A Breviate of Monsieur Picarts *Account of the Measure of the Earth.*

THIS Account hath been printed about two years since, in *French*; but very few Copies of it being come abroad, (for what reasons is hard to divine;) it will be no wonder, that all this while we have been silent of it. Having at length met with an Extract thereof, and been often desired to impart it to the Curious; we shall no longer resist those desires, but faithfully communicate in this Tract what we have received upon this Argument from a good hand.

The Author then, whose name is not prefixed to the Book (though generally 'tis thought to be the Intelligent and Learned *Picartus*, an Eminent member of the Royal Academy of the Sciences at *Paris*,) divides his Treatise into 13. Articles; of which we shall first of all represent the sum, as 'twere, in one view; and then, for the satisfaction of the more curious, deliver the Breviat of every Article.

The Sum then of the whole amounts, in short, to this; That the French Author hath found 57060 toises or fathoms for one degree, that is, $28\frac{1}{2}$ leagues and 60 toises; which being multiplyed by 360 (the number of the degrees) makes 10270 leagues and 1600 toises, reckoning 2000 toises to a league, or 2400 paces, 5 foot to a pace. The Method employ'd by him hath been, To measure on a plain and straight ground a space of 5663 toises, to serve for the first *basis* to divers Triangles, by which he hath concluded the Length of a Meridian line to be equivalent to a degree. That which is remarkable for the certainty of this Observation, is, 1. That no body, we know of, hath ever measur'd so great a *basis*; the greatest of the former Observations having been but of a 1000 toises. 2. That here have been emploied, for taking the Angles of position, very accurate Instruments, and Telescopical Sights instead of common ones; all described in the said Book: of which we shall now proceed to deliver the import of every Article.

In the *first* then, he begins with a Preamble, shewing, that this Probleme concerning the Just Dimensions of the *Circumference of the Earth* is no New thing, but hath been the Inquiry of several Ages, in which Princes have been curious, and Learn'd men encouraged to the search and clearing of this Difficulty. And to

Mm this

this purpose he alledges a passage out of *Abulfeida*, to this effect, that *Almamon*, a Prince of the *Arabes*, desirous to know, what the True measure of a Celestial *Degree* might be upon Earth, commanded the Experiments to be made in the Plains of *Sanjar*; where a Station being chosen, and thence Troups of Horsemen let out, that went in a straight line, till one of them had raised a degree of *Latitude*, and the other had deprest it; at the end of both their marches, they who raised it, counted $56\frac{2}{3}$ miles, and they who deprest it, reckon'd 56 miles just. This Observation can instruct us but very little, because we know not justly, of what length these miles were. Then, the Author observes, that the Ancient computations of miles for a Degree run alwayes upon the decrease; so as *Aristotle* counting to a Degree 1111 *stadia*, after him *Eratosthenes* counted but 700; *Possidonius* but 666; *Ptolomy* but 500. Nor do these Observations teach us any thing certain, because the precise length of these *stadiums* is unknown to us; and they were also different among themselves; the *stadia* of *Alexandria* differing from those of *Greece*. At last *Fernelius* brought it to 56746 *Toises* or Fathoms of *Paris*, each of which is equal to 6 *Parisian* feet; *Snellius*, to 55021.

In the second *Article*, he judges *Snellius* his way of measuring to be the most artificial; which was by a *Scale* of *Triangles*. But in one thing he esteems it deficient, which is, that *Snellius* took his Object only by Pinnules, or Common Sights, which do not so distinctly point it out.

In the *third* Article he begins to speak of his own Method, and its exactness, and saith, That, when the resolution was taken of *Measuring a Degree*, he chose his *Meridian*, out of which he intended to take his Measure, between *Sourdon* in *Picardy*, and *Malvoysin*, which is upon the confines of the *Gastinois* and *Hurepois*. To attain the exact Measure of this Arch of the Meridian, lying between *Sourdon* and *Malvoysin*, he saith, he actually measur'd a way that lay very straight, between *Villejuifve* and *Ivoisy*, viz. A.B.; And he began to measure from the middle of a Mill at *Villejuifve*, and continued till he came to the Pavillon of *Ivoisy*, and found the distance between these two termes, in going forward, to be 5662 toises and 5 feet, and in comming back, 5663 toises and 1 foot; which being measured with great exactness, he stated the distance between these two places, in round reckoning, 5663 toises.

See Fig. 1. Tab. 1.

The

The Inſtrument he meaſured with, was Pikes joyned together at their ends by a ſcrew, which meaſure was 4 toiſes long: This he applied along a cord ſtretched horizontally, and at the end of every ſuch Pike had a ſtake; of which ſtakes he had 10 in all. This diſtance of 5663 toiſes was the Baſe of the *firſt* Triangle, upon which the meaſure of all the depending ſcale was formed.

Here in *Art.*4. he takes occaſion to diſcourſe of *Meaſures* in general, and ſaith, That a *Pendul* vibrating a *ſecond* of time, computed according to the *Mean* motion of the Sun, is 36 inches and $8\frac{1}{2}$ lines of the Chaſtelet of *Paris* meaſure. And he eſteems, that this Meaſure may probably ſerve in all Countries, becauſe the ſame Length of a Pendul ſerved for a *Second* both at the *Hague* and *Paris*; whence he conjectures, the ſame may ſerve alſo in other Latitudes. Whereupon he inferrs, that if one had a mind to conſtitute an *Univerſal Meaſure*, which might be common to all Countries, it might be thus made, *viz.*

Call this Pendul for *ſeconds* (of 36 inches and $8\frac{1}{2}$ lines) the Aſtronomical *radius*; the $\frac{1}{3}$ of this *radius* the *Univerſal foot*; the double of which *radius* might be called the *Univerſal Toiſe* or Fathom, which would be to the *Pariſian Toyſe* as 881. to 864; the Quadruple might be called the *Univerſal Perch*, which is equal to the length of a Pendul for *two* ſeconds. In a word, the *Univerſal Mile* might contain a 1000 of theſe Perches.

The Inſtrument, (in *Art.*5.) wherewith the Angles were taken in the Menſuration of the Triangles, was a Quadrant of 38 Inches *radius*, furniſh't with Teleſcopical-glaſſes, the better to point out the Objects: Which Inſtrument, he ſaith, never miſs'd a minute in taking an Angle; ſometimes it came within *five* ſeconds.

But to proceed; In the *ſixth* Article he relates the Manner of taking the Diſtance between *Sourdon* and *Malvoyſin*, together with the Triangles, and the Stations from whence he obſerv'd his Angles. This diſtance is 68343 toiſes and 2 feet.

The *Baſe*, which he actually meaſur'd, as we ſaid above, was AB, the high way lying between *Villejuifve* and *Ivoiſy*, which he found, (as hath been already intimated) equal to 5663 toiſes of *Paris*. And from this Baſe he deduced the meaſure of all the 13 Triangles, *viz.*

In the *first* Triangle ABC, to find the ſide AC, BC.

Angles	CAB=	54°.	4′.	35″.
	ABC=	95.	6.	55.
	ACB=	30.	48.	30.

	Toiſes.	Feet.
The Side AB is	5663.	of actual meaſure.
Hence AC is	11012.	5.
BC	8954.	0.

In the *ſecond* Triangle, ADC, to find DC and AD.

Angles	DAC=	77°.	25′.	50″.
	ADC=	55.	0.	10.
	ACD=	47.	34.	0.

	Toiſes.	Feet.
The Side AC is	11012.	5.
Hence DC	13121.	3.
AD	9922.	2.

In the *third* Triangle, DEC, to find DE, CE.

Angles	DEC=	74°.	9′.	30″.
	DCE=	40.	34.	0.
	CDE=	65.	16.	30.

	Toiſes.	Feet.
The Side DC	13121.	3.
Hence DE	8870.	3.
CE	12389.	3.

In the *fourth* Triangle, DCF, to find DF.

Angles	DCF=	113°.	47′.	40″.
	DFC=	33.	40.	0.
	FDC=	32.	32.	20.

	Toiſes.	Feet.
The Side DC	13121.	3.
Hence DF	21658.	0.

In the *fifth* Triangle, DFG, to find DG, FG.

Angles	DFG=	92°.	5′.	20″.
	DGF=	57.	34.	0.
	GDF=	30.	20.	40.

	Toiſes.	Feet.
Side DF	21658.	0.
Hence DG	25643.	0.
FG	12963.	3.

In the *sixth* Triangle, GDE, to find GF.

The Angle GDE = 128°. 9′. 30″.

		Toises.	Feet.
The Sides	DG	25643.	0.
	DE	8870.	3.
Hence	GE	31897.	0.

So then, the Line of Distance between *Malvoysin* and *Sourdon* being divided into three parts, *viz.* EG, GI, IN, the part EG is already found.

In the *seventh* Triangle FGH, to find GH.

Angles FGH = 39°. 51′. 0″.
FHG = 91. 46. 20.
HFG = 48. 22. 30.

		T.	F.
The Side	FG	12963.	3.
Hence	GH	9695.	0.

In the *eighth* Triangle GHI, to find GI, IH.

Angles GHI = 55°. 58′. 0″.
GIH = 27. 14. 0.
IGH = 96. 48. 0.

		T.
The Side	GH	9695.
Hence	GI	17557.
	HI	21037.

Thus the *Second* part of the Three, *viz.* GI, is found.

In the *ninth* Triangle HIK, to find IK.

Angles HIK = 65°. 46′. 0″.
HKI = 80. 59. 40.
KHI = 33. 14. 20.

		T.
The Side	HI	21043.
Hence	IK	11678.

In the *tenth* Triangle IKL, to find KL, IL.

Angles LIK = 58°. 31′. 50″.
IKL = 58. 31. 0.

		T.	F.
The Side	IK	11683.	0.
Hence	KL	11188.	2.
	IL	11186.	4.

In

In the *eleventh* Triangle KLM, to find LM.

Angles { LKM=28°. 52′. 30″.
KML=63. 31. 0.

	T.	F.
The Side KL	11188.	2.
Hence LM	6036.	2.

In the *twelfth* Triangle LMN, to find LN.

Angles { LMN=60°. 38′. 0″.
MNL=29. 28. 20.

	T.	F.
The Side LM	6036.	2.
Hence LN	10691.	0.

In the *thirteenth* Triangle ILN, to find NI.

The sum of the Angl. IKL, KLM, MLN, taken from 360, there remains Angle ILN=119°. 32′. 40″.

	T.	F.
The Sides { LN	10691.	0.
IL	11186.	4.
Hence IN	18905.	0.

Thus, the Line of Diſtance, EN, being, as hath been ſaid, divided into three unequal parts, EG, GI, IN, the meaſures of all three are found by this Scale of Triangles.

Now then, reaſſuming what hath been already diſcover'd by the help of theſe Triangles, and finding, that

	Toiſes.
EG was in length	31897.
GI	17557.
IN	18905.

Theſe added together, make the length of EN, which is the Line of Diſtance between *Malvoyſin* and *Sourdon*, viz. 68359.

Now to continue this meaſure from *Sourdon* to *Amiens*, (which is the buſineſs of the *ſeventh* Article, undertaken to the end that *Fernelius* his account might be liquidated, whether it were true or no;) you muſt, for the attaining it, make uſe of the Diagram of Fig. 2; where R. ſtands for the Steeple of St. *Peters* in *Montdidier*; T. is a Tree upon the Hill of *Mareuil*; V. is the Lantern of *Noſtre Dame* of *Amiens*.

To find the diſtance NV, you muſt look back upon NLM, the laſt Triangle of Fig. 1, and ſee, how it is diſpoſed in Fig. 3; where in the Triangle LMR,

The

The Angles { LMR = 58°. 21'. 50". MRL = 68. 52. 30.

	T.	F.
The Side LM	6037.	0.
Hence LR	5510.	3.

In the Triangle NRL,

The Angles { NRL = 115°. 1'. 30". RNL = 27. 50. 30.

	T.	F.
The Side LR	5510.	3.
Hence NR	7122.	2.

Go on to Fig. 2. in the Triangle NRT.

The Angles { NTR = 72°. 25'. 40". TNR = 67. 21. 40.

	T.	F.
The Side NR	7122.	2.
Hence NT	4822.	4.

Finally in the Triangle NTV,

The Angles { NTV = 83°. 58'. 40". TNV = 70. 34. 30.

	T.	F.
The Side NT	4822.	4.
Hence NV	11161.	4; which was sought.

	T.	F.
Now, adding the Dist. between *Malvoysin* & *Sourdon*, *viz.*	68359.	0.
to the distance between *Sourdon* and *Amiens*	11161.	4.
The whole will be the dist. between *Malvoysin* & *Amiens*	79520.	4.

Having thus measured the particular distances between *Malvoysin*, *Mareuil*, *Sourdon*, and *Amiens*, he proceeds to examine, in the *eight* Article, the Position of each of these Lines of distance in respect of the *Meridian*, or to deduce the Length of the Meridian intercepted between the Parallels of *Malvoysin* and *Amiens*: Which was thus done;

In *Septemb.* 1669. he went to the Hill of *Mareuil*, and from the top of it, which is mark't with G in *Fig.* 1. (from whence one can discern *Clermont* on one side, at I, and *Malvoysin* on the other side, at E.) he took the *Meridian*, and with a Quadrant took the Angles of Declination from this Meridian. The manner he relates at length; the result whereof is, That by these Observations he found,

	gr.	′	″
The Angle EGε in *Fig.* 1, which is the Declination of EG from the Meridian westward	0.	26.	0.
The Angle GIθ, which is the Declination of G I from the Meridian Eastward	1.	9.	
The Angle INV, which is the Declination of IN from the Meridian Eastward	2.	9.	10.
The Angle VNβ in *Fig.* 2. which is the Declination of NV from the Meridian Westward	18.	55.	0.

So that in all these 4 Triangles, EGε, GIθ, INV, VNβ, you have two Angles known (for the Angles at ε, at θ, at V, at β, are right,) and a side, *viz.* EG. GI. IN. NV. whene he concludes,

	Toises.	Feet.
The length of the Meridian Gε to be	31894.	0.
of the Meridian I θ	17560.	3.
of the Meridian NV	18893.	3.
of the Meridian N β	10559.	3.
And hence the length of the whole Meridian α β between the Parallels of *Malvoysin* and *Amiens* to be	78907.	3.

Here he casts in an Objection, and saith, that these Lines, which make up the Meridian, are not, in a strict sense, a Curve, but in reality the side of a Polygone circumscribed about the Circumference of the Earth. But, for answer to this, he affirms the Difference between those Lines and a true Curve to be but 3 foot *per* degree, which he saith is scarce worth taking notice of. This he proveth afterwards, where he makes the Table, in which he calculates, what difference there is between the real Level and the apparent.

To this he subjoyns a Note, importing, that though he took these Meridians, for greater exactness, with a Quadrant; yet he omitted not to use a Compass, whose Declination to the *Westward*, he saith, in the Year 1670, towards the end of the Summer, he found 1°. 30′.

Whereas *A.* 1666. he observed very little variation, if any at all.

But *A.* 1664. it varied *East-ward* 0. 40.

Here he makes a pretty Note, telling us, that the Difference of Variation in a years time amounts to 0. 20′.

The Length of the Meridian between *Malvoysin* and *Amiens* being thus stated, his next business is, in the *ninth* Article, to enquire, What answers to it in the Heavens, comparing those Meridian distances, already measur'd, with *Minutes* and *Seconds* there: which

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were taken by the help of an Instrument, whose Limb was an Arch of $\frac{1}{20}$ of a Circle of 10 foot *radius*; whereof he gives the *Figure*, and his manner of rectifying any Errors, which in using it might deceive him.

In the *tenth* Article he relates, that the *knee* of *Cassiopeia* was the Starr he pitch't on, from whence to measure the *Minutes* and *Seconds* of a Degree in the Heavens; adding the reasons, why he chose that Starr.

In the *eleventh* he gives the resolution of the thing in Question, that is to say, How many Toises or Fathoms, *Parisian* measure, answer a *Degree* of the *Circumference* of the *Earth*; as for instance, the Difference of Latitude between *Malvoysin* and *Sourdon* is found, by Observations made in the Heavens, to be 1°. 11'. 57".
Between *Malvoysin* and *Amiens* 1. 22. 55.

Now, the Meridian distance between *Malvoysin* and *Sourdon*, calculated from Measures taken upon Earth, was, as may be seeen above; Toises. 60430. Feet. 3.

Whence 'tis concluded, that 57064 Toises and 3 feet, or, in a round number, 57060 Toises are equal to a *Degree*.

Which if you would reduce to *Universal Measure*, you are to remember, that the *Universal* toise is to the *Parisian*, as 881 to 864: Whence one Degree is equal to 55959 Toises *Universelles*.

The Reduction of which to the measures of other Countries is this;

	parts.
Suppose the *Paris* foot to consist of	1440.
The *Rhynland* (or Leyden) foot, contains of these	1390.
The *London*-foot	1350.
The *Bolonian*-foot	1686.
The Braccia of *Florence*	2580.

Hence a *Degree* in a grand Circle of the Earth, according to the Measures of different Countries, is,

Toyses du Chastelet de Paris	57060.
Pas de Bologna	58481.
Verges du Rhin *de* 12 *pieds chacune*	29556.
Lieuës Parisiennes de 2000 *Toises chacune*	$28\frac{1}{4}$.
Lieuës moyennes de France d'environ 2282 *Toises*	25.
Lieuës de marine, *de* 2853 *Toises*	20.
*Milles d'*Angleterre, *de* 5000 *pieds chacune*	$73\frac{7}{100}$.
Milles de Florence, *de* 3000 *brasses*	$63\frac{7}{10}$.

Nn Hence

Hence the *Circumference* of the *Earth*,

In Parisian Toises or Fathoms	20541600.
In Leagues of which 25 make a Degree	9000.
In Marine Leagues	7200.

The *Diameter* of the *Earth* is,

In Parisian Toises	6538594.
In Leagues of 25 to a Degree	$2464\frac{56}{71}$.
In Marine Leagues	$2291\frac{19}{71}$.

He also gives a Table, shewing the Correspondent value in measure to the parts of a Degree: E. g.

Min.	Toises.	Second.	Toises.
1 =	951	1 =	16.
2 =	1902	2 =	32.
60=	57060	60=	951.

After this follows a Table of the Difference of Latitude, which is

Between *Malvoysin* and the *Observatoire* of *Paris*		19'. 22".
Between *Malvoysin* and *Nostre Dame de Paris*		20. 22.
Between *Malvoysin* and	*Mareuil*	33. 32.
	Clermont	52. 0.
	Sourdon	71. 52.
	Nostre Dame d' Amiens	82. 58.
Between *Nostre Dame* of *Paris* and of *Amiens*		62. 36.

Then follows a Table of Elevations of the Pole of several places, as

The Elevation of the Pole	In the Garden of the R. Academy at *Paris* is,	48°. 58'. 0".
	At *Nostre Dame de Paris*	48. 52. 10.
	At St. *Jaques de la Boucherie*	48. 52. 20.
	At *Malvoysin*	48. 31. 48.
	At the *Observatoir* of *Paris*	48. 51. 10.
	At *Marevil*	49. 5. 20.
	At *Clermont*	49. 22. 48.
	At *Sourdon*	49. 43. 40.
	At *Nostre Dame d' Amiens*	49. 54. 46.

As

As to Differences of Longitudes;

Sourdon	more Easterly then	*Amiens*	by	0°.	5'.	54''.
Clermont		*Sourdon*		0.	1.	9.
Mareuil		*Clermont*		0.	0.	34.
Mareuil		*Malvoysin*		0.	0.	20.
Mareuil		*Paris*		0.	4.	37.

So much of the *eleventh* Article. The *twelfth* is framed upon an *Objection*, that might be made, *viz.* Whether the Meaſure is the ſame taken at *Paris*, with that which is taken upon a Level by the Sea-ſide. Here he computes upon the fall of the River *Seine*, and judgeth the place where he meaſured to be raiſed above the Sea not more then 80 Toiſes; and concludes the Difference between meaſuring at *Paris* and by the *Sea* not above 8 feet *per* degree. Where he makes a Table of *Levels*; deſcribes an Inſtrument to take Levels with; diſcourſes of Refractions, and how to correct them.

In the *thirteenth* Article he examins ſeveral opinions, different from his, concerning this ſubject; as of *Fernelius*, *Snellius*, and *Riccioli*; and points at the occaſions of their reſpective miſtakes; delivering withal the Differences of their Meaſures from his. Of the three, *Fernelius* comes the nigheſt; which M. *Picart* imputes to meer chance, ſince he uſed not half the exactneſs in obſerving that *Snellius* did. *Snellius* his difference from accurateneſs he attributes, 1. To too ſmall a baſe, he took to meaſure, and to too ſmall triangles, which he was forced to take afterwards: 2. To the want of ſo good Inſtruments, as were employed in theſe Obſervations.

To adde ſomething of the *three Figures*; they repreſent the Connexion of Triangles, by which our Author meaſur'd the Diſtance from *Malvoyſin* to *Sourdon*, and from *Sourdon* to *Amiens*: From which meaſure he concluded, what the juſt length of a *Degree* might be, reduced to the Pariſian Toiſe.

Concerning which Triangles nothing more needs to be added, but only a fuller Explication of what the Letters in them do ſtand for; *viz.*

A. the middle-point at the Mill of *Villejuifve*.

B. the neareſt corner of the Pavillon of *Ivoiſy*.

C. the top of the Steeple of *Brie Compte Robert*.

D. the middle of the Tower of *Montlehery.*

E. the top of the Pavillon of *Malvoysin.*

F. a pole placed for this purpose on the ruins of the Tower of *Montjay*, with a lock of hay put upon it, that it might be seen at a greater distance.

G. the middle of the Hummock of *Mareuil*, where it was requisite to have a fire made, to distinguish it at a distance.

H. the middle of the great Oval Pavillon of the Castle of *Dammartin.*

I. the Tower of St. *Sampson* in *Clermont.*

K. the Mill of *Jonquieres* near *Compiegne.*

L. the Tower of *Coyvrel.*

M. a little Tree on the hill of *Boulogne* near *Montdidier.*

N. the Tower of *Sourdon.*

O. a little forked Tree upon the point of the *Griffon* neer *Villeneuve St. George.*

P. the Tower of *Montmartre.*

Q. the Tower near St. *Christopher* at *Senlis.*

Thus we have given you, we hope, some satisfaction as to this point, at least as to the material parts of it. As to all the particular niceties, (which it would be too tedious to describe) the Book it self, which surely some time or other will come abroad, may render that satisfaction compleat.

Mean time, I would by no means, that this should put a stop to the Ingenuity and Industry of our Philosophical Friends here in *England*, or deprive either them of the pleasure of comparing their exactness with that of M. *Picarts*, or the world of the advantage of having so important a Problem resolved by divers Artists in different Countries, by different wayes; that so, the whole comming to be reflected upon, one may be able to conclude from the accurateness of the Observers, who they are that are come the nearest to truth in their Observations.

An Extract of the French Journal des Scavans, *concerning a New Invention of Monsieur* Christian Hugens de Zulichem, *of very exact and portative Watches.*

THE Watches of this Invention being made in small, shall serve for very exact Pocket-watches, and when made greater, shall

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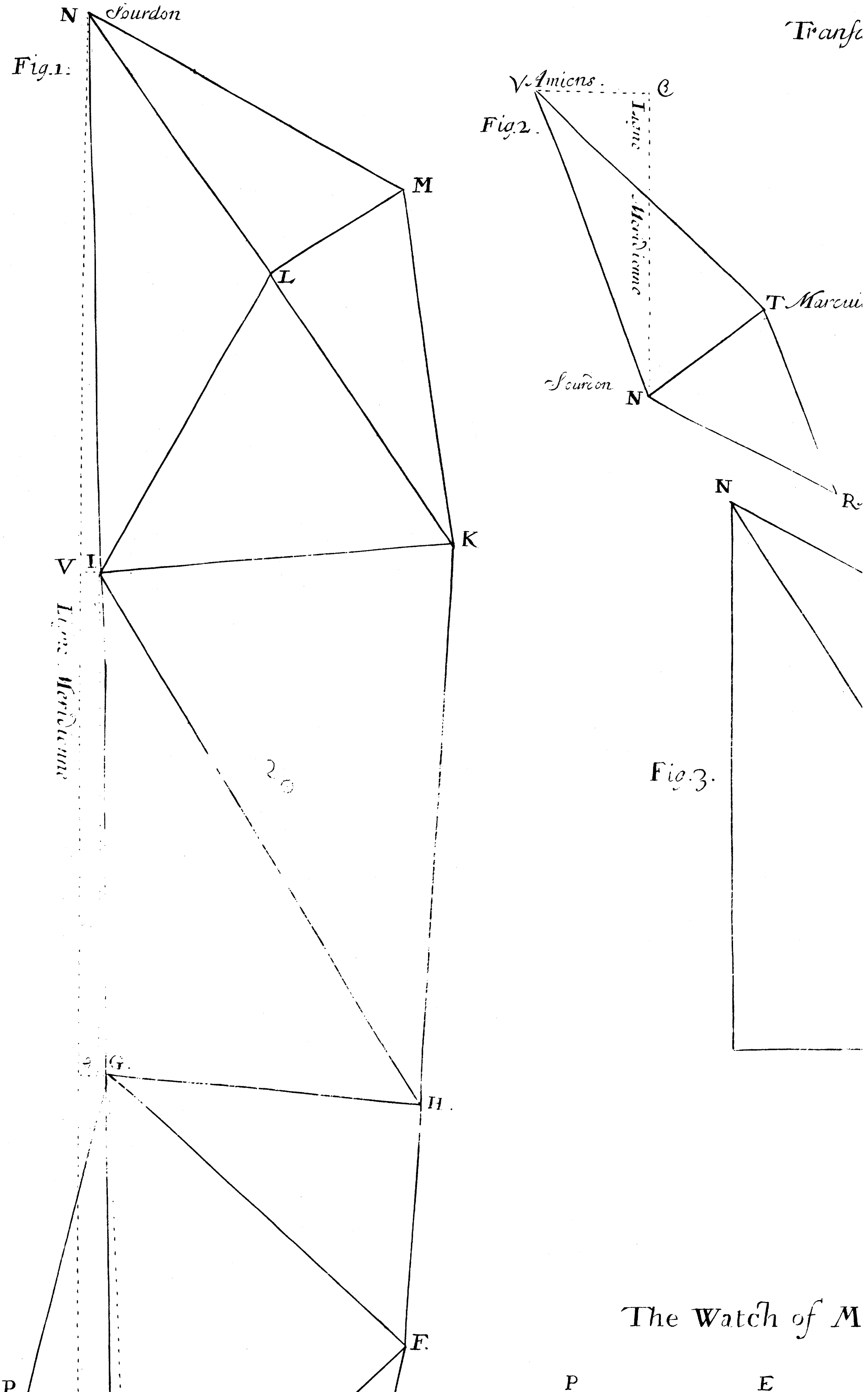

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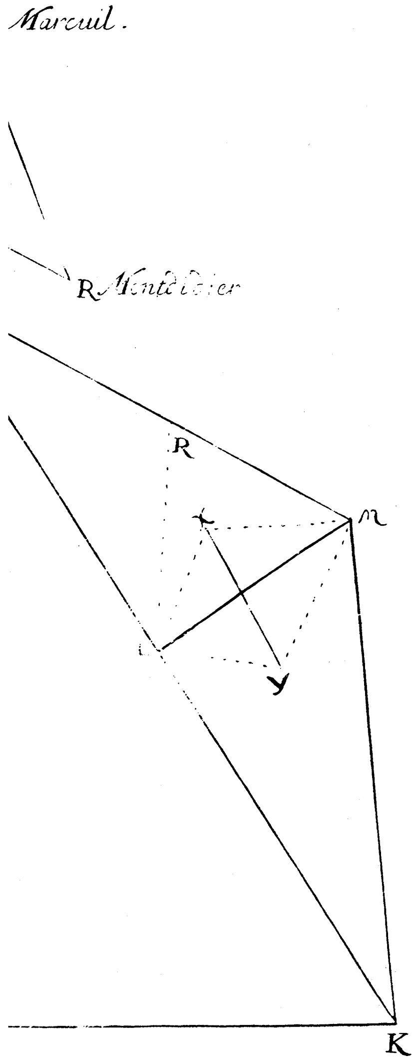

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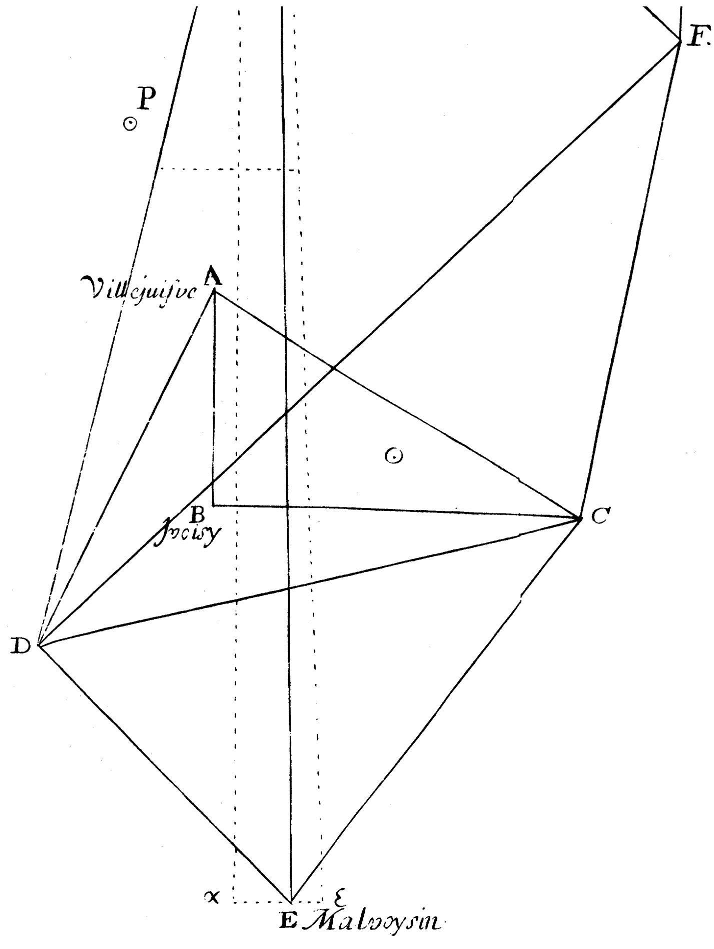
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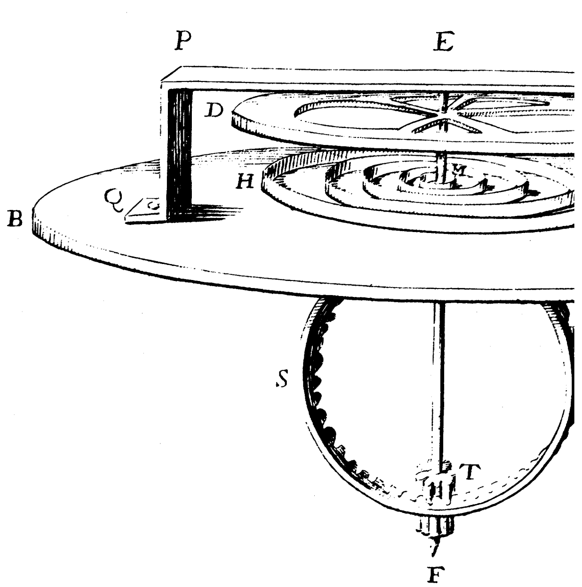
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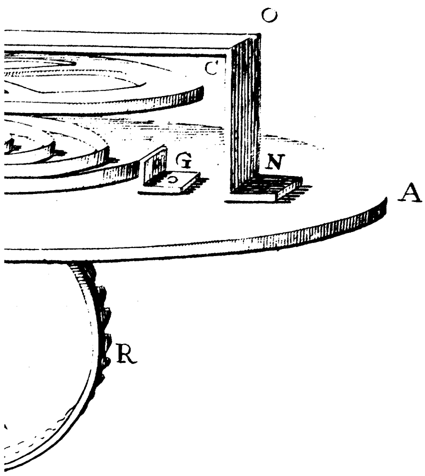
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Fig. 1.

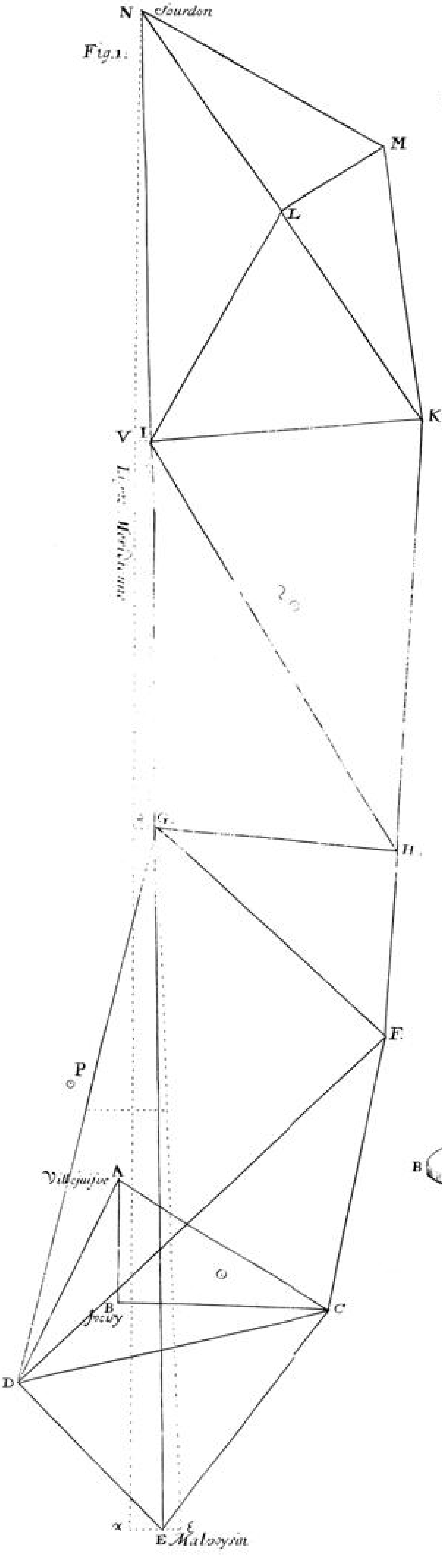


Fig. 2.

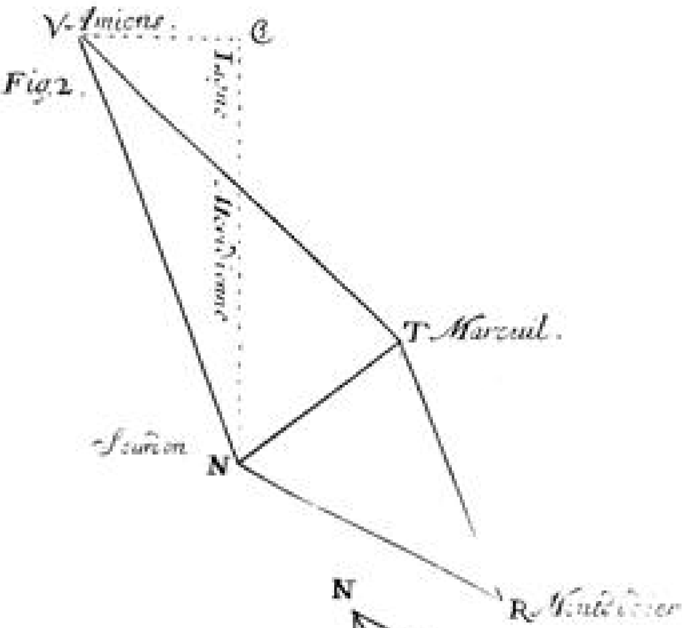
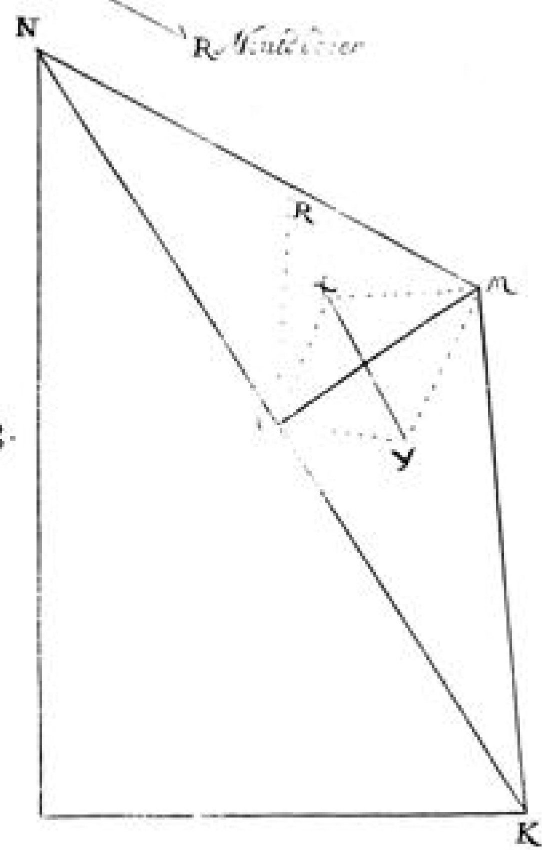


Fig. 3.



The Watch of M. Hugens.