THE MOST EXPEDITIOUS METHOD OF DETERMINING ALTITUDES OF EVERY DENOMINATION,

WITH

THE NEW PORTABLE

MOUNTAIN BAROMETER;

TOGETHER WITH A

DESCRIPTION OF THE INSTRUMENT,

EXAMPLES OF ITS USE,

And prepared Pages for Registering the Observations.

BY SIR HENRY C. ENGLEFIELD, BART. F. R. S. &c.

TO WHICH IS ADDED,

A SHORT DESCRIPTION AND USE OF

THOMAS JONES'S PATENT SECTOGRAPH.

AS MADE AND SOLD

BY THOMAS JONES,

(Pupil of the late Mr. Ramsden,)

MATHEMATICAL, OPTICAL, AND PHILOSOPHICAL INSTRUMENT MAKER,

NO. 21, OXENDON-STREET, HAYMARKET, LONDON.

1811.

THE MOST

EXPEDITIOUS METHOD

OF DETERMINING

ALTITUDES.

THE experience of three years having ascertained the convenience and utility of the Mountain Barometers, (made on the principles of which a description was drawn up by me and inserted in the Philosophical Journals,) I have, at the request of Mr. T. JONES, whom I originally employed in making them, and who has continued to do so, very much to my satisfaction, made some additions to my former description, respecting improvements in their construction and use.

The mensuration of heights by the Barometer has been, by the labours of Mr. De Luc, Sir George Shuckburgh, General Roy, and several other scientific men, brought to such perfection, and affords so much an easier mode of ascertaining the elevations of the different parts of the surface of the earth, to a considerable precision, than any other known process, that it might have been supposed that, in the course of thirty years, which have elapsed since this branch of science has been perfected, a very great number of observations would have been made, and the heights of almost the whole surface of our own country ascertained by the numerous travellers who continually traverse it. The contrary is, however, the case; and the small number of observations of this kind may be attributed to several causes. The instruments are of considerable expense, and, from their complicated construction, easily liable to be out of order in the course of a long journey.

The observations themselves, though each not taking up any very long time, yet, when multiplied on every hill and valley, as they ought to be, for the purpose of obtaining a just idea of the face of the country surveyed, in the aggregate consume much of the traveller's time; and the constant unpacking and re-packing the instrument, becomes

a greater

a greater labour than our natural indolence easily submits to.

It has moreover been generally supposed, that two instruments and two observers, making simultaneous observations at the upper and lower stations of the height to be measured, are indispensably necessary. This, of course, would put it out of the power of a solitary traveller to make any observations at all.

Whether from these, or other causes, the fact is, that whoever reads the numerous Tours, Surveys, and Reports, of the different parts of our island, published within these last twenty years, and many of them professedly with a view to science, either of agriculture, mineralogy, or geology, will be perpetually disappointed, by meeting with mere guesses at the elevations of the tracts of country described; though a knowledge of those elevations is almost indispensable to the geologist, mineralogist, and military surveyor; highly useful to the scientific agriculturist, and very interesting to every one, who, from mere motives of enlarged and enlightened curiosity, reads books of travels, or employs his own leisure in traversing the countries described by other voyagers.

I cannot, therefore, but hope, by simplifying the Barometer, and thereby rendering the instrument much less expensive, and its use at the same time more easy, and shewing that very considerable accuracy may be attained by a single observer, this most useful branch of science may be cultivated, to so great an extent, that, in the course of a few years, we may have almost as perfect an idea of the relative heights of the different parts of England, as we now have of their horizontal distance.

A Barometer, nearly similar to that which I am now about to describe, was constructed, several years since, by Dr. Hugh Hamilton, and is by him described at large in the fifth volume of the Transactions of the Irish Academy. I saw the instrument in his hands nearly sixteen years ago, and was much pleased with its performance. I do not know, however, that any more were then made. I have lately constructed the Barometer, whose description I shall now give, which is still more simple than Dr. Hamilton's, and much cheaper, and which, in many trials I have made of it, appears to unite solidity, lightness, and ease of observation, to as great a degree as can be wished.

The Barometer tube is about $33\frac{1}{2}$ inches in length; its bore is a tenth of an inch in diameter, and external diameter

meter is three-tenths of an inch. This sized bore is fully sufficient to allow the free motion of the mercury. The cistern is of box-wood, turned truly cylindrical, and is one inch in its internal diameter, and an inch in depth; a short stem projects from its top (the instrument being in a position for making an observation), for the purpose of giving a firmer hold to the tube: this stem is perforated with an hole sufficiently large to admit the tube, which is glued to it in the usual mode. This tube projects into the cistern exactly to half its depth. The bottom of the cistern is closed by a strong lid of box, which screws on the cistern, and pressing against a leather glued to the inside of the lid, renders the whole perfectly impervious to the mercury in every position. The tube being filled and boiled in the common way, and the instrument held inverted in a perpendicular position, mercury is poured into the cistern till it is filled within two-tenths of an inch of the top. The lid is then firmly screwed on, and secured from being opened by idle curiosity, by a small screw passing through its side. The essential part of the instrument is now finished. The end of the tube in the cistern can never be uncovered by the mercury in any possible position, and of course no air can ever enter into it; and, as the areas of the cistern and tube are as the squares of the diameters, the diameter of the bore of the tube being ,1, its external diameter ,3, and the diameter of the cistern 1,0, the area of the cistern is 100—9 91, and there being two-tenths of an inch left empty in the cistern, the mercury must fall 182-tenths, or 18 inches and two-tenths, before the cistern is quite full; a space adequate to the measure of greater heights than any known mountain on the earth, much more so to any height in this country. It will not easily be believed, by those who have not seen it, that the air will act on a cistern thus completely closed, and of which the wood, in its thinnest part, is above a quarter of an inch in thickness; but the fact is, that even when the pores of the box wood are closed by thick varnish, (except in that part which touches the mahogany tube), in order to prevent the wood from being affected by damp, the mercury, on turning up the Barometer, takes its level almost instantaneously, certainly in less than half a minute; and that, when the instrument is suspended by the side of the best Mountain Barometer, of Ramsden's construction, with an open cistern, no difference whatever can be perceived in their sensibility to the variations of the atmosphere.

atmosphere. It is obvious that the variations of Altitude, in this instrument of dimensions, above stated, will be one ninety-first part less than in a Barometer furnished with an apparatus for bringing the surface of the mercury in the cistern to a fixed level: this defect might be remedied by dividing the scale accordingly; but it is much more convenient to divide the scale to real inches, and make the necessary allowance on the result.

The tube and cistern being thus prepared, are mounted in a mahogany tube, of the size of a common walking stick. The stem of the cistern goes tight into the mahogany tube, and is there secured by two small brass screws; or the stem may be on the outside, cut into a male screw, and so to be screwed into the mahogany tube. The tube is secured in the mahogany case by passing through perforated corks in the usual way.

For the observation of the height of the mercury, two opposite slits are cut in the mahogany tube, reaching from about 32 to 20 inches for the long scales; and 32 to 25 inches for the short ones; which are sufficiently long for any purpose in this country. The front slit has its sides bevelled, and is, exteriorly, about three-fourths of an inch wide; on one side is fixed a brass plate, divided as usual into inches, tenths, and twentieths. On this plate a nonius slides, moveable by a small piece, which reads off, as in other Barometers, to 500th of an inch. To this nonius a small portion of brass tube is attached, which embraces the Barometer tube, and its lower edge is, in observation, made a tangent to the convex surface of the mercury, as in other well-constructed Barometers; and the very narrow slit behind gives abundant light for observation.

On the bevelled side of the front slit, opposite the scale, a Thermometer is placed for taking the heat of the instrument; which is so contrived as to take out of its place, and answer the purpose of the attached and detached Thermometer.

A thin brass tube, with slits in it, turns half round, in the usual manner, and covers the apertures above described in the mahogany tube when the Barometer is not in use.

The mahogany tube is made rather tapering, and with a ferrule at the end opposite the cistern. This ferrule unscrews and shows a steel ring, by which the Barometer may be suspended when convenient.

 Along

Along the mahogany tube is a scale of feet, carefully divided to inches; the zero of which commences at the end of the ferrule.

Having concluded the description of its original make, I shall now notice the improvement before alluded to.

It had been found that when the instrument was exposed to great motion in an unfavourable position, which in long journies is not easily avoided, the agitation of the mercury had several times cracked the tube towards the top in a fissure scarcely perceptible to the eye, yet sufficient to let in slowly a small portion of air. To remedy this inconvenience, the cistern has now a bottom of leather, on which a screw passes in the usual mode, so as to force the mercury nearly to the top of the tube when packed for carriage; this screw is to be unscrewed as far as it can when the Barometer is prepared for use; and the leather bag is so, that there is no reason to fear that the capacity of the cistern, thus unscrewed for use, will ever be sensibly different from itself at different times. It may be just mentioned, that when the Barometer is carried by a careful person, it is by no means necessary to screw up the bag between every station; as when unscrewed the instrument is in the same state that it always was, in those of the first construction. The bottom screw is protected by an outer cap from being disturbed.

In order to get an exact correction for the fall of the mercury in the cistern, Mr. Thos. Jones now measures the contents of every tube separately, and makes the correction with a diamond near the top of the glass tube in the front of the instrument; by which method it is presumed that all errors, from the want of a gage-point, must be prevented: they are marked $\frac{1}{44}$, $\frac{1}{50}$, $\frac{1}{60}$, &c. according to the bores of the tube; and the quantity is always to be added; that is, one 44th, 50th, &c. of the result found by the usual methods, is to be added to that result.

Having thus described the instrument, a few practical remarks on the manner of using it, may not be superfluous.

When I am about to make an observation, about five minutes before I arrive at the place I take out the Thermometer, holding it by the upper end at nearly arm's length from my body, and, if the sun shines, in the shade of my person. It very soon takes the temperature of the

air,

air, and is not sensibly affected by the heat of the hand. The heat being observed and written down, the Barometer is turned up, the bottom screw unscrewed as far as it will come, the brass tube half turned, and the instrument held between the finger and thumb of the left hand above the slit, so as to let it hang freely in a perpendicular position. Few persons, if any, have sufficient steadiness of hand to prevent little vibrations in the mercury in this position: the hand, therefore, should be either rested against any fixed body, or, if no such occurs, by kneeling on one knee. The cistern should be let down so as to touch the ground, the left hand holding the Barometer in a vertical position, which a little practice will render very easy. The index must then be moved by the knob till its under surface, as before stated, is tangent to the mercury. A few light taps should be given to the tube, to ascertain that the mercury has fallen as low as it can The height being then read off and registered, together with that of the attached Thermometer, the brass tube is turned back, so as to cover the slits; the instrument gently inverted, and the whole is finished. All this may be done in two minutes.

It may not be improper here to add, that I have found by experience that it is not necessary to quit the chaise in order to make observations with this Barometer; it is only requisite for the horses to stand still. The Thermometer, if held at arm's length out of the chaise-window, will give the temperature exactly, before the order is given to stop the carriage, and the delay to the traveller will not much exceed a minute, as the observation may be read off and written down while the carriage is again going on.

The most convenient mode for deducing the heights from the Barometical Observations is, certainly, by the common logarithmic tables; and it is unnecessary here to detail the method, which may be found in numerous books. Tables of logarithms are not, however, always at hand. The Engraved Table, formed by Mr. Ramsden, is on a single narrow sheet, and extremely portable, besides being very easy in its use; but it may be lost or mislaid when wanted Several ingenious formulæ have been devised, which may either be engraven on the instrument itself, or committed to memory. Of the former, Sir George Shuckburgh has given a very concise one in his second paper on the measurement of heights by the Barometer, in the 68th volume of the Philosophical Transactions ; and Mr. Professor Leslie has invented a very elegant one of the latter sort ; but those, though very simple in form, require a considerable number of figures in the operation, and are, on that account, inconvenient. For the purpose therefore, of computing on the spot, and very near to the truth, any observations made on a journey, and that almost without the necessity of writing at all, I have caused the following short table to be engraven on the scale of the Barometer. It expresses the value of the difference of the tenth of an inch in the height of the mercury at the temperature of freezing, in English feet.

Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
20.05	130	22,25	117	25,05	104	28,35	92
,20	129	,45	116	,30	103	,65	91
,35	128	,65	115	,55	102	,95	90
,50	127	,85	114	,80	101	29,27	89
,66	126	23,05	113	26,05	100	,61	88
,82	125	,25	112	,30	99	,95	87
21,00	124	,45	111	,57	98	30,30	86
,18	123	,65	110	,85	97	,65	85
,35	122	,87	109	27,15	96	31,00	84
,53	121	24,10	108	,45	95	,37	83
,70	120	,32	107	,75	94	,75	82
,87	119	,55	106	28,05	93	32,10	81
22.05	118	,80	105				

The method of using it is as follows : 1st, Add the two observed heights of the Barometer, and halve the sum to obtain the mean height. 2d, Subtract the lesser height from the greater, the remainder is of course the difference of height in tenths, &c. of an inch. 3d, Enter the table with the mean height, and take out the feet answering to it, making a proportion, if the mean height does not exactly answer to a foot. (This proportion may be made by head.) Multiply the number thus obtained by the tenths, &c. of an inch of difference of height. The result will be nearly the number of feet, answering to the difference of height between the two Barometers at the temperature of freezing. When the lower Barometer stands between 29 and 30 inches, and the elevation does not exceed 1500 feet, this rule will give the height within one foot of the result from the Logarithmic method. When the elevation is about 3000 feet, the error will be nearly three

three feet, and at heights greater than 3000 feet, the error increases in an higher ratio. It is always in defect. In this country, however, such elevations do not exist, and in those parts where a knowledge of the comparative heights of the different hills is the most generally useful, they seldom exceed 1000 feet; at all events such observations as relate to great elevations, may be always recomputed by more rigorous methods at leisure.

The correction of the heights thus obtained, for the temperature of the air above freezing, is by Sir G. Shuckburgh supposed to be as the height of the Thermometer, and to be 2,44 thousandth of the approximate height for each degree of Farenheit additive when the temperature is above freezing, and subtractive when below freezing. General Roy's observations and experiments lead to a supposition, that the correction is not exactly as the height of the Thermometer, and that at about the temperature of 50 degrees, it amounts to 2,5 thousandths, and is less, both much above and much below that temperature. For the purpose of immediate computation, I take the correction at 2,5, which, though certainly rather too great, will in general be productive of very small error, and affords a rule which is easily remembered and quickly applied. It is this:—

For every four degrees that the mean temperature of the two detached Thermometers exceeds 32° add one-hundredth of the approximate height, as before obtained, to it, for every 40° one-tenth, and so for any greater or lesser number of degrees. I have not hitherto mentioned the correction, which, in fact, ought to be the first in order, viz. that for the difference of temperature of the two Barometers themselves: but this correction is in general so small, as to be safely neglected. Should it, however, be thought necessary to apply it in this approximate method of computing heights, the rule delivered by Sir G. Shuckburgh's method is as follows, and it wants no table, though he has given one for it:—

When the Barometer stands at 20 inches, the expansion of the mercury for one degree of Farenheit is two thousandth of an inch; when it stands at 30 inches, it is three thousandths; and for the intermediate inches it increases exactly as the height of the mercury, that is, at 21 inches it is 0021, at 22 inches, 0022, and so on, so that the height in inches is the number of ten thousandths of expansion for one degree of Farenheit:—this is very easily remembered.

bered. The expansion for any other number of degrees is in proportion to the degrees themselves; that is for two degrees it is twice as much, for ten degrees ten times as much, and so on. Take, therefore, the difference of heights of the *attached Thermometers* at the two stations, and multiply the expansion for one degree at the coldest Barometer, (which will almost always be the one at the highest station,) by the number of degrees of difference between the height of the two Barometers, and add the quantity to the observed height of the coldest Barometer, and it is corrected for the expansion of the mercury by the heat of the instrument.

An example will make the whole clear.

	Inches	Ther. attached
Observation at bottom	29,400	50°
Observation at top	25,190	46
	Difference	4

Expansion for 1° at 25 Inches	,0025
Multiply by difference	4
	,0100

One-hundredth of an inch is therefore to be added to the observed height of the upper Barometer 25,190, so the corrected height is 25,200. It is, however, to be observed, that the application of this correction is of doubtful accuracy in practice, as it is by no means certain that the attached Thermometer, be placed where it may in the mounting, will give the real heat of the column of mercury in the Barometer, and therefore I had at first said that it might, on the whole, in general practice, be neglected. If much accuracy is wished, and time permits, the surest way is to leave the Barometer in the shade so long as for the whole instrument to acquire the temperature of the air, and then to make this correction according to the rule given above from the two *detached Thermometers;* and this Barometer, from the lightness of its mounting, will have the advantage of taking the temperature of the air sooner than those formerly made with solid wooden cases.

It may not be improper to give an example of the method already detailed.

Observation

Observation at bottom	29,400	Therm. in air ..	45
Observation at top	25,200	Therm. in air ..	41
	2)54,600		2)86
Mean	27,300	Mean heat	43
		Standard	32
Difference	42 tenths		
Value of a tenth by the table	95,5 feet	Difference	11
	1910		
	3820		
Approximate height	4011,0 feet		
Do. by Sir G. Shuckburgh ..	4016,0		
Error	5 feet		

CORRECTION FOR TEMPERATURE.

	Feet
For $8^\circ = 2$ hundredths	80
For $3^\circ = 3$ four hundredths	30
Correction .... + ...	110
Do. by Sir G. Shuckburgh	107,4
Error ...... + ...	2,6

Approximate height by me ..	4011	By Sir G. S.	4016
Correction for temperature ..	110		107,4
Result	4120		4123,4

EXAMPLE II.

Obser. at bottom	30,017	Therm. in air	60°
——— at top	29,534	Do.	57
	2)59,551		2)117
Mean......	29,775	Mean	58,5
Difference ..	4,83	Standard	32
Value of a tenth by the table	87,5	Difference	26,5
	350,0		
	70,00		
	2,665		
Approximate height ..	422,625		
Do. by G. Shuckburgh	422,9		
Error	00,3		

CORRECTION

CORRECTION FOR TEMPERATURE.

For 24° = 6 hundredths	25,3 Feet	
2 = 2 four hundredths ..	2,0	
$\frac{1}{2}$ = 1 eight hundreth ..	0,5	
Correction .... + ...	27,8	
Do. by Sir G. S.	27,2	
Error .... + ...	0,6	
Approximate height by me ..	422,6	By Sir G. S. 422,9
Correction for temperature +	27,8	27,2
	450,4	450,1

These two examples show how near the truth the method here recommended will come, even in considerable heights.

It now remains to say a few words on the necessity of two Barometers, for the mensuration of heights, and the probable error to be incurred by using a single one. There is no doubt, that when very great accuracy is required, two Barometers ought to be used; but even with every precaution, altitudes cannot be taken by Barometers sufficiently near for the purpose of carrying water, either by pipes or canals, and for the purpose of the Geologist, Military Surveyor, or Agriculturist, it is of very little importance, whether a mountain is a 1000 or 1010 feet high, though it is of the highest utility that he should know whether it is 800 or 1000.

I have, during the course of many years, been in the habit of taking observations of altitudes by a single Barometer, and have had many opportunities of repeating my observations on the same hills, when the Barometer has been at different heights, and either falling or rising during the time of observation; and more than once I have observed heights which had been trigonometrically taken by the best instruments; and I can safely say, that the difference between these observations has seldom amounted to so much as two feet on a hundred. The mode I use is this:—At setting out I take the height of the mercury, and note the time of observation; I likewise note the time of the second observation; and on returning to the first station, observe again, and note the time. If the Barometer has altered in the interval, a simple proportion corrects either of the three observations, and reduces the heights to what would have been observed had the mercury

cury been stationary. It is true, that this method supposes the motion of the mercury to have been uniform during the interval of observation, but except in very variable weather, which does not very often occur, particularly in summer, when the greater number of these observations will naturally be made, this supposition may be safely made. It is also true, that a traveller has often no opportunity of making a second observation at the spot he set out from. Even in this case, a near approximation may often be made by observing, for example, at a stream on each side of the hill to be measured. If also he observes the Barometer repeatedly in the morning before he sets out, and sees its tendency, and does the same at every halt during the day, he will have data whereon to found nearly an accurate correction. But if all this should be out of his power, even under the most unfavourable circumstances, Barometrical observations will give a much more accurate idea of the outline of a country than any we now possess; and it should be ever remembered, that observations accurately made and faithfully recorded are valuable. The repeated observations of different travellers, though separately defective, will, in most cases, correct each other, and from the whole very accurate conclusions may be drawn.

I have entered into a greater detail than would be necessary for a greater part of your readers, in the hope of being intelligible to those who are less acquainted with the subject.

I compared several of the Barometers that were first made, and found that in some of them the mercury did not take its true height on turning up the instrument quite so quick as in the two which you first constructed for me, (the difference of which is owing to the greater closeness of fibre in some pieces of box-wood than in others, but which does not affect the accuracy of the instrument). They now take their level perfectly well, a small aperture or two being made in the cisterns, which are filled up by pins of open-grained wood.

It may not be superfluous to say, that the weight of this Barometer is less than $1\frac{1}{2}$ pound. The weight of Ramsden's last improved Barometer is $4\frac{1}{2}$ pounds, and that of his earliest about $6\frac{3}{4}$ pounds. I subjoin a few observations, by which the accuracy of this Barometer may be fairly estimated.

1806.		Barom.	Ther.	Results.
Jan. 1,	Hill Top	29,540	44	
	Thames side	29,686		
		,146		133
Jan. 2,	Hill Top	29,708	38	
	Thames side	29,860		
		,152		134
Jan 31,	Hill Top	29,301	36	
	Thames side	29,453	37	
		,152		137
Feb. 23,	Hill Top	29,758	51	
	Thames side	29,912		
		,154		139
Feb. 24.	Hill Top	30,180	53	
	Thames side	30,334	54	
		,154		140

On the Signal Hill at Brighthelmstone, in 1796, with a Barometer of Ramsden's.

	Feet
Signal House above High Water mark	410
In 1806, with my Barometer	403
	416
	418

Devils Dyke, near Brighthelmstone.

In 1788, with a Barometer of Ramsden's	697
In 1806, with my Barometer	695

Lord Abercorn's Lodge at Stanmore, above the Stream in Edgeware Town.

Jan. 3.	306
7.	306

The Observations from which this Height was deduced, were made in the chaise, both in January 3d and 7th.

I am your's truly,

H. C. ENGLEFIELD.

Tilney-street, Sept. 9, 1811.

THOMAS JONES'S PATENT SECTOGRAPH,

NO. 21, OXENDON-STREET.

THESE instruments are made by placing a number of pieces or bars parallel to each other, placing other pieces across the same at the ends and middle, and securing them by pins passing through both; the points are placed diagonally, or from corner to corner; the exterior of the whole nearly forms a square: they are made with any number of points, and of any length.

The letters referred to in the following description are marked on the instrument. The common size is about 8 inches long, and measures to the extent of that distance. The Sectograph is packed in a neat morocco case, (with a printed description inside,) the exterior of which is 9 inches long, and about three quarters of an inch square. The price of the 8-inch instrument is two guineas, that of others in proportion to their length; they are stamped, *Thos. Jones's Patent.*

DIRECTIONS FOR USING THE INSTRUMENT.

Open the instrument by pulling A and B asunder, until the exterior nearly forms a square. Hold it in the hand, or place it on paper, with A next to you: the points will then appear in line, and numbered from left to right 0, 2, 4, &c and may be made to recede from, or advance to each other at pleasure. For dividing *Lines* place 0 on the beginning, and the 2d, 3d, 4th. &c. on the other point or distance to be divided, and press down the intermediate points, or as many as may be required. When a transfer or copy is to be taken, take care to clamp the instrument by the milled head as soon as it is set. For measuring *Distances* place 0 on one point, and the point of the opposite corner on the other: the scale on the side where the divisions are marked 1, 2, 3, 4, &c. (indicating inches) will give at the edge of the bevelled clamp, the inches and parts of the required distance. For laying down *Angles*, (the other side of the scale marked 10, 20, 30, &c. are the degrees, the point A the angular point, and the other two points C and D, or 0 and 8, form with A the sides of the angle,) set the bevelled edge to the number of degrees, clamp the instrument, and apply the points to the paper, or other surface. For measuring *Angles*, place the point A in the angle, and the other points to the sides respectively, clamp the instrument, and the scale will give the number of degrees. On the edge of the scale, next to B, are a set of divisions which shew when the points are one inch, one-half, one-quarter, one-eighth, or one-sixteenth, from each other. The intermediate distances may be had by the scale of inches. In order to get the hundredth part of an *Inch*, set the bevelled edge of the clamp to five inches, beyond which are ten divisions, then place the 7th point in the dot where you want the hundreds to commence; let fall the 8th point, on which place the second finger of the right hand firmly, with the other hand hold the end 0, letting the fingers touch the paper, then raise the 7th point, still keeping the 8th down, and move the points towards each other, until you come to the first of the ten divisions, then with the first finger of the right hand make a dot with the 7th point, (which may easily be done without marking with the other points,) which distance will be one-hundredth of an inch; then raise the 7th point, move to another division, dot, &c. &c. By using every second division you will have the fiftieth part of an inch, &c. Fractional parts of distance may be measured by the same means.

Instruments made and sold by Thos. Jones.

		£.	s.	d.
THE Englefield Mountain Barometer, with short scale,	. .	4	4	0
Ditto, long scale,	. .	4	14	6

Astronomical and Transit Instruments of every size and description, with the very best improvements.

Repeating Circles of the French and English construction,—Reflecting Circles,—Sextants, &c.

Hydrostatic Ballances, with all the actions of agate, (being much more durable than steel).

Thomas Jones's Patent Sectograph for dividing lines at one opening of the instrument, laying down and measuring angles, &c. with singular dispatch.

Telescopes of every description.—House Barometers, with improved Circular nonius, and every other sort.—Improved Register Thermometers.—Professor Leslie's Barometer Altitude Scale, in several ways.—Kater's Hygrometer.—Instruments for drawing in perspective, &c.

Mr. Barton's Improved Steering Compass, being the latest improvement in that valuable instrument, and presumed to be the very best construction.

Various Optical Apparatus, particularly the Phantasmagoria, Pantascope, &c. with hail, rain, thunder, lightning, &c.; to which may be added, Astronomical Slides, exhibiting the different appearances of the heavenly bodies, microscopic, opake, and transparent objects, artificial fireworks, &c. &c. together with various other appearances, exhibiting all that fancy or superstition may have depicted.

Besides the preceding, every other instrument peculiar to the arts and sciences, as well as every species of machinery or instruments, made from drawings, or as described or noticed by different authors, the whole executed in the best and most accurate manner, and every attention paid to make them produce the desired effect in the most satisfactory way.

Most of the above Instruments may be had of Mr. W. P. Doughty, of Cony-street, York, (late Pupil of Thos. Jones).

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