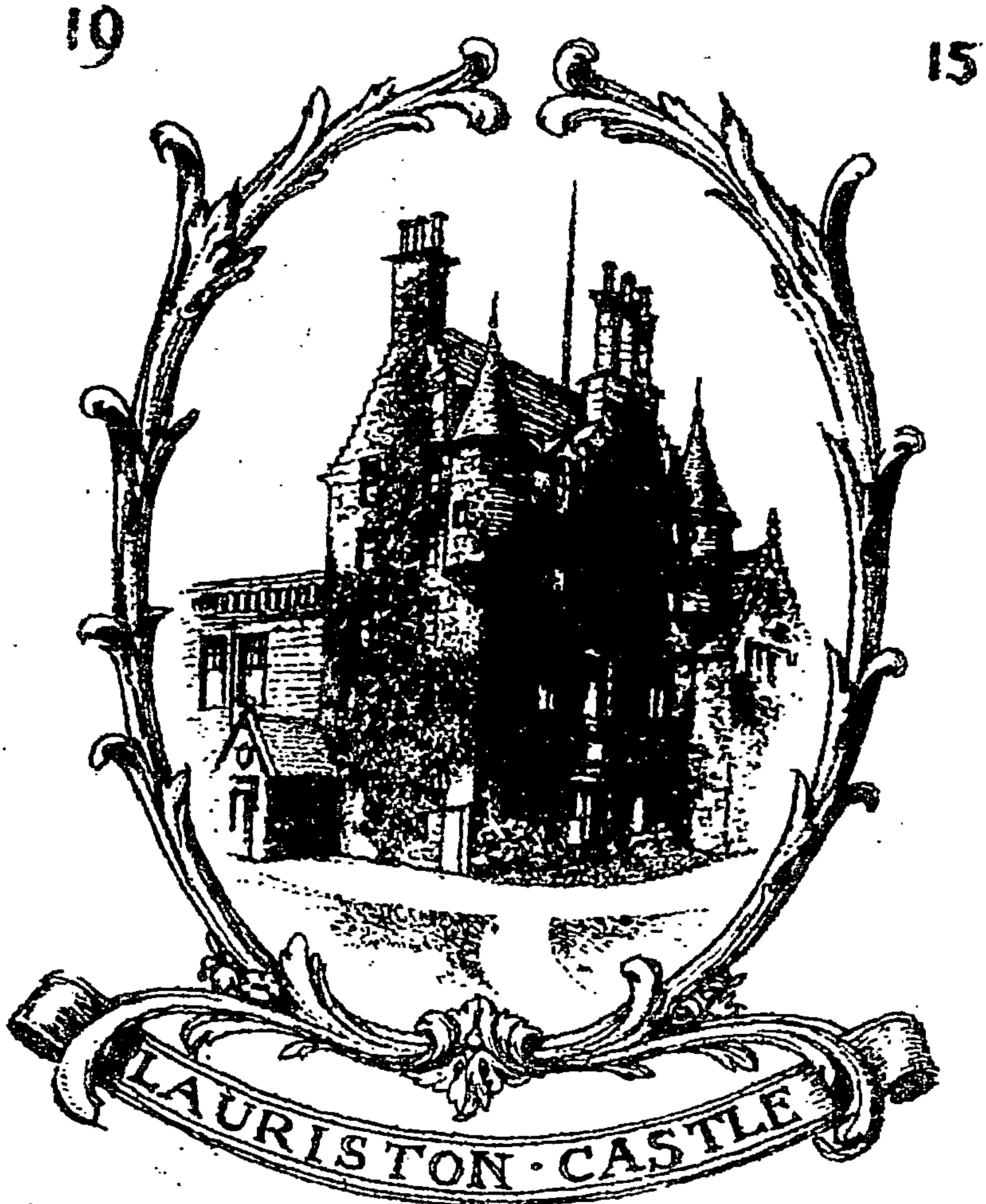

William Robert Reid

L. C. 1983.

A COMPANION TO THE WEATHER-GLASS:

OR THE

NATURE, CONSTRUCTION, AND USE,

OF THE

BAROMETER, THERMOMETER,

AND

HYGROMETER,

WITH A SHORT ACCOUNT OF AQUEOUS METEORS, THE FORM OF A REGISTER OF THE WEATHER, &c.

Selected from the most approved Authors.

" Hinc tempeftates dubio prædifcere cœlo
" Poffumus: hinc meffifque diem, tempufque ferendi:
" Et quando infidum remis impellere marmor
" Conveniat;"———— VIRGIL.

EDINBURGH:

Printed by T. Ross, for J. GUTHRIE, Bookfeller, No. 2, Nicolfon's Street.

1796.

CONTENTS.

AQUEOUS METEORS.

THE following pages are ſelected from various authors of eſtabliſhed reputation; the works from which they are extracted are many, and all of them high priced: this puts it out of the power of thoſe who have either little time to ſpend in literary purſuits, or money in procuring books, to become acquainted with the nature, conſtruction, and uſe of the inſtruments herein deſcribed, and ſo generally uſeful. To ſupply the deficiency is the intention of the preſent work, which, though condenſed into ſo ſmall a compaſs, contains the eſſence of ſeveral larger publications.

COMPANION

TO THE

WEATHER-GLASS, &c.

As the various phenomena of the Barometer depend upon the gravity of the air, it is, therefore, neceſſary to take notice of ſome of its properties.

AIR is an inviſible, thin, tranſparent, elaſtic, compreſſible, and dilatable body, which appears to be one of the great agents of Nature in the economy of the world. That maſs of fluid, conſiſting of air, aqueous and other vapours, which ſurrounds the Earth, is called the ATMOSPHERE. Beyond the atmoſphere, it was ſuppoſed, by many of the ancients, that there was a purer and more ſubtile fluid, which they called ETHER.

Air is of the utmoſt importance, not only to mankind, in promoting many

uſeful

uſeful arts, but abſolutely neceſſary to the preſervation of animal and vegetable life.

"*Aer ſonorum nuncius eſt, odorum delator, vocis efformator; tantuſque ejus in reſpiratione uſus eſt, ut non modo vitæ ſervator, verum etiam anima ipſa videatur.*"

FLUIDITY, which is one of the moſt obvious properties of the air, ſeems to be owing to the tenuity of its parts. That air is a fluid appears from the eaſy paſſage which it affords to all bodies moving in it. It varies in denſity according to its height from the Earth's ſurface, (the denſity decreaſing upwards), and is incapable of fixation, at leaſt by itſelf.

GRAVITY is another property of air, eſſential to the life of animals and plants, and highly important in the general economy of Nature itſelf. Of this gravity we have many direct proofs from ſenſe and experiment: thus, the hand laid cloſe upon the end of a veſſel, out of which the air is drawn at

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the other end, ſoon feels the load of the incumbent atmoſphere:—thin glaſs veſſels, exhauſted of their air, are eaſily cruſhed to pieces by the weight of the external air, *&c.*

The weight of the air in the animal economy, is like the weight of a Clock, which gives motion to all the machinery. It is found ſometimes to ſuſtain a pillar of Mercury, thirty-one inches high in the Barometer, at others only a pillar of twenty-eight inches. Taking, therefore, twenty-nine inches and a half for the mean altitude of the Mercury, a column of it, whoſe baſe is one ſquare inch, weighs about fifteen pounds, which is equal to the preſſure of the atmoſphere upon every ſquare inch of the Earth's ſurface. As the air, like other fluids, preſſes equally on all ſides, it is computed that a middle-ſized man, whoſe body contains about fifteen ſquare feet of ſurface, is preſſed by 32,400 pound weight of air; which, however, is not felt by us, on account of the equal preſſure it makes on all parts of our bodies.

Although we think the air lighteſt in fair weather, yet the Barometer ſhews the contrary, as the ſuſpenſion and riſing of the Mercury in the tube is owing to the preſſure of the air on the ſtagnant Mercury in the baſon. The gravity of the air is not the ſame at all times, and at all places; for we know by experience, that it is lighter in a high place than in a low one, and that vapours do not increaſe its gravity; for when they are in the lower region, as in rainy weather, then the air is lighteſt, as it appears by the falling of the Mercury in the Barometer.

The reaſon why there is ſometimes a greater preſſure on the Mercury of the Barometer than at others, is owing to the variation of the atmoſphere, and this variation frequently proceeds from winds: for, if the wind, which is nothing but a ſtream of air, ſhould blow on any one place, and the air thus moved, ſhould be kept in that place

by

by mountains; or, if two contrary winds ſhould blow on the ſame place, the air will be accumulated in the middle, and conſequently its preſſure on the Mercury will be increaſed. But if the wind ſhould blow in a ſtream over a country, the air which is over that place will be carried away, and conſequently the preſſure on the Mercury diminiſhed.

This difference of the preſſure of the air muſt often affect the animal functions, as is experienced by thoſe who labour under aſthma.

ELASTICITY, another eſſential proproperty of air, is evident from the common experiment of a blown bladder, which, when ſqueezed in the hand, we find a ſenſible reſiſtance from the included air. The elaſticity of air, or the force whereby it endeavours to expand itſelf, is always as its denſity. Heat is found to increaſe the elaſticity of air, and cold to have a contrary effect.

HEAT and COLD in the air, muſt be

be of the utmost consequence upon many accounts, since the health, and consequently the life of man, is greatly affected by it.

There is no need of giving instances of the manifold miseries, diseases, and other misfortunes that have happened to mankind, in every age, from the intemperature and extremity of heat and cold in the air; and, therefore, we cannot be too well instructed in all the proper methods of guarding against them: and not only so, but the vegetation of different kinds of plants and trees depends upon a peculiar degree of warmth or heat in the air, water, or earth, in which they grow.

MOISTURE and DRYNESS of the air are properties by which most things are affected, and particularly the animal economy. A dry air, whether hot or cold, is always healthy; so a moist or damp air is well known to be productive of many disorders to mankind, as colds, rheumatisms, pains in the joints, and many other dangerous diseases.

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An index, therefore, to ſhew conſtantly the different ſtate of the air, in a room where we uſually ſit, muſt be conſidered as one thing neceſſary towards the preſervation of our health; and we cannot be too well prepared againſt the attacks of ſo great a number of diſorders that we are liable to from every quarter.

Therefore, the *weight* of the air we ſhall illuſtrate by the BAROMETER,—the *heat* and *cold* by the THERMOMETER,—and the *dryneſs* and *moiſture* by the HYGROMETER.

BAROMETER.

THE Barometer is an inſtrument by which we meaſure the weight of the atmoſphere, and the variations therein, in order to determine the changes of the weather. By the Barometer we alſo meaſure the height of mountains, *&c.*

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The Barometer is founded upon an experiment of *Evangeliſta Torricelli*, an eminent Italian, (Profeſſor of Mathematics at Florence), who was born A. D. 1608, and died in 1647; who, obſerving that a column of water of about thirty-three feet, was equal in weight to a column of air of the ſame baſe, concluded that a column of Mercury, no longer than about twenty-nine inches and a half would be ſo too; ſuch a column of mercury being as heavy as thirty-three feet of water.

The pillar of Mercury which is kept up in the tube of the Barometer, is equal in weight to a pillar of the atmoſphere of the ſame thickneſs, conſequently as the weight of the atmoſphere varies, the height of the Mercury in the Barometer muſt vary alſo; the Mercury conſtantly riſing as the weight of the air increaſes, and ſinking as that leſſens.

If the Barometer be carried to a higher ſtation, the Mercury will deſcend lower in the tube, but when carried

ried to a lower place, it will riſe higher in the tube, according to the difference in elevation between the two places, as appears by the following

History *of the* Barometer.

About the beginning of the laſt century, when the doctrine of Plenum was in vogue, it was a common opinion among philoſophers, that the aſcent of water in pumps, was owing to what they called Nature's abhorrence of a vacuum; and that thus fluids might be raiſed by ſuction to any height whatever. But an accident having juſt diſcovered, that water could not be raiſed in a pump unleſs the ſucker reached to within 33 feet of the water in the well,—it was conjectured by *Galileo*, who flouriſhed about that time, that there might be ſome other cauſe of the aſcent of water in pumps; or, at leaſt, that this abhorrence was limited to the finite height of 33 feet. Being unable to ſatisfy himſelf on this head, he recommended

commended the confideration of the difficulty to Torricelli, who had been his difciple. After fome time Torricelli began to fufpect that the preffure of the atmofphere was the caufe of the afcent of water in pumps; that a column of water, 33 feet high, was a juft counterpoife to a column of air, of the fame bafe, and which extended up to the top of the atmofphere; and that this was the true reafon why the water did not follow the fucker any farther: and this fufpicion was foon after confirmed by various experiments.

Torricelli confidered, that if a column of water 33 feet high, was a counterpoife to a whole column of the atmofphere, then a column of Mercury of about 2 feet and a half high, would alfo be a counterpoife to it, fince quickfilver is near 14 times heavier than water, and fo the 14th part of the height, or near 2 feet and a half, would be as heavy as the column of water. This reafoning was foon verified, for having filled a glafs tube with quickfilver, ſilver, and inverted it into a baſon of the ſame, the Mercury preſently deſcended, till its height above that in the baſon was about 2 feet and a half, juſt as he expected. And this is what has, from him, been called the *Torricilian experiment.*

The new opinion, with this confirmation of it, was readily acquieſced in by moſt of the philoſophers, who repeated the experiment in various ways. Others, however, ſtill adhered to the old doctrine, and raiſed ſeveral pretended objections againſt the new one; ſuch as, that there was a film or imperceptible *rope of Mercury*, extended through the upper part of the tube, which ſuſpended the column of Mercury, and kept it from falling into that in the baſon. This, and other objections were, however, ſoon overcome, by additional confirmations of the true doctrine; particularly, by varying the elevation of the place. It was hinted by *Deſcartes* and *Paſcal*, that if the Mercury be ſuſtained in the tube by the preſſure of the atmoſphere, by carrying it to a higher ſituation, it would deſcend lower in the tube, having a ſhorter column of the atmoſphere to ſuſtain it, and *vice verſa*. And Paſcal engaged his brother-in-law, M. Perier, to try that experiment for him, being more conveniently ſituated for that purpoſe than he was at Paris. This he accordingly executed, by obſerving the height of the quickſilver in the tube, firſt at the bottom of a mountain in *Auvergne*, and then at ſeveral ſtations of different altitudes in aſcending; by which it was found that the Mercury fell lower and lower all the way to the top of the mountain; and ſo confirming the truth of the doctrine relating to the univerſal preſſure of the atmoſphere, and the conſequent ſuſpenſion of the Mercury in the tube of the Barometer.

It was ſometime, however, before it was known that the preſſure of the air was various, at different times, in the ſame place. This could not, however,

ever,

ever, remain long unknown, as the frequent meaſuring of the column of Mercury, muſt ſoon ſhew its variations in altitude; and experience and obſervation would preſently ſhew that thoſe variations in the Mercurial column were always ſucceeded by certain changes in the weather, as to rain, wind, froſts, *&c.* Hence this inſtrument ſoon came into uſe, as the means of foretelling the changes of the weather; and on this account it obtained the name of the *Weather-glaſs*, as it did that of *Barometer*, from its being the meaſure of the weight or preſſure of the air.

CONSTRUCTION *of the* BAROMETER.

THOUGH men of ingenuity have conſtructed a variety of different Barometers, juſtly admired for their mechaniſm, yet I intend only to deſcribe that which is not only the moſt common, but the moſt uſeful and accurate. Its conſtruction is ſimple, and does not admit of any kind of reſiſtance to the free motion of the Mercury in the tube. The Barometer conſiſts of

1. A ſmall GLASS TUBE about three feet long, hermetically ſealed at one end, and open at the other. The ſize of the bore ought not to be leſs than two-tenths of an inch, nor need it be more than four.—In tubes of a ſmall bore, there is a ſenſible force of attraction from the ſides of the tube, which prevents the free motion of the Mercury in it; and in ſuch caſes, no alteration in the weight of the air can be ſeen, till it is great enough to overcome the force of attraction in the tube; on the contrary, in tubes which are large, the weight of the Mercury will render it independent of the attraction of the tube, its motion will always be free, and it will ſhew the very firſt and moſt immediate alteration in the weight of the air.

2. A ſmall WOODEN BASON, in form of a tea-cup, whoſe circular area is

is generally thirty or forty times greater than that of the tube, (the tubes of moſt Barometers being only two-tenths of an inch wide, and the baſon one inch and a quarter.) If, on the contrary, the baſon be made too ſmall, the Mercury, which ought to be ſtagnant in the baſon, will riſe and fall with that in the tube; for, ſhould the ſtagnant Mercury ſink upon the riſing of the Mercury in the tube, or riſe as that ſinks, (which muſt be the caſe when the baſon is ſmall,) the riſe or fall of the Mercury in the tube will appear to be leſs than it really is; as for inſtance, when the Mercury riſes half an inch in the tube, and does at the ſame time fall a quarter in the baſon, the riſe in the tube, which appears to be only half an inch, is, in truth, three quarters; becauſe the height of Mercury is always to be computed from the ſurface of that in the baſon.

3. A FRAME, (which is made of mahogany, and needs no explanation,)

to the lower end of which the baſon is fixed.

4. The SCALE is commonly braſs, plated with ſilver; the lower end of which is placed upon the frame, twenty-eight inches from the ſurface of the Mercury in the baſon, and marked 28, and at the top 31, it being three inches long:—each inch is divided into ten parts.

On the ſcale are alſo inſcribed, in their proper places, ſuch conſtitutions of the air and weather, as have been obſerved to accompany different heights of the Mercury. Oppoſite 31 inches is marked *very dry* on the one ſide for ſummer, and *very hard froſt* on the other for winter; at 30½ is marked *ſet fair* on the one ſide, and *ſet froſt* on the other; at 30 is marked *fair* on the one ſide, and *froſt* on the other; at 29½ is wrote *changeable*; at 29 *rain* on the one ſide, and *ſnow* on the other; at 28½ *much rain* on the one ſide, and *much ſnow* on the other;

and

and at 28 inches is marked *ſtormy*.

The ſcale being divided into 30 viſible parts, (*viz*. into 3 inches, and each inch into 10 parts,) each of theſe 10 parts may be divided into 10 others, by means of a little ſliding piece of braſs, having an index at the top, from which it is divided into 10 equal parts, which are equal to eleven of thoſe on the ſcale, that is to eleven tenths.

5. This contrivance is called a NONIUS, (being the name of the perſon who firſt publiſhed it to the world). It is alſo called a VERNIER SCALE. By this means the height of the Mercury is evident, by inſpection only, to the 100th part of an inch. To underſtand this, nothing more is neceſſary than to conſider that *one tenth part of a tenth of an inch* is the *one hundredth part of an inch*. Now, every 10th part of an inch on the ſcale is divided into 10 equal parts by the vernier; for ſince ten diviſions on that exceed ten on the ſcale by one diviſion, that is, by

by one tenth of an inch; therefore one diviſion on the vernier will exceed one diviſion on the ſcale by one tenth part, *&c.* And every diviſion on the vernier will exceed the ſame number of diviſions on the ſcale, by ſo many tenths of a tenth, or by ſo many hundreth parts of an inch. Therefore the ten equal diviſions of an inch on the ſcale, muſt be looked upon as ſo many ten-hundredth parts of an inch, and numbered thus, 10, 20, 30, 40, *&c.* parts of an inch. Then the vernier gives the unit to each ten, thus:—Set the index to the top of the ſurface of the Mercury, and if, at the ſame time, the beginning of the diviſions at the index on the vernier coincide with a line of diviſion in the ſcale, then it ſhews the altitude of the Mercury in inches, and tenths of an inch exactly. But ſuppoſe the index line of the vernier falls between two diviſions on the ſcale, then there will be a coincidence of lines in both, at that number of the vernier which ſhews how many tenth

parts

parts of that tenth the index of the vernier has paſſed the laſt decimal diviſion of the ſcale: Thus, for

EXAMPLE,

Suppoſe the index of the vernier were to point ſomewhere between the ſixth and ſeventh tenth above 30 on the ſcale; then, if by looking down the vernier, you obſerve the coincidence at No. 8, it ſhews that the altitude of the Mercury is 30 inches, and 68 parts of a hundredth of another inch; or ſimply thus, 30.68 inches.

But as a greater accuracy as to the height of the Mercury is ſtill requiſite in meaſuring hills, *&c.* by means of the Barometer:—for this purpoſe, the ſcale is divided into Engliſh inches, and each inch into 20th parts, which are ſubdivided by a vernier into 25th parts, or 500th parts of inches; by this means ſhewing the height of the Mercury to the 500th part of an Engliſh inch. But this vernier is figured double, or each

each diviſion is accounted 2, which reduces the meaſures to 1000ths of an inch, for the conveniency of calculation.

6. *How to fill the* TUBE *with* MERCURY.

Take of Mercury one pound and a quarter, made very pure for the purpoſe, which being done, put it into a phial ſet before the fire to heat.

Then take the glaſs tube and make it very clean, heat it gently before the fire, and rub it pretty briſkly with a piece of leather or cloth, juſt before the Mercury is poured in.

In the next place, take a paper funnel with a ſmall hole in it, and put it into the mouth of the tube, filling it by ſlow degrees; but obſerve, as the Mercury riſes in the tube, there are bubbles of air in ſeveral parts of it left behind, which are got out in the following manner: continue pouring in the Mercury till it fill the tube within an inch of the top; then ſet down the

the phial, applying your finger hard and cloſe upon the top of the tube, and invert it; by which means you will ſee the air, which was on the top, riſing through all the Mercury, gathering every bubble in its way; then revert the tube, or turn it up again, the bubble of air now re-aſcends, and if any ſmall bubbles remain, they are by this means taken quite away, and the whole body of the Mercury is left entire.

Next take the phial and fill the tube to the top; pour the remainder of the Mercury into the baſon; put your finger faſt on the top of the tube, and once more invert it; then put your finger with the end of the tube under the Mercury in the baſon, and withdraw your finger gently from the tube, ſo that the Mercury in the baſon and tube may readily unite, without a particle of air getting in: then will the Mercury ſubſide, or ſink down from the top to its neceſſary height.—There is no fear of its falling too far, for the air will ſupport ſo much in the tube

tube as is equal to its own weight upon the ſame baſe with that of the Mercury; for when two fluids mutually preſs upon each other, they will always keep moving till they come to an equilibrium, or, where the weight is on each ſide equal, and then they muſt neceſſarily ſuſtain each other at reſt.

The method of filling the tube moſt to be depended upon, in order that all aerial particles which line the inſide of it may be got out, is to take a chaffing-diſh with burning coals, and place it on a table; the tube, hermetically ſealed at one end, is inverted, and filled with Mercury within two inches of the top; then it is gradually brought near the fire, moving it obliquely up and down, that the whole length of it may be heated, and advancing it nearer and nearer, till it is actually in the flame, when the globules of air begin to move viſibly towards the top: the boiling at laſt commences, and it is eaſy to make it take place from

from one end to the other, by cauſing the ſeveral parts of the tube ſucceſſively to paſs with rapidity through the flame. The tube may be afterwards emptied and filled even with cold Mercury, when it will be found nearly as free of air as before.

The tube being put into the baſon, (but not touching the bottom) and the frame being ſuppoſed to anſwer properly, you will not only have a good Barometer, but an ornamental piece of furniture.

Uſe of the BAROMETER *as a* WEATHER-GLASS.

THE words engraved on the ſcale, though, in general, the Mercury will agree with them, are not to be ſo much attended to as the Mercury's riſing and falling. For if it ſtand at *much rain*, and then riſe up to *changeable*, it preſages fair weather, though not to continue ſo long as if it had riſen higher: and ſo on the contrary, if the Mercury ſtand at *fair*, and fall to *changeable*, it preſages foul weather; though not ſo much of it as if the Mercury had ſunk lower.

Nor is it ſo much the height of the Mercury in the tube, that indicates the weather, as its motions up and down: wherefore, in order to paſs a right judgment of what weather is to be expected, we ought to know whether the Mercury be actually riſing or falling; for which purpoſe the following rules are of uſe.

RULES *to know whether the* MERCURY *is riſing or falling in the* TUBE.

1. IF the ſurface of the Mercury be convex, ſtanding higher in the middle of the tube than at the ſides, it is generally a ſign that the Mercury is riſing.

2. If the ſurface be concave, it is then ſinking; and,

3. If it be level, the Mercury is ſtationary; or rather, if it be a little convex;

convex: for Mercury being put into a glaſs tube, eſpecially a ſmall one, will naturally have its ſurface a little convex, becauſe the particles of Mercury attract one another more forcibly than they are attracted by the glaſs.

4. If the glaſs be ſmall, ſhake the tube; and if the air is grown heavier, the Mercury will riſe about half the tenth of an inch higher than it ſtood before; if it be grown lighter, it will ſink as much.

This proceeds from the Mercury's ſticking to the ſides of the tube, which prevents the free motion of it till it is diſengaged by the ſhock; and, therefore, when an obſervation is to be made with ſuch a tube, it ought always to be ſhaken firſt; for ſometimes the Mercury will not vary of its own accord, till the weather, which it ought to have indicated, be preſent.

Dr. HALLEY's *account of the various* PHENOMENA, &c. *of the* BAROMETER.

I conceive that the principal caufe of the rife and fall of the Mercury is from the variable winds which are found in the temperate zone, and whofe great inconftancy in England is notorious.

A fecond caufe is, the uncertain exhalation and precipitation of the vapours lodging in the air, whereby it comes to be at one time much more crowded than at another, and confequently heavier; but this latter depends in a great meafure upon the former. Now, from thefe principles, I fhall endeavour to explain the feveral phenomena of the Barometer.

1. *In calm weather, when the air is inclined to rain, the Mercury is commonly low.* The Mercury's being low indicates rain, becaufe the air being light, the vapours are no longer fup-

ported

ported thereby, having become ſpecifically heavier than the medium wherein they floated; ſo that they deſcend towards the earth, and, in their fall, meeting with other aqueous particles, they incorporate together, and form little drops of rain. But the Mercury's being at one time lower than another, is the effect of two contrary winds blowing from the place where the Barometer ſtands, whereby the air of that place is carried both ways from it, and conſequently the incumbent cylinder of air is diminiſhed, and accordingly the Mercury ſinks. As for inſtance, if, in the German ocean, it ſhould blow a gale of weſterly wind, and, at the ſame time, an eaſterly wind in the Iriſh ſea; or, if in France it ſhould blow a northerly wind, and in Scotland a ſoutherly, it muſt be granted, that that part of the atmoſphere impendent over England would thereby be exhauſted and attenuated, and the Mercury would ſubſide, and the vapours, which before floated in theſe parts of the air of equal gravity with themſelves, would ſink to the earth.

2. *In ſerene, good, and ſettled weather, the Mercury is generally high.* The greater height of the Barometer is occcaſioned by two contrary winds, blowing towards the place of obſervation, whereby the air of other places is brought thither and accumulated; ſo that the incumbent cylinder of air being increaſed both in height and weight, the Mercury preſſed thereby, muſt needs ſtand high, as long as the winds continue ſo to blow; and then the air being ſpecifically heavier, the vapours are better kept ſuſpended, ſo that they have no tendency to fall down in drops, which is the reaſon of the ſerene, good weather, indicated by the greater heights of the Mercury.

3. *Upon very great winds, though not accompanied with rain, the Mercury ſinks loweſt of all, with relation to the point of the compaſs from which the wind blows.* This is owing to the very rapid motion of the air in ſtorms of

wind. For the tract, or region of the earth's ſurface wherein the winds rage, not extending all round the globe, the ſtagnant air which is left behind, as likewiſe that on the ſides, cannot come in ſo faſt as immediately to ſupply the evacuation made by ſo ſwift a current, ſo that the air muſt neceſſarily be attenuated when, and where, the ſaid winds continue to blow; and that more or leſs, according to their violence: add to this, that the rapid horizontal motion of the air may, in all probability, take off ſome part of the perpendicular preſſure thereof; and the great agitation of its particles is the reaſon why the vapours are diſſipated, and do not condenſe into drops, ſo as to form rain, otherwiſe the natural conſequence of the air's rarefaction.

4. *The greateſt heights of the Mercury are found upon eaſterly or north-eaſterly winds; other circumſtances alike.* The Mercury ſtands higheſt upon the eaſterly or north-eaſterly winds; becauſe in the great Atlantic ocean,

ocean, on this ſide the 35th degree of north latitude, the winds are almoſt always weſterly or ſouth-weſterly; ſo that, in this country, when ever the wind comes up at eaſt and north-eaſt, it is ſure to be checked by a contrary gale, as ſoon as it reaches the ocean; wherefore, according to our ſecond remark, the air muſt needs be heaped over this iſland, and conſequently, the Mercury muſt ſtand high as often as theſe winds blow. This holds true in this country, but is not a general rule for others, where the winds are under different circumſtances: and I have ſometimes ſeen the Mercury here as low as 29 inches upon an eaſterly wind; but then it blew exceedingly hard, and may be accounted for by what was obſerved in the third remark.

5. *In calm froſty weather, the Mercury generally ſtands high.* Becauſe (as I conceive) it ſeldom freezes but when the winds come out of the northern and north-eaſtern quarters; or, at leaſt, unleſs thoſe winds blow at no great

great diſtance off. For the north parts of Germany, Denmark, Sweden, Norway, and all that tract whence north-eaſtern winds come, are ſubject to almoſt continual froſts during the winter; and thereby the lower air is very much condenſed, and in that ſtate is brought hither by thoſe winds, and being accumulated by the oppoſition of the weſterly wind blowing on the ocean, the Mercury muſt needs be preſſed to a more than ordinary height; and as a concurring cauſe, the condenſation of the lower parts of the air by cold muſt needs cauſe a deſcent of the upper parts of the atmoſphere, to bring the cavity made by this contraction to an equilibrium.

6. *After very great ſtorms of wind when the Mercury has been very low, it generally riſes again very faſt.* I once obſerved it to riſe one inch and an half, in leſs than ſix hours, after a long-continued ſtorm of ſouth-weſt wind. The reaſon is, becauſe the air being very much rarefied by the great evacu-

evacuations occaſioned by ſuch continued ſtorms, the neighbouring air runs in the more ſwiftly to bring it to an equilibrium; as we ſee water runs the faſter for having a greater declivity.

7. *The more northerly places have greater alterations of the Barometer than the more ſoutherly near the equator.*—Stockholm, for inſtance, has greater than Paris, (compared by M. Paſchal;) becauſe the more northerly parts have uſually greater ſtorms of wind than the more ſoutherly regions; for the northerly winds bringing in the more denſe and ponderous air from the neighbourhood of the pole, and that again being checked by a ſoutherly wind at no great diſtance, when thus accumulated, muſt of neceſſity make the Mercury, in ſuch a caſe, ſtand higher.

8. *Within the tropics, and near them, thoſe accounts we have had from others, and my own obſervations at St. Helena, make very little or no variation of the height of the Mercury in all weathers.*

weathers. This remark, that there is little or no variation near the equinoctial, does, above all others, confirm the hypotheſis of the variable winds being the cauſe of theſe variations of the height of the Mercury; for in the places above named, there is always an eaſy gale of wind, blowing nearly upon the ſame point, *viz.* E. N. E. at *Barbadoes*, and E. S. E. at *St Helena*; ſo that there being no contrary currents of air to exhauſt or accumulate it, the atmoſphere continues much in the ſame ſtate: however, upon hurricanes, (the moſt violent of ſtorms) the Mercury has been obſerved very low; but this is but once in two or three years, and it ſoon recovers its ſettled ſtate, about $29\frac{1}{2}$ inches.

We muſt obſerve, that the abovementioned phenomena are peculiar to places lying at a conſiderable diſtance from the equator; for, in the torrid zone, the Mercury in the Barometer ſeldom either riſes or falls much. In *Jamaica*, it is obſerved by Sir William Beeſton,

Beeſton, that the Mercury in the morning conſtantly ſtood at one degree below *changeable*, and at noon ſunk to one degree above *rain*; ſo that the whole ſcale of variation there, was only $\frac{3}{10}$ of an inch.

Mr.

Mr. PATRICK'S RULES *to judge of the* WEATHER *by the* BAROMETER,—*which are esteemed the best of any general rules hitherto made public.*

RISING *of the* MERCURY.	FALLING *of the* MERCURY.
Preſages in general FAIR weather.	Preſages FOUL weather, as *rain*, *ſnow*; alſo *high winds* and *storms*.
In *Winter* preſages *froſt*.	In very hot weather, indicates *thunder*.
In *continued froſt* preſages *ſnow*.	In froſty weather if it fall 3 or 4 diviſions, it will *thaw*.
If it prove *fair* immediately after the Mercury's *riſing*, its duration will be ſhort.	When *foul weather* happens ſoon after the falling of the Mercury. expect but little of it.
Riſing much in *foul weather*, and before it is over, and continuing ſo for two or three days, preſages a continuance of *fair weather*.	In *fair weather* when the Mercury falls much, and continues ſo for two or three days before rain comes; expect a great deal of *wet weather*, or *high winds*.
In *ſerene*, *good*, or *calm froſty weather* the Mercury is generally high.	The Mercury is *low* in calm weather, when the air is inclined to *rain*.
Its greateſt heights are found upon *easterly* or *north-easterly* winds.	The Mercury ſinks loweſt of all upon *very high winds*.
The Mercury generally riſes faſt after great ſtorms of wind, if it has been very low.	The unſettled motion of the Mercury denotes *changeable weather*.

To the foregoing may be added the following additional rules, accurately drawn from later and more cloſe obſervation of the motions of the Barometer, and the conſequent changes of the air in this country.

1. In *winter*, *ſpring*, and *autumn*, a ſudden and conſiderable falling of the Mercury denotes *high winds*, and and *ſtorms*, but in *ſummer heavy ſhowers*, and often *thunder*: it always ſinks low with great winds, though more with wind and rain together, than with either of them alone. If, after rain, the wind change into any part of the north, with a clear and dry ſky, and the Mercury riſe, it is a certain ſign of fair weather.

2. After very great *ſtorms of wind*, when the Mercury has been low, it commonly riſes again very faſt. In ſettled, fair and dry weather, except the Baremeter ſink much expect but little rain; for its ſmall ſinking then, preſages only a little wind, or a few drops of rain, and the Mercury ſoon riſes

riſes again to its former ſtation. In a wet ſeaſon, (ſuppoſe in *hay-time* and *harveſt*) due attention muſt be paid to the ſmalleſt ſinking of the Mercury; for when the conſtitution of the air is much inclined to ſhowers, a little ſinking in the Barometer denotes more rain, as it never then ſtands very high. And if, in ſuch a ſeaſon, it riſe ſuddenly very faſt and high, expect not fair weather more than a day or two, but rather that the Mercury will fall again very ſoon, and rain immediately follow. The ſlow, gradual riſing for two or three days together, being moſt to be depended on for a week's fair weather.

3. The greateſt heights of the Mercury, in this country, are found upon eaſterly and north-eaſterly winds; and it may often rain or ſnow while the wind is in theſe points, and the Barometer ſink little or none; or what is more ſingular, may even be in a riſing ſtate. The Mercury ſinks with wind as well as rain, in all the other points of

of the compaſs; but riſes as the wind ſhifts about to the north or eaſt, or between theſe points: but if the Barometer ſhould ſink with the wind in that quarter, expect it ſoon to change from thence; or elſe, ſhould the fall of the Mercury be much, a heavy rain is then likely to enſue.

To account for the foregoing phenomena of the Barometer, many hypotheſes have been framed, which may be reduced to two general heads, *viz.* *mechanical* and *chemical*. The chief writers upon theſe cauſes, are Paſcal, Beal, Wallis, Garcin, Garden, Liſter, Halley, Garſten, De la Hire, Mariotte, Le Cat, Woodward, Leibnitz, De Mairan, Hamberger, D. Bernoulli, Muſchenbroek, Chambers, De Luc, Black, &c. and an account of moſt of their hypotheſes may be ſeen at large in M. De Luc's *Recherches ſur les Modifications de l' Atmoſphere*, vol. 1. chap. 3. See alſo the *Philoſ. Tranſ.* and various other works on this ſubject.

MENSURATION *of* HEIGHTS *by the* BAROMETER.

HAVING ſhewn the uſe of the Barometer as a Weather-glaſs, I ſhall now proceed, briefly, to conſider it alſo as an inſtrument for meaſuring acceſſible altitudes. For this purpoſe, however, a PORTABLE BAROMETER is neceſſary, and the kind in general uſe differs only from the one already deſcribed, in having a *wooden reſervoir* with a *leathern bag* at the bottom, cemented to the lower extremity of the tube. The bag contains the Mercury, but it muſt not be filled quite full; and, though the external air cannot get into the bag to ſuſpend the Mercury in the tube, by preſſing on its ſurface, (as in the one deſcribed) yet it has the ſame effect by preſſing on the outſide of the bag, which being flexible yields to the preſſure, and keeps the mercury ſuſpended in the tube to its proper height. Through the under part of the frame paſſes a *ſcrew*, with a flat round plate at its end; by turning of this ſcrew, the bag may be ſo compreſſed as to force the Mercury up to the top of the tube, which keeps it ſteady, and hinders the tube from breaking by the Mercury's daſhing againſt its top, when carried about.

The air being of an elaſtic or ſpringy nature, its lowermoſt parts are preſſed with the weight of all that is above them; it is therefore plain, that it muſt be more denſe or compact at the earth's ſurface, than at any height above it, and gradually rarer the higher up; of courſe the Mercury in the Barometer ſinks lower and lower according to the height to which it is carried.

The method of meaſuring heights by the Barometer was firſt propoſed by M. Paschal, and ſucceeding philoſophers have been at no ſmall pains to aſcertain the proportion between the ſinking of the Mercury, and the height to which it is carried: various rules have alſo been given by the writers on this

ſubject,

ſubject, for computing the height aſcended from the given fall of the Mercury in the tube of the Barometer; the beſt of which, was that of DR. HALLEY, till it was rendered more accurate by the indefatigable reſearches of DE LUC, by introducing into it the corrections of columns of Mercury and air, on account of heat.—The moſt correct rule is deduced from one experiment only, and it is this, *viz.*

$$10000 \times \log. \text{ of } \frac{M}{m}$$ is the altitude in fathoms, in the mean temperature of 31°.; and for every degree of the Thermometer above that, the reſult muſt be increaſed by ſo many times its 435th part, and diminiſhed when below it: in which theorem M denotes the length of the column of Mercury in the Barometrical tube at the bottom: and *m* that on the top of the hill, or other eminence: which lengths may be expreſſed in any ſort of meaſures, whether feet, or inches, or tenths, *&c.* but

but the reſult is always in fathoms of 6 Engliſh feet each.

PRECEPTS *for the practice of* MEASUREMENTS *by the* BAROMETER.

1. Obſerve the height of the Barometer at the bottom of any height or depth, propoſed to be meaſured; together with the temperature of the Mercury by means of a Thermometer *attached* to the Barometer, and alſo the temperature of the air in the ſhade by another Thermometer, which is *detached* from the Barometer.

2. Let the ſame thing be done alſo at the top of the ſaid height or depth, and as near to the ſame time with the former as poſſible. And let the altitudes of Mercury be reduced to the ſame temperature, if it be thought neceſſary, by correcting either the one or the other, *viz.* augmenting the height of the Mercury in the colder temperature, or diminiſhing it in the warmer, by its 9600th part for every degree of difference

ence between the two; and the altitudes of Mercury ſo corrected, are what are denoted by M and *m* in the algebraic formula above.

3. Take out the common logarithms of the two heights of Mercury, ſo corrected, and ſubtract the leſs from the greater, cutting off from the right-hand ſide of the remainder three places for decimals, ſo ſhall thoſe on the left be fathoms in whole numbers, the tables of logarithms being underſtood to be ſuch as have ſeven places of decimals.

4. Correct the number laſt found for the difference of the temperature of the air, as follows; *viz.* Take half the ſum of the two temperatures of the air, ſhewn by the *detached* Thermometers, for the mean one; and for every degree which this differs from the temperature of 31°. take ſo many times the 435th part of the fathoms above found, and add them if the mean temperature be more than 31°. but ſubtract them if below it; ſo ſhall the ſum or

or difference be the altitude in fathoms, or, being multiplied by 6, it will give the altitude in English feet.

EXAMPLE I.

Let the state of Barometers and Thermometers be as follows, to find the altitude.

THERMOM. detached.	THERMOM. attached.	BAROMETERS.
57	57	29.68 lower
42	43	25.28 upper
mean $49\frac{1}{2}$	diff. 14	

As 9600 : 14 : : 29.68 : .04

cor. .04 logs.

mean $49\frac{1}{2}$	M = 29.64 — 4718782	
stand 31	m = 25.28 — 4027771	

diff. $18\frac{1}{2}$ As 435 : $18\frac{1}{2}$: : 691.011 : 29.388

29.388

The altitude sought is { 720.399 fath. or 4322.394 feet.

EXAMPLE

EXAMPLE II.

Suppose the following observations to be made, it is required to find the altitude of the hill.

THERMOM. detached.	THERMOM. attached.	BAROMETERS.	
35	41	29.45	lower.
31	38	26.82	upper.
mean 33	diff. 3		

As 9600 : 3 : : 29.45 : .01
.01 logs.

mean 33 $M = 29.44$ — 4689378
stand. 31 $m = 26.82$ — 4284588

diff. 2 As 435 : 2 : : 404.790 : 1.86
1.86

The altitude is { 406.65 faths.
or 2439.90 feet.

See the rule investigated in Hutton's Mathematical Dictionary, under the the article *Pneumatics*.

Mr.

Mr. FERGUSSON, author of the Lectures on Mechanics, and other ingenious publications, has, in his Mechanical Exercises, given us the following table of the proportion between the finking of the Mercury and the height to which it is carried; by which the height of a hill, *&c.* is feen by infpection only, though not with fo great accuracy as the method already defcribed.

TABLE.

At the height of feet.	Mercury finks in. 100pts.	At the height of feet.	Mercury finks in. 100pts.
100	0 .11	800	0 .87
200	0 .22	900	0 .98
300	0 .33	1000	1 .09
400	0 .44	1100	1 .19
500	0 .54	1200	1 .30
600	0 .65	1300	1 .40
700	0 .76	1400	1 .50

At

At the height of feet.	Mercury finks in. 100pts.	At the height of feet.	Mercury finks in. 100pts.
1500	1 .61	3700	3 .83
1600	1 .72	3800	3 .92
1700	1 .82	3900	4 .02
1800	1 .93	4000	4 .12
1900	2 .03	4100	4 .21
2000	2 .14	4200	4 .30
2100	2 .24	4300	4 .39
2200	2 .34	4400	4 .49
2300	2 .44	4500	4 .58
2400	2 .54	4600	4 .67
2500	2 .65	4700	4 .77
2600	2 .75	4800	4 .86
2700	2 .85	4900	4 .95
2800	2 .95	5000	5 .04
2900	3 .05	5100	5 .13
3000	3 .15	5200	5 .22
3100	3 .25	5300	5 .31
3200	3 .34	5400	5 .40
3300	3 .44	5500	5 .49
3400	3 .54	5600	5 .58
3500	3 .63	5700	5 .67
3600	3 .73	5800	5 .76

At the height of feet.	Mercury finks in. 100 pts.	At the height of feet.	Mercury finks in. 100 pts.
5900	5 .85	8100	7 .71
6000	5 .94	8200	7 .79
6100	6 .02	8300	7 .87
6200	6 .11	8400	7 .95
6300	6 .20	8500	8 .03
6400	6 .28	8600	8 .11
6500	6 .37	8700	8 .19
6600	6 .45	8800	8 .27
6700	6 .54	8900	8 .35
6800	6 .63	9000	8 .43
6900	6 .71	9100	8 .51
7000	6 .80	9200	8 .58
7100	6 .88	9300	8 .66
7200	6 .97	9400	8 .74
7300	7 .05	9500	8 .82
7400	7 .13	9600	8 .89
7500	7 .22	9700	8 .97
7600	7 .30	9800	9 .05
7700	7 .38	9900	9 .12
7800	7 .46	10000	9 .20
7900	7 .55	10100	9 .27
8000	7 .63	10200	9 .34

At the height of feet.	Mercury finks. in.	100 pts.	At the height of feet.	Mercury finks in.	100 pts.
10300	9	.42	12500	11	.01
10400	9	.50	12600	11	.08
10500	9	.57	12700	11	.15
10600	9	.64	12800	11	.22
10700	9	.72	12900	11	.29
10800	9	.79	13000	11	.36
10900	9	.87	13100	11	.43
11000	9	.94	13200	11	.50
11100	10	.01	13300	11	.56
11200	10	.08	13400	11	.63
11300	10	.16	13500	11	.70
11400	10	.23	13600	11	.77
11500	10	.30	13700	11	.84
11600	10	.37	13800	11	.90
11700	10	.44	13900	11	.97
11800	10	.52	14000	12	.04
11900	10	.59	14100	12	.11
12000	10	.66	14200	12	.17
12100	10	.73	14300	12	.24
12200	10	.80	14400	12	.30
12300	10	.87	14500	12	.37
12400	10	.94	14600	12	.44

At the height *of feet.*	Mercury finks *in. 100 pts.*	At the height *of feet.*	Mercury finks *in. 100 pts.*
14700	12 .50	16400	13 .59
14800	12 .57	16500	13 .65
14900	12 .63	16600	13 .71
15000	12 .70	16700	13 .78
15100	12 .76	16800	13 .84
15200	12 .83	16900	13 .90
15300	12 .89	17000	13 .96
15400	12 .96	17100	14 .02
15500	13 .02	17200	14 .08
15600	13 .09	17300	14 .15
15700	13 .15	17400	14 .21
15800	13 .21	17500	14 .27
15900	13 .28	17600	14 .33
16000	13 .34	17700	14 .39
16100	13 .40	17800	14 .45
16200	13 .47	17900	14 .51
16300	13 .53	18000	14 .57

By a common Barometer, the height of any hill may be found, if its height, taken in perpendicular meafure, be not much above half a mile.—Thus, if the

the Mercury be 2 inches and 95 hundred parts of an inch lower in the tube at the top of the hill, than what it was obſerved to be at the bottom, the perpendicular height of the hill is 2800 feet, which is 160 feet more than half a mile.

But, as there are many hills much higher than 2800 feet, and the common Barometer-ſcale is only 3 inches long, let a ſcale, 14 inches long, divided into inches, and hundred parts of an inch, by diagonal lines, be applied to the tube, and have a ſliding index acroſs it in the common way: this, I apprehend, will anſwer for the higheſt mountain on the earth.—For, ſuppoſing the quickſilver was obſerved to be 13 inches, and 21 hundred parts of an inch lower in the tube, when at the top of the hill, than it was when at the foot, againſt 13.21 inches in the above table is 15800 feet for the height of the hill, which wants only 40 feet of being 3 miles high; 5280 feet being a mile.

The following table for meaſuring heights, &c. by the Barometer, is taken from EMERSON'S MECHANICS. The firſt column is the height of the mountain, &c. in feet or miles; the ſecond the height of the Mercury in the Barometer; the third its deſcent; and this at a mean denſity of the air.

Feet.	*High Barom.*	*Deſcent.*
0	29 .500	
100	29 .400	.100
200	29 .301	.199
300	29 .203	.297
400	29 .105	.395
500	29 .007	.493
600	28 .910	.590
700	28 .812	.688
800	28 .716	.784
900	28 .619	.881
1000	28 .523	.977
1100	28 .428	1 .072
1200	28 .332	1 .168
1300	28 .237	1 .263

Feet.	*High Barom.*	*Descent.*
1400	28.143	1.357
1500	28.048	1.452
1600	27.954	1.546
1700	27.860	1.640
1800	27.766	1.734
1900	27.672	1.828
2000	27.579	1.921
2100	27.487	2.013
2200	27.394	2.106
2300	27.302	2.198
2400	27.210	2.290
2500	27.119	2.381
2600	27.028	2.472
2700	26.938	2.562
2800	26.848	2.652
2900	26.758	2.742
3000	26.668	2.832
3100	26.578	2.922
3200	26.489	3.011
3300	26.400	3.100
3400	26.311	3.189
3500	26.222	3.278
3600	26.136	3.364
3700	26.049	3.451

Feet.	*High Barom.*	*Descent.*
3800	25.961	3.539
3900	25.874	3.626
4000	25.786	3.714
4100	25.699	3.801
4200	25.613	3.887
4300	25.527	3.973
4400	25.441	4.059
4500	25.355	4.145
4600	25.270	4.230
4700	25.185	4.315
4800	25.101	4.399
4900	25.017	4.483
5000	24.933	4.567

The Table continued in Miles.

Miles.	*High Barom.*	*Descent.*
0.	29.50	
0.25	28.21	1.29
0.50	26.98	2.52
0.75	25.80	3.70
1.	24.70	4.80
1.25	23.62	5.88
1.50	22.60	6.90

Miles.	*High Barom*	*Descent.*
1 .75	21 .62	7 .88
2 .	20 .68	8 .82
2 .25	19 .78	9 .72
2 .50	18 .93	10 .57
2 .75	18 .11	11 .39
3 .	17 .32	12 .18
3 .25	16 .57	12 .93
3 .50	15 .85	13 .65
3 .75	15 .16	14 .34
4 .	14 .50	15 .00
4 .25	13 .87	15 .63
4 .50	13 .27	16 .23
4 .75	12 .70	16 .80
5 .	12 .15	17 .35
5 .25	11 .62	17 .88
5 .50	11 .12	18 .38
5 .75	10 .64	18 .86
6 .	10 .18	19 .32

At the foot of a mountain the Mercury in the Barometer ſtands at 29.500 inches, and its top ſinks to 28.143, What is its height?

Look down the column for the *height*

height of the *Barometer*, at the top of the mountain, *viz.* 28.143, oppoſite to which, in the column marked *feet*, is 1400, being the height required, and in the column marked *deſcent*, 1.357, which is the difference in the altitude of the Mercury at the top and bottom of the mountain.

TABLES *of* HEIGHTS *taken by the* BAROMETER *in different places.*

Heights above the level of the ſea, near EDINBURGH.

	Feet.
Piazza of Holy-rood-houſe,	135
Nether Bow, Edin. -	210
Croſs of Edin. - -	315
Caſtle of Edin. on the 24 lb. gun battery, -	510
Calton hill, - - -	350
Saliſbury Craig, - -	550

Arthur's

Arthur's Seat,	- -	796
Libberton Tower,	- -	590
Dalkeith Town,	- -	200
Pentland Hill,	- -	1700

Clydesdale.

Summit of Tinto, *Col. Roy*,	2432
Mr Stirling's houſe at Lead-hills, - - -	1564
Summit of the higheſt of the Luthers at Lead-hills,	2522

Highlands *of* Scotland.

Inver Ferry, at Dunkeld,	150
Caſtle Menzies, - -	283
Ben Lawers, *Lord Privy Seal*,	4015
——— ——— above Loch-Tay, *Maſon*, -	3588
——— ——— ——— Tay-Bridge, *Col. Roy*,	3729
Ben More, *Lord Privy Seal*,	3903
Ben Lomond, *Dr Wilſon and Profeſſor Anderſon*,	3150
Paps of Jura. - -	2444

Ben

Ben Clo, in Athol, *Lord Privy Seal*, - -	3724
——— above the Cascade, at Blair, *Mason*, -	2998
Shehallien, in Athol, -	3550
——— from the base, *Mason*, - -	2090
——— above Taybridge, *Col. Roy*, - -	3281
Bennevis, in Lochaber, by the nearest computation,	4284

There is probably still higher ground than Bennevis in some inland parts of the Highlands, but, as it rises immediately from the sea, it is reckoned the the highest hill in Scotland.

Different Parts *of* Europe.

Vesuvius, *Sir W. Hamilton*,	3659
Mount Ætna, *Mr Brydone*,	10,617
——— ——— *Saussure*, -	10,660
Pay de Dome, in France,	5221
Mount d' Or, in Auvergne,	6696
Highest of the Pyrenees,	8646

Flag

Flag-houſe, at Gibraltar,	1276
Peak of Teneriffe, *D. Borda*,	11,092
—— — ——— geometrically, *Dr Heberden*,	15,396
Snowden, in Wales, *Mr Caſewell*, - -	3720

SOUTH AMERICA.

City of Quito, in Peru, *Bouguer*, - -	9242
Mountain Chinculagua, in Peru, - - -	11,790
Catopaxi, in Peru, geometrically, *French feet*,	18,756
Chimborazo, in Peru, geometrically, *Bouguer*,	20,588

This laſt is the higheſt part of the globe yet meaſured, and Quito *the higheſt that is inhabited.*

SWITZERLAND *and the* ALPS.

Lake of Geneva, *De Luc*,	1126
City of Zurich, *Scheuzer*, *French feet*, -	1264

Mountain Tettlesberg, above the adjacent valley, *French feet*, -	4650
Stella, one of the highest of the Rhætian Alps, *French feet*, - - - -	9585
Mount Blanc, *De Luc*,	15,403
——— ——— *Sir G. Shuckbrugh*, - - -	15,662

THERMOMETER.

THE Thermometer is an instrument for measuring the increase and decrease of the heat and cold of the air, *&c.* Its invention is attributed to several persons, by different authors, *viz.* to *Sanctorio*, *Galileo*, *Father Paul*, and *Drebbel*. But whoever was the author of it, like most other discoveries, it was, in its infancy, very rude and imperfect.

It is now known to be a general law of

of Nature, that the effect of heat on most bodies, is an increase of their dimensions, and that fluids are much more subject to a dilatation and contraction of their bulk than solid bodies; hence recourse is naturally had to them in the construction of Thermometers.

Air is a fluid of all others most apt to be rarefied by heat, and condensed by cold; and would serve for the medium of a Thermometer the best of any thing in nature, were it not that the same effects are produced by its gravity, as well as from different degrees of heat and cold, and so the experiment of a Thermometer with air, would become ambiguous.

Water is a fluid which expands and contracts the least of any, and consequently not fit for a Thermometer.

Oil is a fluid with which our virtuosi have greatly succeeded in their Thermometers, particularly *linseed-oil*, as it requires a much greater heat to make it boil than water, or spirits, or that which melts wax, tin, and lead; yet

yet, as it is apt to ſtick to, and foul the tube in which it is contained, the oil Thermometer is, therefore, but very little in uſe.

The fluid which we call SPIRIT has been, and ſtill is, uſed for a Thermometer; but it can ſhew no greater degree of heat than that which will make it boil, in which reſpect it is much inferior to oil.

Of all fluids MERCURY is the beſt, becauſe it is very moveable and ticklish, and heats and cools faſter than any liquor we know; it bears a great deal of heat before it arrives at a boiling expanſion, and a greater cold without freezing than any other fluid; and, if well purified, does not wet or ſtick to the inſide of the tube.

The Mercurial Thermometer is ſaid to have been firſt contrived by *Olaus Roemer*. Mr *Fahrenheit* manufactured very many of them, and that in a neat, portable, and convenient form, for many purpoſes; and, to this day, they ſtill go by his name.

CONSTRUCTION *of the* THERMOMETER.

THE *Tubes* may be had at the Glaſs-houſe, and care muſt be taken to ſee that their cavities be equal, or cylindrical, throughout. This is done by immerſing one end into Mercury, and withdrawing it after cloſing the other end with the finger. By this means a ſmall quantity of Mercury will enter the tube, which will occupy a longer ſpace the deeper the tube is immerſed. Lay the tube horizontally upon a graduated ſcale, and obſerve the length of the Mercurial column in different parts of the tube, in which it may be made to run, by inclining it more or leſs. If the length continues invariably the ſame, it is a proof that the tube is uniformly cylindrical; but if otherwiſe the diameter varies, and the tube cannot be uſed to make a good Thermometer, unleſs the graduations in the different parts of the tube be be lengthened or ſhortened, in proportion to the meaſures of the Mercurial column.

Direct the flame of a large candle, or a lamp with ſpirits of wine, upon one end of the glaſs tube, by means of a blow-pipe;—the extremity will ſoon become red-hot, and in a ſtate of imperfect fuſion:—remove the tube from the flame, and blow into its other end, and the heated part will be inflated ſo as to form a bulb. This laſt inflation is the moſt difficult part of the buſineſs; but it may be performed with great eaſe and advantage, by previouſly faſtening the neck of a ſmall bottle of elaſtic gum, about the end of the tube; which, when the other end is ignited, may be preſſed by the hand, ſo as to blow the bulb very commodiouſly.

Immerſe the open end of the tube into ſome very clean dry, Mercury, that has been boiled, and warm the bulb with a candle; part of the air will be immediately heard ruſhing through the

Mer-

Mercury; withdraw the candle, and, as the bulb cools, the Mercury will riſe in the tube. This will be facilitated, by holding the tube as near an horizontal poſition as can be done, without raiſing its lower end above the ſurface of the Mercury. In this way the bulb will be nearly half filled. Without altering the poſition of the apparatus, move the whole, ſo that the bulb may be held over a candle. The Mercury will ſoon boil, and moſt of the remaining air will be heard eſcaping from the bulb. As ſoon as this eſcape has ceaſed, remove the bulb from the candle, and it will be ſuddenly filled with Mercury from the veſſel.

Take the Thermometer, thus filled, out of the Mercury, and wrap round its open end a piece of thin paper, in ſuch a manner as to leave a cavity beyond the tube, at leaſt ſufficient to hold as much Mercury as the bulb contains; ſecure this by wrapping it tight with pack-thread

thread about the tube; then put a drop of Mercury into the paper cavity, and apply the bulb again over a ſnuffed candle, holding the tube upright between the finger and thumb, or a pair of ſmall pincers; the Mercury will ſoon boil, and about half the contents of the bulb will ruſh violently up the tube into the paper. Remove the bulb from the candle, and the Mercury will ſuddenly return; then boil it again, and repeat the operation till the ſpeedy boiling of the Mercury, when placed over the candle, and the diminiſhed noiſe and agitation, ſhew that the whole has been well heated, and deprived of the air or moiſture, which might have adhered to it.

The operation of boiling will fail, if the Mercury, or the inſide of the bulb be moiſt; for, in this caſe, the bulb is uſually burſt by the Mercurial vapour. It is prudent not to boil the Mercury ſtrongly the firſt or ſecond time; and it is likewiſe of importance to keep the bulb

bulb clear of the flame, as the contact of this last against the empty part of the bulb would melt it, and a hole would be immediately made by the excluded vapour.

After the boiling is completed, plunge the bulb into cold water, whose temperature is known. Melting ice, or snow, (or snow and water) always has the temperature of 32° of Fahrenheit's scale. Then take off the paper, and put the bulb into the hand, and afterwards into the mouth: this heating will cause some of the Mercury to drop out of the tube. Cool it again to 32°, by immersing it in the cold water, and mark where the Mercury stands. The distance between this station and the top of the tube measures the interval between freezing and blood heat, or 32 and 96, which makes 64 degrees; and will, consequently, shew whether the degrees will be large or small, and what extent the scale is capable of; that is to say, it will shew whether the bulb is of the proper ſize. This laſt, ſuppoſing the judgment of the operator not ſufficient to proportion the bulb nearly to the tube, and the intended ſcale, might, however, have been more conveniently aſcertained after the firſt filling, before the boiling had been undertaken.

When the number of the degrees, to which the length of the tube will extend, is thus known, the operator muſt ſettle whereabouts he will have the freezing point, which may be nearer or farther from the bulb, according as he intends the inſtrument to be uſed, more particularly to aſcertain great degrees of heat or cold. At this ſtage of the buſineſs, likewiſe, he may heat the upper part of the tube with the blow-pipe, and draw it out to a fine capillary tube, ready for ſealing. The bulb muſt then be heated in the candle, till a few particles of Mercury have fallen off the top of the tube; and notice muſt then be taken how much nearer the freezing point

point is to the bulb than before; which may be done by immerſing it in melting ſnow, as formerly. If it be not as low as deſired, the heating muſt be repeated, carefully obſerving not to throw out too much Mercury at a time. When the due quantity of Mercury is thus adjuſted, two candles muſt be prepared; the one to heat the bulb, and the other to cloſe the tube. The blow-pipe being in readineſs, the upper part of the tube near the flame of one candle, and the bulb near the flame of the other, the Mercury will riſe, and at laſt begin to form a globule at the point of the capillary tube. At this inſtant the bulb muſt be withdrawn from the lower candle, at the ſame time that the flame of the upper is directed by the blow-pipe upon the point of the tube. This laſt will be immediately ignited, and will cloſe, by the melting of its parts, before the Mercury has perceptibly ſubſided. When the Mercury has fallen, this cloſure may be rendered

dered more secure from accidental breaking, by fusing the whole point of the tube, till it becomes round.

In the original graduation of Thermometers, two fixed points of temperature are necessary. These are the freezing point of water, or temperature of ice or snow, at the instant of formation, or, rather, when it is just beginning to liquify; and the boiling point of water, or temperature at which, under a known pressure, it is plentifully converted into steam. For settling the freezing point, nothing more is necessary than to immerse the Thermometer so deep in melting snow or ice, as that the Mercury may be barely visible above its surface, and carefully mark the place at which it stands. The boiling point is not quite so easily ascertained; crude, hard, or saline waters acquire a greater heat in boiling, than such as are purer; and the same water will acquire a greater heat under a greater pressure. For this last reason the boiling point should be be fixed when the Barometer ſtands at 29.8 inches.

The beſt method is to provide a a veſſel ſomewhat longer than the Thermometer, with a cover and two holes in it, one about an inch in diameter, for the ſteam to eſcape, and the other ſmaller, for the Thermometer tube to be faſtened in it. When this is uſed, the Thermometer muſt be faſtened in the cover, ſo that the eſtimated place of the boiling point may be juſt above the hole. Water muſt be put into the veſſel, not ſufficient to touch the bulb of the Thermometer, when the cover ſhall be put on. The veſſel muſt then be covered, a thin plate of metal laid on the ſteam hole, and the water made to boil by heat applied to the bottom only. The Thermometer will then be ſurrounded with ſteam, which will raiſe its temperature to the boiling point; and this point muſt be carefully marked on the tube.

The Thermometers moſt in uſe are *Fahrenheit's*, *Reaumur's*, and *Celſius's* (*or the Swedish Thermometer*). In Fahrenheit's scale, the number of degrees between the freezing and boiling water point is 180; the freezing point being at 32°, and the boiling point at 212°, both above 0°, or or the part from which the degrees are reckoned both ways. In Reaumur's scale, the number of degrees between these two points is 80, and the freezing point is called 0°, from which the degrees are reckoned both ways. In Celsius's Thermometer, the interval is divided into 100°, and the freezing point is called 0°, as in Reaumur's.

RULES *for reducing the degrees of Reaumur's and of the Swedish Thermometer, to the corresponding degrees on Fahrenheit's scale.*

To reduce these scales to each other, it must be observed that one degree of Fahrenheit's is equal to $\frac{4}{9}$ of a degree of Reaumur, and to $\frac{5}{9}$ of a degreee of Celsius. Therefore, if the number of degrees of Fahrenheit, reckoned above or below the freezing point, be multiplied by 4, and divided by 9, the quotient will be the correſponding number on Reaumur's ſcale. Or if the multiplier 5, and the diviſor 9, be uſed, the quotient will give the degrees of Celſius's ſcale. On the contrary, if any number of degrees, either of Reaumur or Celſius be multiplied by 9, and divided by 4, if of Reaumur, or by 5, if of Celſius, the quotient will give the degrees of Fahrenheit.

A ſcale thus divided, and the tube accurately fixed to it, completes the Thermometer.

THERMOMETERS *for particular uſes.*

Lord Cavendiſh, in 1757, preſented to the Royal Society, an account of a curious conſtruction of Thermometers, of two different forms; one contrived to ſhew the greateſt degree of heat, and the other the greateſt cold, that may happen at any time in a perſon's abſence.

absence. *Philosoph. Transact.* vol. 50. page 300.

Since the publication of Mr Canton's discovery of the compressibility of spirits of wine and other fluids, there are two corrections necessary to be made in the result given by *Lord Cavendish's* Thermometer; for the method of making these, see *Phipps's voyage to the North Pole*, page 145.

Instruments of this kind, for determining the degree of heat or cold, in the absence of the observer, have been invented and described by others. *Van Swinden* (*Diss. sur la comparaison du Therm.* p. 253, &c.) describes one which he says, was the first of the kind, made on a plan, communicated by Bernoulli to Leibnitz. *Mr Kraft* made one nearly of the same construction. *Mr Six*, in 1782, proposed another construction of a Thermometer of the same kind, described in the *Philosoph. Transact.* vol 72. p. 72.

M. de Luc has described the best method of constructing a Thermometer

fit

ſit for determining the temperature of the air, in meaſuring of heights by the Barometer.

Mr Cavallo, in 1781, propoſed the conſtruction of a *Thermometrical Barometer*, which, by means of boiling water, might indicate the various gravity of the atmoſphere, or the height of the Barometer. *Philoſoph. Tranſact.* vol. 71. p. 524.

Mr Wedgwood has contrived to make a Thermometer for meaſuring the higher degrees of heat, by means of a diſtinguiſhing property of argillaceous bodies, *viz.* the diminution of their bulk by fire. This diminution commences in a low red heat, and proceeds regularly, as the heat increaſes, till the clay becomes vitrified. The total contraction of ſome good clays, which he has examined in the ſtrongeſt of his own fires, is conſiderably more than one-fourth part in every dimenſion. By meaſuring the contraction of ſuch ſubſtances, Mr Wedgwood contrived to meaſure the moſt intenſe heats of ovens, furnaces, &c. For the curious particulars of which, see *Philosoph. Transact.* vol. 72. p. 305, &c.

Uses *of the* Thermometer.

The nature of the Thermometer is one of the most pleasant speculations in philosophy; and the instrument itself, in its present improved state, is of the greatest utility. To know the different degrees of heat and cold in the atmosphere proves a pleasure to inquisitive minds; especially as we can see it exactly measured by the divisions on the scale, much better than we can be acquainted with it by the feeling of the human body, which is extremely delusive. It may also be of considerable use in medicine, being a good index for shewing the heat of the human body;—for a Thermometer placed in the hand, in the mouth, or under the arm-pit, and there held for the space of a minute, will undoubtedly discover the degree

degree of heat in ſuch a body; by which it will be eaſy to underſtand if it has a tendency to be feveriſh, and how far it is ſo.

An Experiment.

Take the Thermometer off from the plate, and hold the bulb about an inch above the flame of a ſpirit-lamp, or well ſnuffed candle; the Mercury inſtantly riſes up very faſt. By bringing it nearer the flame, the Mercury, in a ſhort time, riſes half-way up the tube; but by placing the bulb in the body of the flame, the heat immediately cauſes it to riſe to the top; and if continued there but a very ſhort ſpace, the Mercury would boil and fly out of the tube.

Thermometers are of great importance to Botaniſts, and thoſe gentlemen who are curious in the culture of exotic plants; and thence it is we ſee theſe inſtruments ſo common in ſtoves, green-houſes, and botanic gardens, to regulate and determine the degrees of heat

neceſſary

neceſſary for each reſpective ſpecies of plants; for as thoſe of foreign extraction are brought from different countries, the degrees of native heat, or that peculiar to their climes, muſt be imitated, as near as poſſible, in the hot-houſe and hot-beds which alone can be done by a botanical Thermometer; in which you will obſerve thoſe foreign plants require the ſeveral degrees of heat againſt which their names are placed on the ſcale.

The Thermometer is of excellent uſe in chemiſtry, for diſcovering the ſeveral degrees of heat which ariſe upon the mixtures of different kinds of fluids, and fermentations conſequent thereupon; they will diſcover great degrees of heat, where, otherwiſe, none at all would be ſuſpected: thus, *for inſtance*, a little oil of vitriol, poured into a tumbler of water, ſhews, by the Thermometer placed in it, a conſiderable degree of heat, when no commotion of the compound fluid appears to the naked eye.

That the heat of boiling water is greater at the foot of a mountain than at its top, has been found by experiment. In order to determine the height of the column of air which corresponds to 1 degree of Fahrenheit's Thermometer, the following experiment was made upon the Paps of Jura.

A Barometer was filled upon the ſhore, and when placed by a level, ſtood at 29.7 inches. Upon the top of the mountain it ſtood at 27.1, that is 2.6 inches lower than upon the ſhore. The Thermometer was then put into a kettle of boiling water, prepared for the purpoſe; and, after repeated immerſions, roſe no higher than 207°.—Having reached the ſhore, the ſame Barometer again ſtood exactly at 29.7, as before. The Thermometer being put into boiling water, roſe to 213°.

From this experiment, it appears, that the difference of the column of Mercury

Mercury in the Barometer, *viz.* 2.6 inches (aſſuming 94 feet for each $\frac{1}{10}$), will make the height of the mountain 2444 feet above the level of the ſea. The difference of the heat of boiling water at the top and bottom is 6°, and the height of the mountain divided by this number is 407 feet for each degree.

The reſult therefore is, that for every 407 feet you aſcend, the heat of boiling water diminiſhes one degree: and the Thermometer, on this account, may be uſed as an inſtrument for meaſuring acceſſible heights.

THE medium heat of the atmoſphere, in any place, may be known by immerſing the Thermometer in a ſpring-well; for it is found by experiments that the heat of ſprings is the ſame with the medium and ſubterranean heats of the climate to which they belong.— The medium heat of the atmoſphere in Scotland is 45° of Fahrenheit,—in England

England 48°,—in the cave of the obſervatory at Paris 53°,—and at Upſal 43°;—and this is found to be the heat of the ſprings in the neighbourhood of theſe places.

TABLE OF SCALES OF HEAT.

Degrees of Fahrenheit.	
5237	Fine gold melts.
4717	Fine ſilver melts.
3807	Braſs melts.
1050	Iron as hot as common fire could make it.
884	Iron red in the twilight.
752	Iron red in the dark.
635	Loweſt ignition of iron in the dark.
600	Oil of linſeed and other expreſſed oils boils. Alſo quickſilver boils.
560	Oil of turpentine boils.
546	Vitriolic acid boils.

Degrees of Fahrenheit.	
540	Lead melts.
460	Bifmuth melts.
408	Tin melts.
334	A mixture of 3 parts of tin and 2 of lead melts.
283	A mixture of equal parts of tin and bifmuth melts.
244	Sulphur melts.
242	Nitrous acid boils.
240	Lixivium of tartar boils.
218	Saturated folutions of falts boil.
213	Cows milk boils.
212	WATER BOILS. A mixture of 5 parts of bifmuth, 3 of tin, and 2 of lead melts.
206	Human urine boils.
190	Brandy boils.
174	Alkohol boils.
156	Serum and albumen coagulate.
146	Kills animals in a few minutes.
142	Bees wax melts.
108	Hens hatch eggs.
107	Feverifh heat.

Degrees of Fahrenheit.	
106	To 110 Heat of the ſkin in a common ague and fever.
102	Greateſt heat in Georgia.
99	To 92, heat of the human ſkin in health.
98	Summer heat in Charleſtown, South Carolina.
97	Heat of a ſwarm of bees.
100	To 96, animal heat, or blood-warm.
94	Heat in Philadelphia, May 23, 1793.
93	Summer heat in Maryland.
88	Heat at Plymouth, July 12, 1757.
87	Summer heat in Minorca.
80	Very warm and ſultry weather.
80	Heat of the ocean under the equator.
74	Butter begins to melt.
66	Heat to grow Pimento.
64	Summer heat in this climate.

Degrees of Fahrenheit.	
63	Heat to grow Euphorbium.
50	Heat to grow Ficoides.
48	Medium heat of England.
47	Heat to grow Oranges.
45	Medium heat of Scotland.
44	Heat to grow Myrtles.
36	Olive oil melts.
32	WATER FREEZES.
30	Milk freezes.
28	Vinegar freezes.
25	Human blood freezes.
24	Very cold weather.
20	Strong wines freeze.
16	Mercury ſeldom lower in this country.
8	Cold at Paris, 1708—9.
7	A mixture of 1 part of alkohol, and 3 of water, freezes.
6	Cold at Cambridge, 12th Feb. 1771.
5	Greateſt cold in Pennſylvania, in 1731—2, lat. 40°.
2	Cold at New Poſſo, in January 1768.

Degrees of Fahrenheit.	
0	A mixture of ſnow and ſalt, which can freeze Oil of Tartar per deliquium, but not Brandy.
* — 1	Cold at Upſal, 1732.
— 2	Cold at Glaſgow, 1768.
— 4	Cold produced by a mixture of ſnow and ſalt.
— 7	Brandy, or a mixture of equal parts of alkohol and water, freezes.
—11	A mixture of two parts of alkohol and one of water freezes.
—34	The ſpirit of wine in Reaumur's Thermometer froze at Torneo.
—40	Fahrenheit's experiments with freezing mixtures. Quickſilver congeals. Nitrous acid cryſtalizes.

* This character — ſignifies below 0, or *Zero*: thus, — 7 means 7 degrees below 0, or below the beginning of the ſcale.

Degrees of Fahrenheit.	
—69	Cold produced by Mr M'Nab at Hudſon's Bay, in December 1784, by a mixture of vitriolic acid and ſnow.

HYGROMETER.

THE Hygrometer, or Hygroſcope, is an inſtrument by which we meaſure the degrees of dryneſs, or moiſture of the atmoſphere.

There are many different forms of theſe inſtruments. The materials of which they have been made, depend, in general, upon three different principles, *viz.*

1. The *expanſion or contraction* of bodies, by moiſture or dryneſs.

2. The *different motions* of the ſame body, occaſioned by thoſe different qualities of the air.

3. And

3. And the *increaſe or decreaſe* of weight from the ſame cauſes.

Thoſe Hygrometers which belong to the firſt principle, are commonly made of wood: thus, every plank or board becomes an Hygrometer, by *expanding or contracting* with moiſture and dryneſs, which you ſee very often in the pannels of the wainſcoat, the doors of the rooms, &c. which are often found narrower and wider, as the air is more or leſs dry: and this is particularly the caſe with Fir; the moiſt particles of air inſinuating into the pores of this wood, will cauſe a conſiderable increaſe of its dimenſions, laterally or ſideways.

CONSTRUCTION *of an* HYGROMETER *upon the principle of* EXPANSION *or* CONTRACTION.

TAKE ſeveral pieces of deal-board ſawn off acroſs the grain, of about an inch wide, and then glued together by their ends; they will, by this means, make a very convenient Hygrometer; as the difference in length will vary by moiſture and dryneſs, and conſequently by being applied to a *graduated ſcale*, will ſhew the degrees of moiſture or dryneſs of the air.

This inſtrument, however, in time, becomes ſenſibly leſs and leſs accurate, till at laſt it loſes it seffect entirely, and ſuffers no alteration from the weather.

CONSTRUCTION *of an* HYGROMETER *upon the principles of* DIFFERENT MOTIONS *of the* SAME BODY.

FASTEN a hempen cord or fiddle-ſtring to an iron hook, to the end of which is faſtened a round ball, divided into any number of equal parts, and fix an index to a proper ſupport, ſo that it may almoſt touch the diviſions of the ball; hence the cord or gut, twiſting or untwiſting, will ſhew the change of the moiſture, &c. by the ſucceſſive application of the index to to the diviſions of the circle. Or ſtretch a common cord, or fiddle-ſtring, along a wall, paſſing it over a pulley, and fix it at one end, and to the other end hang a weight, carrying a ſtyle or index: againſt the ſame wall fit a graduated ſcale, divided into any number of equal parts, and the Hygrometer is complete.

For it is matter of conſtant obſervation, that moiſture ſenſibly ſhortens cords and ſtrings; and that, as the moiſture evaporates, they return to their former length again. Hence it follows, that the weight will aſcend when the air is more moiſt, and deſcend again when it becomes drier: by which means the index will be carried up and down, and, by pointing to the ſeveral diviſions on the ſcale, will ſhew the degrees of moiſture and dryneſs.

The following Hygrometer, though not of the moſt accurate conſtruction, yet will act very ſenſibly in the common changes of the air.

Take

Take a ſmall board, or ſlip of wood, of any convenient length, draw upon it a ſtraight line from one end to the other, (which will ſerve to point out the diviſions, as hereafter deſcribed), and to its upper end fix a ſmall bracket, or iron hook;—from the hook ſuſpend a ſtring of whip-cord, catgut, &c. which divide into 10 equal parts;—paſs the cord through two ſmall circular cards, (having a piece of cork glued upon the center on the under ſide of each, to preſerve their horizontal poſition), the firſt, divided into 10 equal parts, or diviſions, faſten upon the cord at the firſt diviſion from the point of ſuſpenſion; and the other, divided into 100 equal parts, fix at the tenth diviſion from the ſame point, and let the cord be kept extended by a weight at the bottom; conſequently, from the twiſting and untwiſting of the cord, by the different changes of the air, the lower card (from the mechanical principles of motion) will deſcribe 10 revolutions for one of the upper card; or when the lower

lower card has made one revolution, the upper card will have described but the 10th part, or one of its divisions. From whence it appears, that by the assistance of the upper card, an index is thereby obtained of the number of revolutions the lower card performs, which are reckoned by the line (mentioned above) on the slip of wood.

EXAMPLE.

It must first be observed what division of the upper card the line is against, suppose 6; and also what division of the the lower card is cut by the same line, suppose 20: it then appears that the state of the Hygrometer is thus, 6 degrees and 20 hundredths of another.—If the whole 10 divisions of the upper card have passed the line on the board, the lower card will have revolved 10 times, or ten hundred parts, equal to 1000.

Before use, the Hygrometer should be thus adjusted; set 0 or commencement

ment of the graduations on both the cards, to the line on the ſlip of wood, and whatever direction the cards afterwards take, muſt evidently proceed from the change to greater moiſture or dryneſs in the air; and they will accordingly point it out.

CONSTRUCTION *of an* HYGROMETER *upon the principle of* INCREASE *or* DECREASE *of* WEIGHT.

TAKE a nice balance, or ſteelyard, and a piece of ſponge, ſo cut as to contain as large a ſuperficies as poſſible. This ſponge hangs by a fine ſilk-thread from one end of the beam, and is exactly balanced by another thread of ſilk, ſtrung with the the ſmalleſt lead-ſhot at equal diſtances, to keep the equipoiſe in different weights of the air; part thereof is ſupported by a ſtand for that purpoſe, and the balance adjuſted when the air is in a middle ſtate, between the greateſt moiſture and the greateſt dryneſs. Upon that end of the

the beam where the thread ſtrung with ſhot is, there is placed an index, which, when the balance is equal, points to the middle of a graduated arch, which ſhews the air to be in a middle ſtate, between moiſture and dryneſs. As the ſponge imbibes the moiſt particles of air, and of courſe becomes heavier, the point of the index is raiſed to the degree of moiſture upon the arch; but if it is dry, the index falls.

In making Hygrometers of this kind, the piece of ſponge ſhould be firſt prepared by dipping it in a ſolution of Salt of Tartar, Sal Ammoniac, &c. and then dried again; for by this means, the ſponge becomes impregnated with ſalts, which attract more readily a large quantity of moiſture in the air.

An Hygrometer of this ſort is more durable than thoſe already deſcribed, ſerving for many years with tolerable accuracy. For a deſcription of various Hygrometers, ſee *Encyclop. Brit. Hutton's Mathematical Diction.* &c.

USE *of the* HYGROMETER.

HEALTH, that ineſtimable bleſſing, without which exiſtence itſelf would become burdenſome, and the good things of this world be of little avail; —without which the riches of the Eaſt, added to the poſſeſſion of half the globe, could yield little comfort; is found to be much affected by the dryneſs and moiſture of the air.

The air, (whether hot or cold) when dry, is always healthy, but a moiſt, or damp air; is productive of many diſorders to mankind, as rheumatiſms, colds, *&c.*

The preſervation of health, and conſequently of life, by the application of whatever is conducive thereto, is what we owe, not only to ourſelves, but to HIM who hath beſtowed them upon us.

As the air affects the animal economy by its gravity and lightneſs, heat and cold, moiſture and dryneſs, it is therefore, in ſome meaſure, incumbent

upon

upon us to pay due attention to the *Barometer*, *Thermometer*, and *Hygrometer*.

Having now given an account of the inſtruments in uſe for keeping a Regiſter of the Weather, I ſhall alſo give the form of ſuch a Regiſter; but prior to this, it may be proper to take notice of aqueous meteors.

Clouds are formed from aqueous vapours raiſed by the heat of the ſun, from the ſea, and ſurface of the earth, and from the circulation of electricity. They are ſuſpended in the atmoſphere at different heights, ſometimes one over another, according as their various ſpecific gravity is *in equilibrio* with the circumambient air. The clouds are often tinged with beautiful colours at the riſing and ſetting of the ſun, which ariſes from the light that ſtrikes upon the tranſparent globules of vapour entering them; and being reflected, and then refracted, parts into colours. The uſes of clouds are evident; as from them proceeds the rain which refreſhes the earth: they are likewiſe as a ſcreen interpoſed between the earth and the ſcorching rays of the ſun: they alſo ſerve as a medium for conveying the electrical fluid from the atmoſphere into the earth, and from the earth into the atmoſphere.

RAIN is a very frequent and uſeful meteor, deſcending from above, in form of ſmall drops of water. The common opinion of philoſophers concerning rain, is, that when vapours ariſe to the cold regions of the atmoſphere, they are there condenſed, and fall down in drops. The annual depth of rain is a circumſtance generally taken notice of in regiſters of the weather.

DEW, though a common appearance in the atmoſphere, has many articles in its hiſtory as yet undetermined. It has been thought by ſome, that this vapour fell by night, and was collected by the leaves of plants; by others, that the drops of dew are only the ſweat of plants, which continually perſpires through the orifices of their veſſels.

FOG or MIST is formed by vapours

and exhalations which aſcend ſlowly from the earth, or fall towards it from on high. Fogs which ariſe thick from the ſurface of the earth, partake of the qualities of the ſoil, and are very prejudicial to the health.

HOAR FROST is nothing elſe but frozen dew, that by night exudes out of the veſſels of plants; or a vapour riſing out of the earth, and adhering to the ground, or the ſurfaces of all low things in winter, which, by means of the cold air freezing its particles, is changed into ice covering plants, &c.

SNOW is formed by the falling of watery vapours from clouds, which, by congelation, is changed into oblong filaments. It is generally very white, and ſtrongly reflects the light that falls upon it. Snow is of uſe to preſerve the herbs in winter againſt the ſeverity of the froſt, and to ſupply water to brooks and rivers.

HAIL is formed from vapours in the higher regions of the atmoſphere, which collecting into drops, are frozen as they paſs through a cold medium on their way to the earth.

Frost is ſuch a ſtate of the atmoſphere as occaſions the congelation or freezing of water and other fluids. It is very deſtructive to vegetables. In general, metals are contracted by froſt, though there may be a few exceptions to this rule; for a ſtrong barrel of a gun, with water in it, cloſe ſtopped, and frozen, has been rent by the expanſion of froſt.—From a ſimilar cauſe, trees have been burſt in a cold of —2° of Fahrenheit.

Wind is a motion of the air from the place it is in to any other, with an impetus that is ſenſible to us. If the wind blows gently, it is called a breeze; if it blows harder, a gale; and when very hard, a ſtorm. Whenever any part of the atmoſphere has become rarefied or condenſed, the equilibrium is removed, and the more rarefied muſt give way to the more condenſed parts, which occaſions the current in this fluid.

Form

FORM OF A REGISTER OF THE WEATHER.

Day of the	Barometer.		Thermometer.		EDINBURGH, *June* 1796.		
Month.	Noon.	10 P. M.	Noon.	10 P. M.	Weather.	Winds.	Diary.
1	29.34	29.41	58	55	Showers.	S. 1	
2	29.39	29.41	53	56	Clear.	S. W. 0	
3	29.49	29.58	58	54	Ditto.	S. W. 0	
4	29.64	29.76	60	55	Ditto.	S. 1	
5	29.68	29.9	65	58	Ditto.	S. 1	
6	30.	29.95	66	61	Ditto.	S. E. 0	
7	29.88	29.59	68	62	Showers.	S. W. 0	
8	29.5	29.47	64	62	Cloudy.	S. W. 2	
9	29.5	29.94	61	60	Clear.	S. 1	
10	29.93	29.60	62	61	Showers.	S. W. 1	
	30.	29.95	68	62	Greateſt height of the Mercury.		
	29.34	29.41	58	54	Leaſt ditto.		
	29.67	29.68	63	58	Medium ditto.		

Column 1ſt. Contains the day of the month.

2d. The ſtate of the Barometer at noon, in inches, and decimals of an inch.

3d. The ſtate of the Barometer at 10 o'Clock, P. M.

4th. The ſtate of the Thermometer at noon.

5th. The ſtate of the Thermometer at 10 o'Clock, P. M.

6th. The ſtate of the Weather, as fair, froſt, rain, ſnow, fog, ſhowers, clear, cloudy, &c.

7th. The direction of the winds, as alſo their force; the degrees of which are marked 0, 1, 2, 3, 4. By 0 is denoted a perfect calm; by 1 ſuch a ſmall wind as ſcarce moved the leaves of trees; by 4 a hurricane; and by 2, 3, intermediate forces.

8th. Extraordinary degrees of wind, depth of rain and ſnow, and ſuch obſervations as may occur to the obſerver.

There

There is ſometimes alſo a column for the inſertion of the degrees of dryneſs and moiſture, pointed out by the Hygrometer; but as there has not, as yet, been any fixed points aſſigned to this inſtrument, it cannot point out the dryneſs and moiſture with the ſame preciſion that the Thermometer does the heat and cold; it is therefore omitted in this, as it generally is in all modern regiſters of the weather.

Though the prefixed ſpecimen of a regiſter of the weather is extended only for ten days, it ought to be continued in the ſame manner to the end of the month. Then take out of the regiſter the greateſt and leaſt heights of the Barometer at noon, which place one above the other, at the bottom of the column marked *noon;* theſe being added together, one half of the ſum is the mean height, which is placed below the leaſt height. Proceed in the ſame manner with the column for the Barometer at 10 P. M. as alſo with thoſe for the Thermometer, and then, by

turning

turning to your regiſter for any month, you ſee, at one view, the greateſt, the leaſt, and the mean heights of the Mercury, both in the Barometer and Thermometer, for that month. By proceeding in the ſame manner, from month to month, and year to year, you have it in your power to know the greateſt, leaſt, and mean heights of the Barometer; the heat or cold of one month or year above another; the ſtate of the weather; direction of the winds; and ſuch obſervations as you may have wrote in the diary; which will not only prove a pleaſant amuſement, but a ſource of uſeful information.

Having given an account of the manner by which the Barometer indicates the changes of the weather, (to render this book uſeful alſo to ſuch as have not this inſtrument) there is here ſubjoined

THE

THE
COUNTRY CALENDAR;
OR THE
SHEPHERD OF BANBURY's RULES
TO JUDGE OF THE CHANGES OF THE WEATHER:

Grounded on Forty years experience, by which the weather, for ſeveral Days to come, *may be known, and in ſome caſes, for* Months.

THE cauſes of ſuch alterations, (which are added thereto) are here omitted, but may be ſeen in the ſecond edition of the *Shepherd's Rules, London printed in* 1748.

In the preface to which, it is ſaid, "Moſt of our Shepherd's obſervations give us a day's notice, many a week's, and ſome extend to ſeveral months prognoſtication of the changes of the weather; and of how great uſe theſe may be to all ranks and degrees of people, to the ſedentary valetudinarian, as well as the active traveller, to the ſportſman who purſues his game, as well

well as the induſtrious huſbandman who conſtantly follows his labour; in ſhort, to every man in every ſituation, in ſome degree or other; is ſo very clear and intelligible, that it would be a mere waſte of words, and a very idle diſplay of rhetoric to attempt the making it clearer. Every man living would be glad to foreſee the alterations of the weather, if he could; and conſequently to moſt people, if not to all, theſe obſervations, grounded on no leſs than forty years experience, cannot but be acceptable."

I.

SUN.

" ——*quid Veſper ſerus vehat, unde ſerenas*
" *Ventus agat nubes, quid cogitet humidus Auſter,*
" *Sol tibi signa dabit: ſolem quis dicere falſum*
" *Audeat?*"———— VIRGIL.

1. If the ſun riſe red and fiery—*Wind and rain.*
2. If cloudy, and it ſoon decreaſe—*Certain fair weather.*

" Above

"Above the reſt, the ſun who never lies,
"Foretells the change of weather in the ſkies;
"For if he riſe unwilling to his race,
"Clouds on his brow, and ſpots upon his face;
"Or, if, thro' miſts, he ſhoots his ſullen beams,
"Frugal of light, in looſe and ſtraggling ſtreams,
"Suſpect a drizzling day, and Southern rain,
"Fatal to fruits and flocks, and promis'd grain."

II.

MOON.

———"*Lunaſque ſequentes*
"*Ordine reſpicies; nunquam te crastina fallet*
"*Hora, neque insidiis noctis capiere ſerenae.*"
VIRGIL.

1. Horns of the moon obſcure—*Rain.*
2. When the moon is red—*Wind.*
3. On the fourth day of the new moon, if bright, with ſharp horns—*No winds nor rain till the month be finiſhed.*

"And that by certain ſigns we may preſage
"Of heats and rains, and winds impetuous rage;
"The Sov'reign of the heav'ns has ſet on high
"The *Moon*, to mark the changes of the ſky:
"When ſouthern blaſts ſhould ceaſe, and when the ſwain
"Should near their folds his feeding flocks reſtrain."

III.

III.

STARS.

"*Saepe etiam stellas, vento impendente, videbis*
"*Praecipites coelo labi*;"—— VIRGIL.

When ſtars ſhoot precipitant through the ſky—*Approaching wind.*

IV.

CLOUDS.

1. CLOUDS ſmall and round, like a dapple-grey with a *north wind*—*Fair weather for two or three days.*
2. Large, like rocks—*Great ſhowers.*
3. If ſmall clouds increaſe—*Much rain.*
4. If large clouds decreaſe—*Fair weather.*
5. Clouds in ſummer or harveſt, when the wind has been ſouth two or three days, and it grows very hot, and you ſee clouds riſe with great white tops

tops like towers, as if one were upon the top of another, and joined together with black on the nether ſide, —*There will be thunder and rain ſuddenly.*

6. If two ſuch clouds ariſe, one on either hand,—*It is time to make haſte to ſhelter.*
7. If you ſee a cloud riſe againſt the wind or ſide-wind, when that cloud comes up to you, the wind will blow the ſame way that the cloud came. And the ſame rule holds of a clear place, when all the ſky is equally thick, except one clear edge.

V.

MISTS.

1. If miſts riſe in low ground and ſoon vaniſh,—*Fair weather.*
2. If they riſe to the hill tops,—*Rain in a day or two.*
3. A general miſt before the ſun riſes near the full moon,—*Fair weather.*
4. If in the new moon,—*Rain in the old.*
5. If in the old,—*Rain in the new.*

VI.

WINDS.

1. Obſerve that in eight years time there is as much ſouth-weſt wind, as north-eaſt, and conſequently as many wet years as dry.
2. When the wind turns to north-eaſt, and it continues two days without rain, and does not turn ſouth the third day, nor rain the third day, it is likely to continue north-eaſt for eight or nine days,—*all fair*; and then to come to the ſouth again.
3. If it turn again out of the ſouth to the north-eaſt with rain, and continues in the north eaſt two days without rain, and neither turns ſouth, nor rains the third day,—*It is like to continue north-eaſt for two or three months.* The wind will finiſh theſe turns in three weeks.
4. S. W. winds. After a northerly wind, for the moſt part two months or more, and then coming ſouth,—There are uſually *three or four fair days*

days at firſt, and then on the fourth or fifth day comes rain, or elſe the wind turns north again, *and continues dry*.

5. If it return to the ſouth within a day or two, without rain, and turn northward with rain, and return to the ſouth in one or two days as before, two or three times together after this ſort,—*Then it is like to be in the ſouth, or ſouth weſt, two or three months together*, as it was in the north before. *The winds will finiſh theſe turns in a fortnight*.

6. Fair weather for a week, with a ſouthern wind, is like to *produce a great drought*, if there has been much rain out of the ſouth before. The wind uſually turns from north to ſouth, with a quiet wind without rain, but returns to the north with a ſtrong wind and rain; the ſtrongeſt winds are when it turns from ſouth to north, by weſt.

N. B. When the north wind firſt clears

clears the air, (which is uſually once a week) be ſure of a fair day or two.

VII.

RAINS.

1. Sudden rains never *laſt long:* but when the air grows thick by degrees, and the ſun, moon, and ſtars ſhine dimmer and dimmer,—Then it is like *to rain ſix hours uſually.*
2. If it begin to rain from the ſouth, with a high wind, for two or three hours, and the wind falls, but the rain continues,—*It is like to rain twelve hours or more, and does uſually rain till a ſtrong north wind clears the air.* Theſe long rains ſeldom hold above twelve hours, or happen above once a-year.
3. If it begins to rain an hour or two before ſun-riſing, it is like to be fair *before noon, and ſo continue that day,* but if the rain begin an hour or two after ſun-riſing, it is like *to rain all that day,* except the rainbow be ſeen before it rains.

VIII.

VIII.

SPRING AND SUMMER.

If the laſt eighteen days of *February* and ten days of March be for the moſt part rainy, then the *Spring* and *Summer* quarters are like to be ſo too; and I never knew a great *drought* but it entered in that ſeaſon.

IX.

WINTER.

If the latter end of *October*, and beginning of *November*, be for the moſt part warm and rainy, then *January* and *February* are like to be *froſty* and *cold*, except after a very dry ſummer.—If, in *October* and *November*, there be ſnow and froſt, then *January* and *February* are like to be open and mild.

X.

ANIMALS.

"*Continuo ventis ſurgentibus*———
"*Cum medio celeres revolant ex aequore mergi*
"*Clamoremque ferunt ad litora:*"——

Cormorants

Cormorants ſwiftly returning from ſea to land, making a great noiſe,— } *Winds.*
The *Heron* forſaking the fens and ſoaring aloft,— }

" ——————*Nunquam imprudentibus imber*
" *Obfuit: aut illum ſurgentem vallibus imis*
" *Aeriae fugere grues: aut bucula coelum*
" *Suſpiciens, patulis captavit naribus auras:*"

Cranes forſaking the vallies,— }
Heifers ſnuffing the air,— }
Swallows fluttering about the lakes,— }
Frogs croaking,— }
Ants conveying their eggs from their cells,— } *Rain.*
Ravens flocking together, making a great noiſe,— }
Bees in cluſters humming about the hive,— }

FINIS.