. Own S.	Freehold	11	1				
IV. f. 6.	The House and Home stead called <i>Broadmoor</i> <i>Horse Close</i> W. Own E. N. S.	Copyhold				18	2	28
IV. e. 6.	<i>Horse Close</i> <i>Guinne</i> W. <i>Broadmoor</i> E. <i>Pitts</i> N. S.	Freehold	17	1	6			

In this like Manner, under every different Name, may all the Parcels be expressed separately.

To find any Piece or Parcel of Land in the Lordship readily, first find the Tenant's or Owner's Name in the Alphabetical Order, under which, in the Second Column, may the Parcel be found. The Third shews whether it is Free or Copyhold; the Fourth or Fifth, the Quantity in Statute Measure, either Free or Copyhold.

The numerical Letter in the Margin on the Left IV. shews it is in the Fourth particular Map; f. 6. refers to the Parts of the Map; find f. at the Top, and 6 on the Left Side, and in the Angle of meeting of those Squares is the House, Close; and so for any other.

There is but one Objection I can at present foresee, that can bear any Weight against this Method of dividing the general Map, *viz.*

That by dividing the same into geometrical Squares, many of the Parcels, Lands and Grounds, will be cut into Two separate Pieces; one Part whereof will lie in one particular Map, and the rest in

in another; as in Fig. 4. Map IV. Part of *Calmer* and *Broad-Close* will be in the Vth Map.

In this Case, it is usual to put the Owner's Name, and Quantity, in that which is the greater Part, and in the Terrier refer also to the Remainder; where, if the Shape, Lengths, &c. are required, they may be discovered.

But as this may not be satisfactory, or fully answer the Objection; the Two following Methods will intirely obviate the Difficulty, and make them as fully subservient to all Purposes, as any large and intire Map on one Piece.

1. The first Method is, to take just so much in a particular Map as is circumscribed by some known Roads, Lanes, Brooks, Boundaries of particular Owners or Tenants Lands: This, indeed, will often make the Map very disproportional, and irregularly shaped; but cannot be a material Objection, by reason, in Surveys, there is seldom any thing regularly shaped.

2. The second Method is, to have a wider Margin, or rather draw the particular Maps by a smaller Scale, as Four Chains in an Inch, instead of Three Chains 20 Lines; and that will allow Room to add the Parts of the Parcels so cut off in the Margin, as in Fig. 5. the IVth particular Map varied, where the Whole of *Broadmoor* and *Calmer* is drawn; then in the Vth and IXth particular Map, may the small Parts, which are in the IVth, be drawn in full: Then will they join by indenting or tallying one into another.

To reduce a Scale to fit exactly your general Map.

First see what Extent the whole Survey takes on the Charts you laid it down by in the Field, *viz.* the greatest Depth and Breadth, as from the Specimen of the general Map it may appear.

Depth	Breadth
On the upper Chart is N ^o 2. = 10 Inches.	N ^o 8. = 5 Inches.
N ^o 6. 16 $\frac{3}{4}$ $\frac{1}{2}$	N ^o 9. 16 $\frac{1}{4}$ $\frac{1}{2}$
N ^o 11. 16 $\frac{1}{4}$ $\frac{1}{2}$	10. 16 $\frac{1}{4}$ $\frac{1}{2}$
N ^o 13. 10 $\frac{1}{2}$	11. 16 $\frac{1}{4}$ $\frac{1}{2}$
<hr style="width: 100%; border: 0.5px solid black;"/>	7. 6 $\frac{1}{2}$
The Whole	The Whole
53 $\frac{1}{4}$	60 $\frac{1}{2}$ $\frac{1}{2}$ qr.

Then having fixed on the Size of the general Map to be 16,37 Square, I form a Scale of 60 $\frac{1}{2}$ *per* Inch, that may just extend the whole Breadth of the 16,37 Inches; by which you may form all the Squares, and Parts of Squares, in Depth and Length, as above; and at Fig. 3. is divided,

The Breadth of the whole Map, by a Scale of 32, is 60,62 Inches, which I would reduce into the Compass of 16 $\frac{1}{4}$ and $\frac{1}{2}$ = 16,37 Inches.

Divide 60,62 by 16,37, gives 3.7, which multiplied by 3,20, makes the Product 11,84, that is 11 Chains 84 Links in an Inch, the Scale for the general Map.

Thus have I done all I intended; but shall observe, that several of these Tables have been made, and, as People have fancied, with Alterations and Additions; but all Variations are not really Improvements. The setting it horizontally by Spirit— Tubes, may be curious enough: But as the Difference is very inconsiderable and indiscernible, when it stands Two

or

or Three Degrees out of the Level, I shall not trouble myself or others about it; only further observe, that when Grounds are declining much, and very uneven, if the Table stands horizontal, unless the Sight or Mark on the lower Part is so high as its Top makes a Level with the upper Part of the Table, which is seldom done, or practicable, I do not see why such a Stress should be laid on the Instrument's being level, when neither the View by the Index, nor the Measure of the Line, either can be, or is taken horizontally: If the Sight of the Index stand nearly perpendicular at every Observation, it is more than sufficient for any Exactness requisite in a Survey.

II. *A Letter from Richard Richardson, M. D. and F. R. S. to Sir Hans Sloane, Pr. R. S. &c. inclosing a Paper from William Wright, Surgeon, concerning a large Piece of the Thigh-bone, which was taken out, and its Place supplied by a Callus.*

SIR,

I Take this Opportunity of inquiring after your Health by my Son, who waits upon you with the inclosed, and Part of the *Os Femoris* accompanying it [see TAB. I. Fig. 6.]. As the Case appeared to me something remarkable, I thought proper to communicate it to you. It was drawn up by Mr. *Wright*, a Surgeon, in *Bradford*, in the West-Riding of this County, who performed the Cure; and a few Days ago,

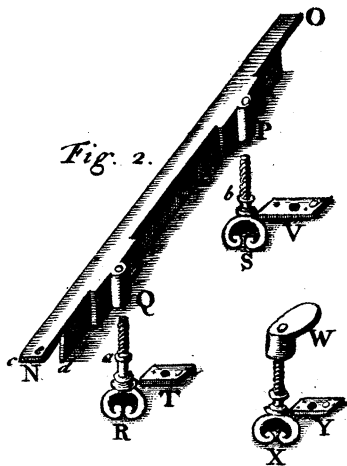
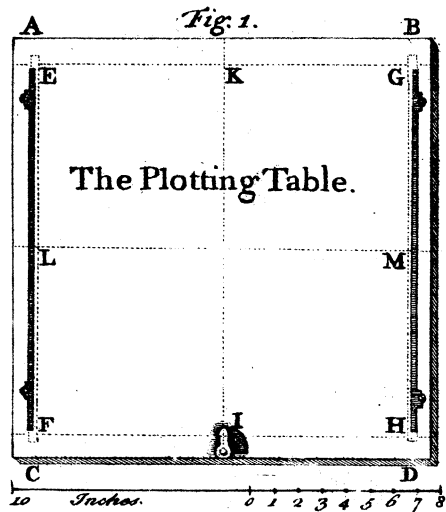


Fig. 6.

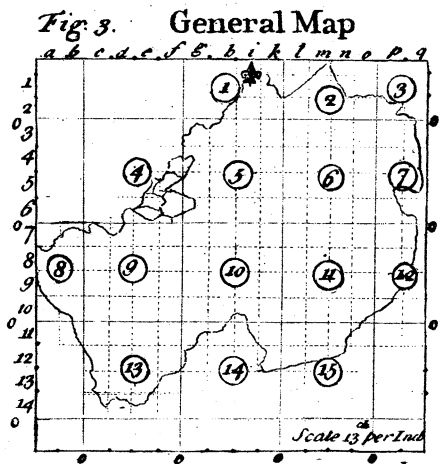
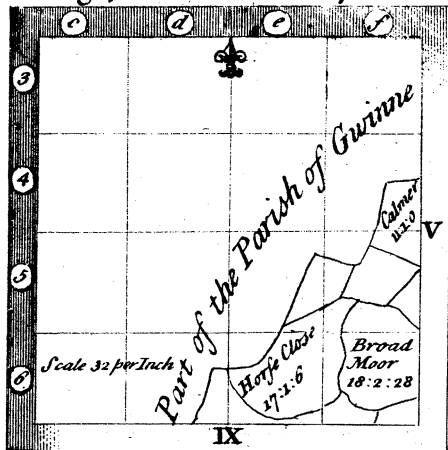


Fig. 4. Particular Map N^o IV.



Particular Map N^o IV Varied

Fig. 5. c d e f

