

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK

Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [1] - -

PUBLIC DOMAIN

Leibn. Marg. 105

Niedersächsische Landesbibliothek Hannover

Leibn. Marg. 105

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK

Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [2] - -

PUBLIC DOMAIN

165 a

LECTURES
De Potentia Restitutiva,
OR OF
SPRING

BIBLIOTHECA REGIA HANNOVERANA

Explaining the Power of Springing Bodies.

To which are added some

COLLECTIONS

Viz.

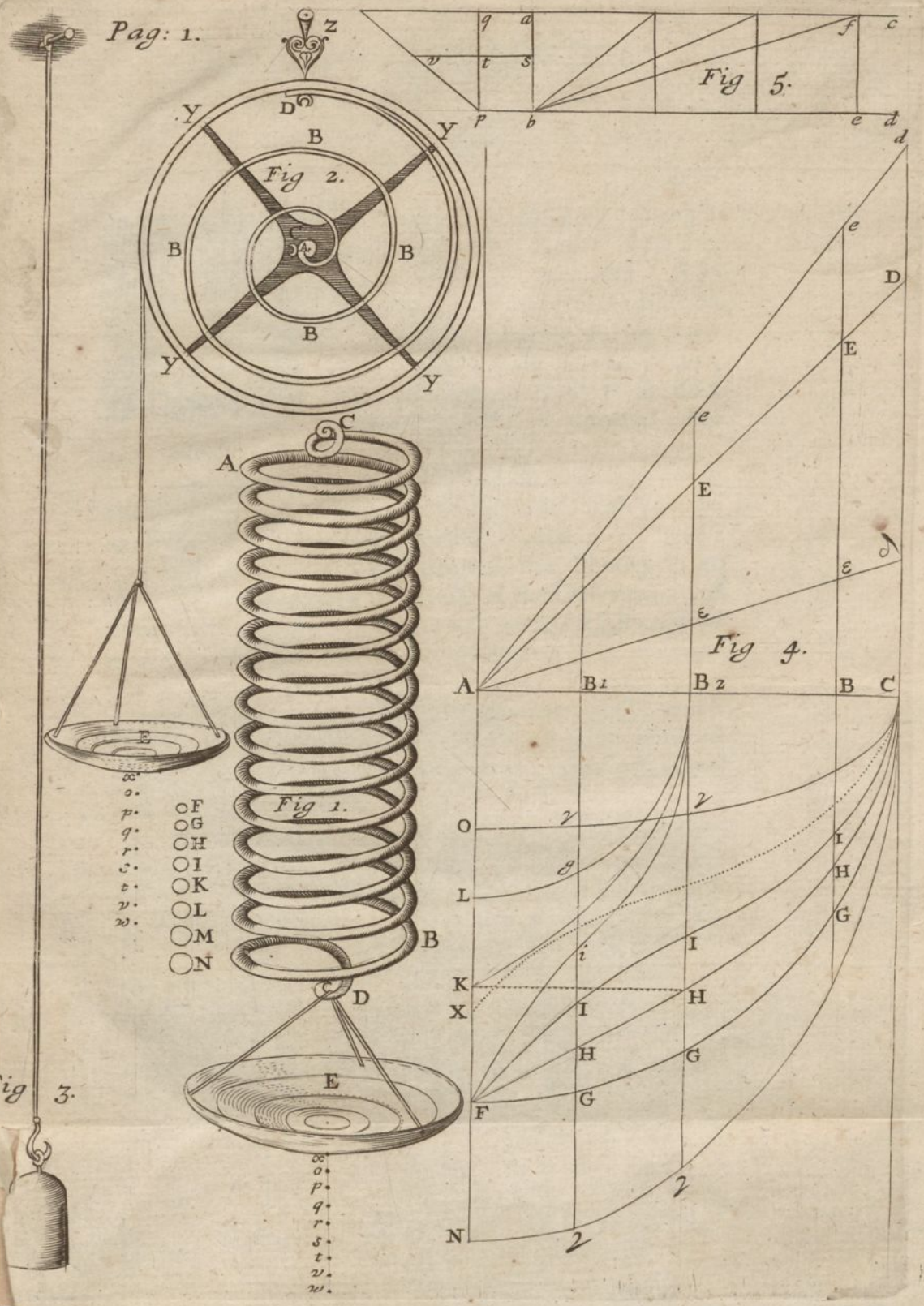
A Description of Dr. Pappins *Wind-Fountain and Force-Pump.*
Mr. Young's *Observation concerning natural Fountains.*
Some other Considerations concerning that Subject.
Captain Sturmy's *remarks of a Subterraneous Cave and Cistern.*
Mr. G. T. Observations made on the Pike *of* Teneriff, 1674.
Some Reflections and Conjectures occasioned thereupon.
A Relation of a late Eruption in the Isle of Palma.

By *ROBERT HOOKE.* S.R.S.

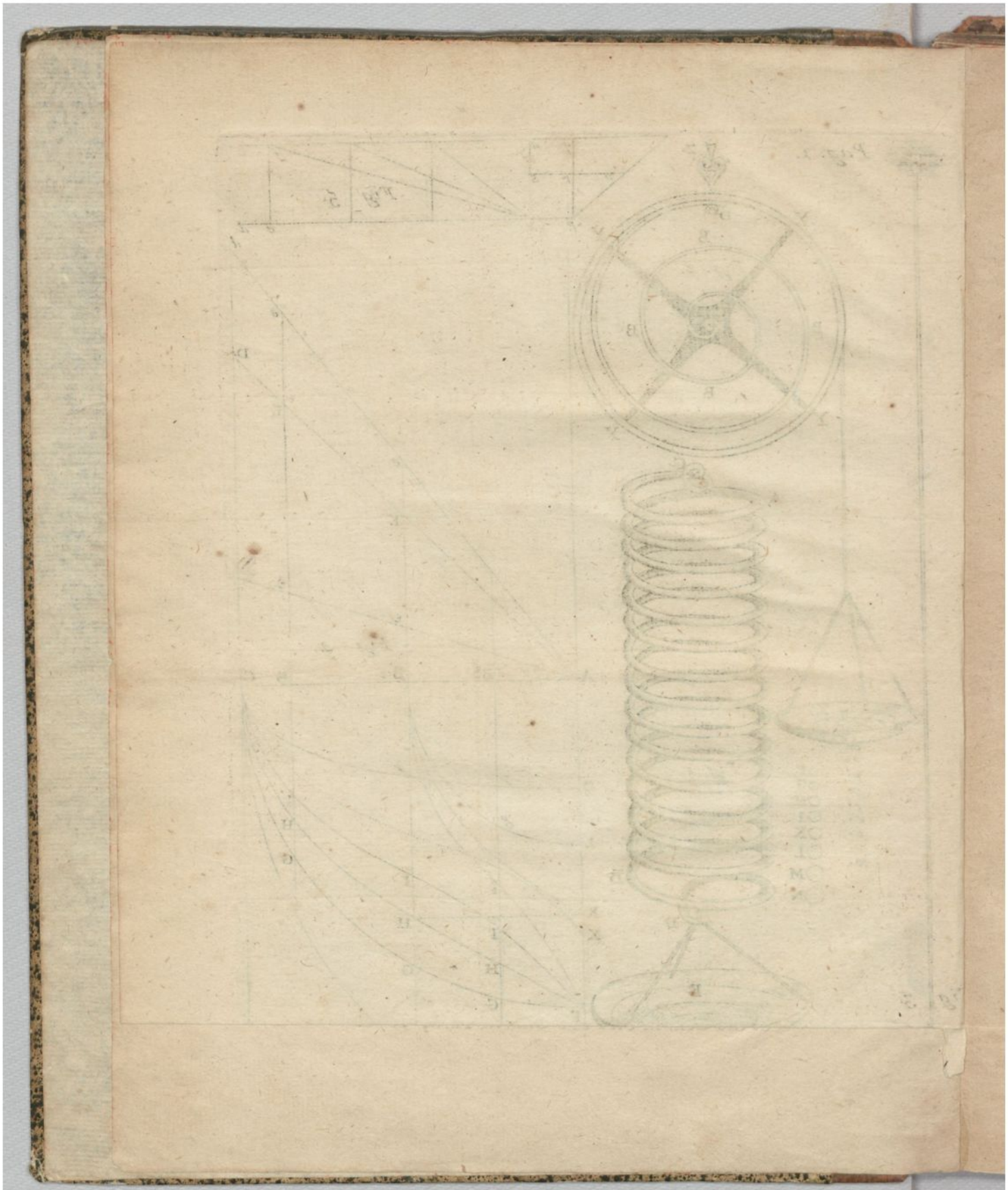
LONDON,
Printed for *John Martyn* Printer to the *Royal Society,*
at the Bell in St. *Pauls* Church-Yard, 1678.

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [3] - -
PUBLIC DOMAIN

Pag: 1.



GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [5] - -
PUBLIC DOMAIN



GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK

Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [6] - -

PUBLIC DOMAIN

Potentia Reſtitutiva,
OR
SPRING.

THe Theory of Springs, though attempted by divers eminent Mathematicians of this Age has hitherto not been Publiſhed by any. It it now about eighteen years ſince I firſt found it out, but deſigning to apply it to ſome particular uſe, I omitted the publiſhing thereof.

About three years ſince His Majeſty was pleaſed to ſee the Experiment that made out this Theory tried at *White-Hall*, as alſo my Spring Watch.

About two years ſince I printed this Theory in an Anagram at the end of my Book of the Deſcriptions of Helioſcopes, *viz. c e i i i n o s s s t t u u, id eſt, Ut tenſio ſic vis*; That is, The Power of any Spring is in the ſame proportion with the Tenſion thereof: That is, if one power ſtretch or bend it one ſpace, two will bend it two, and three will bend it three, and ſo forward. Now as the Theory is very ſhort, ſo the way of trying it is very eaſie.

Take then a quantity of even-drawn Wire, either Steel, Iron, or Braſs, and coyl it on an even Cylinder into a Helix of what length or number of turns you pleaſe, then turn the ends of the Wire into Loops, by one of which ſuſpend this coyl upon a nail, and by the other ſuſtain the weight that you would have to extend it, and hanging on ſeveral Weights obſerve exactly to what length each of the weights do extend it beyond the length that its own weight doth ſtretch it to, and you ſhall find that if

Farbkarte #13 B.I.G.
Inches Centimetres
Blue Cyan Green Yellow Red Magenta White 3/Color Black
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [7] - 1
PUBLIC DOMAIN

one ounce, or one pound, or one certain weight doth lengthen it one line, or one inch, or one certain length, then two ounces, two pounds, or two weights will extend it two lines, two inches, or two lengths; and three ounces, pounds, or weights, three lines, inches, or lengths; and ſo forwards. And this is the Rule or Law of Nature, upon which all manner of Reſtituent or Springing motion doth proceed, whether it be of Rarefaction, or Extenſion, or Condenſation and Compreſſion.

Or take a Watch Spring, and coyl it into a Spiral, ſo as no part thereof may touch another, then provide a very light wheel of Braſs, or the like, and fix it on an arbor that hath two ſmall Pivots of Steel, upon which Pivot turn the edge of the ſaid Wheel very even and ſmooth, ſo that a ſmall ſilk may be coyled upon it; then put this Wheel into a Frame, ſo that the Wheel may move very freely on its Pivots; faſten the central end of the aforeſaid Spring cloſe to the Pivot hole or center of the frame in which the Arbor of the Wheel doth move, and the other end thereof to the Rim of the Wheel, then coyling a fine limber thread of ſilk upon the edge of the Wheel hang a ſmall light ſcale at the end thereof fit to receive the weight that ſhall be put thereinto; then ſuffering the Wheel to ſtand in its own poſition by a little index faſtned to the frame, and pointing to the Rim of the Wheel, make a mark with Ink, or the like, on that part of the Rim that the Index pointeth at; then put in a drachm weight into the ſcale, and ſuffer the Wheel to ſettle, and make another mark on the Rim where the Index doth point; then add a drachm more, and let the Wheel ſettle again, and note with Ink, as before, the place of the Rim pointed at by the Index; then add a third drachm, and do as before, and ſo a fourth, fifth, ſixth, ſeventh, eighth, *&c.* ſuffering the Wheel to ſettle, and marking the ſeveral places pointed at by the Index, then examine the

Diſtances

Distances of all those marks, and comparing them together you shall find that they will all be equal the one to the other, so that if a drachm doth move the Wheel ten degrees, two drachms will move it twenty, and three thirty, and four forty, and five fifty, and so forwards.

Or take a Wire string of twenty, or thirty, or forty foot long, and fasten the upper part thereof to a nail, and to the other end fasten a Scale to receive the weights: Then with a pair of Compasses take the distance of the bottom of the scale from the ground or floor underneath, and set down the said distance, then put in weights into the said scale in the same manner as in the former trials, and measure the several stretchings of the said string, and set them down. Then compare the several stretchings of the said string, and you will find that they will always bear the same proportions one to the other that the weights do that made them.

The same will be found, if trial be made, with a piece of dry wood that will bend and return, if one end thereof be fixed in a horizontal posture, and to the other end be hanged weights to make it bend downwards.

The manner of trying the same thing upon a body of Air, whether it be for the rarefaction or for the compression thereof I did about fourteen years since publish in my *Micrographia*, and therefore I shall not need to add any further description thereof.

Each of these ways will be more plainly understood by the explanations of the annexed figures.

The first whereof doth represent by A B the coyl or helix of Wire, C the end of it, by which it is suspended, D the other end thereof, by which a small Scale E is hanged, into which putting Weights as F G H I K L M N, singly and separately they being in proportion to one another as 1 2 3 4 5 6 7 8, the Spring will be thereby equally stretcht to *o*,*p*,*q*,*r*,*s*,*t*,*u*,*w*,

that is, if F ſtretch it ſo as the bottom of the Scale deſcend to *o*, then G will make it deſcend to *p*, H to *q*, I to *r*, K to *s*, L to *t*, M to *u*, and N to *w*, &c. So that x *o* ſhall be one ſpace, x *p*, 2, x *q*, 3, x *r*, 4, x *s*, 5, x *t*, 6, x *u*, 7, x *w*, 8.

The ſecond figure repreſents a Watch Spring coyled in a Spiral by C A B B B D, whoſe end C is fixed to a pin or Axis immovable, into the end of which the Axis of a ſmall light Wheel is inſerted, upon which it moves; the end D is fixed to a pin in the Rim of the Wheel y y y y, upon which is coyled a ſmall ſilk, to the end of which is fixed a Scale to receive the weights. To the frame in which theſe are contained is fixed the hand or Index z; then trying with the former weights put into the Scale E, you will find that if F put into the Scale E ſinks the bottom of it x to *o*, then G will ſink it to *p*, and H to *q*, I to *r*, K to *s*, L to *t*, and z will point at 1,2,3,4,5,6,7,8 on the Wheel.

The trials with a ſtraight wire, or a ſtraight piece of wood laid Horizontal are ſo plain they need not an explication by figure, and the way of trying upon Air I have long ſince explained in my *Micographia* by figures.

From all which it is very evident that the Rule or Law of Nature in every ſpringing body is, that the force or power thereof to reſtore it ſelf to its natural poſition is always proportionate to the Diſtance or ſpace it is removed therefrom, whether it be by rarefaction, or ſeparation of its parts the one from the other, or by a Condenſation, or crowding of thoſe parts nearer together. Nor is it obſervable in theſe bodys only, but in all other ſpringy bodies whatſoever, whether Metal, Wood, Stones, baked Earths, Hair, Horns, Silk, Bones, Sinews, Glaſs, and the like. Reſpect being had to the particular figures of the bodies bended, and the advantagious or diſadvantagious ways of bending them.

From

From this Principle it will be eaſie to calculate the ſeveral ſtrength of Bows, as of Long Bows or Croſs-Bows, whether they be made of Wood, Steel, Horns, Sinews, or the like. As alſo of the *Baliſtæ* or *Catapultæ* uſed by the Ancients, which being once found, and Tables thereof calculated, I ſhall anon ſhew a way how to calculate the power they have in ſhooting or caſting of Arrows, Bullets, Stones, Granadoes, or the like.

From theſe Principles alſo it will be eaſie to calculate the proportionate ſtrength of the ſpring of a Watch upon the Fuſey thereof, and conſequently of adjuſting the Fuſey to the Spring ſo as to make it draw or move the Watch always with an equal force.

From the ſame alſo it will be eaſie to give the reaſon of the *Iſochrone* motion of a Spring or extended ſtring, and of the uniform ſound produced by thoſe whoſe Vibrations are quick enough to produce an audible ſound, as likewiſe the reaſon of the ſounds, and their variations in all manner of ſonorous or ſpringing Bodies, of which more on another occaſion.

From this appears the reaſon, as I ſhall ſhew by and by, why a Spring applied to the balance of a Watch doth make the Vibrations thereof equal, whether they be greater or ſmaller, one of which kind I ſhewed to the right Honourable the Lord Viſcount *Brounker*, the Honourable *Robert Boyle* Eſq; and Sir *Robert Morey* in the year 1660. in order to have gotten Letters Patents for the uſe and benefit thereof.

From this it will be eaſie to make a Philoſophical Scale to examine the weight of any body without putting in weights, which was that which I mentioned at the end of my deſcription of Helioſcopes, the ground of which was veiled under this Anagram, *c e d i i n n o o p s s s t t u u*, namely, *Ut pondus ſic tenſio*. The fabrick of which ſee in the three firſt figures.

This Scale I contrived in order to examine the gravitation of bodies towards the Center of the Earth,

viz. to examine whether bodies at a further distance from the Center of the Earth did not lose somewhat of their power or tendency towards it. And propounded it as one of the Experiments to be tried at the top of the Pike of *Teneriff*, and attempted the same at the top of the Tower of St. *Pauls* before the burning of it in the late great Fire; as also at the top and bottom of the Abby of St. *Peters* in *Westminster* though these being by but small distances removed from the Surface, I was not able certainly to perceive any manifest difference. I propounded the same also to be tried at the bottom and several stations of deep Mines; and D. *Power* did make some trials to that end, but his Instruments not being good, nothing could be certainly concluded from them.

These are the Phenomena of Springs and springy bodies, which as they have not hitherto been by any that I know reduced to Rules, so have all the attempts for the explications of the reason of their power, and of springiness in general, been very insufficient.

In the year 1660. I printed a little Tract, which I called, *An Attempt for the explication of the Phenomena, &c.* of the rising of water in the pores of very small Pipes, Filtres, *&c.* And being unwilling then to publish this Theory, as supposing it might be prejudicial to my design of Watches, which I was then procuring a Patent for, I only hinted the principle which I supposed to be the cause of these Phænomena of springs in the 31 page thereof in the English Edition, and in the 38 page of the Latine Edition, translated by *M. Behem*, and printed at *Amsterdam*, 1662. But referred the further explication thereof till some other opportunity.

The Principles I then mentioned I called by the names of *Congruity* and *Incongruity* of bodies. And promised a further explanation of what I thereby meant on some other occasion. I shall here only explain so much of it as concerns the explication of this present Phænomenon. By

By *Congruity* and *Incongruity* then I underſtand nothing elſe but an agreement or diſagreement of Bodys as to their Magnitudes and motions.

Thoſe Bodies then I ſuppoſe congruous whoſe particles have the ſame Magnitude, and the ſame degree of Velocity, or elſe an harmonical proportion of Magnitude, and harmonical degree of Velocity. And thoſe I ſuppoſe incongruous which have neither the ſame Magnitude, nor the ſame degree of Velocity, nor an harmonical proportion of Magnitude nor of Velocity.

I ſuppoſe then the ſenſible Univerſe to conſiſt of body and motion.

By Body I mean ſomewhat receptive and communicative of motion or progreſſion. Nor can I have any other Idea thereof, for neither Extention nor Quantity, hardneſs nor ſoftneſs, fluidity nor fixedneſs, Rarefaction nor Denſation are the proprieties of Body, but of Motion or ſomewhat moved.

By Motion I underſtand nothing but a power or tendency progreſſive of Body according to ſeveral degrees of Velocity.

Theſe two do always counterballance each other in all the effects, appearances, and operations of Nature, and therefore it is not impoſſible but that they may be one and the ſame; for a little body with great motion is equivalent to a great body with little motion as to all its ſenſible effects in Nature.

I do further ſuppoſe then that all things in the Univerſe that become the objects of our ſenſes are compounded of theſe two (which we will for the preſent ſuppoſe diſtinct eſſences, though poſſibly they may be found hereafter to be only differing conceptions of one and the ſame eſſence) namely, *Body*, and *Motion*. And that there is no one ſenſible Particle of matter but owes the greateſt part of its ſenſible Extenſion to Motion whatever part thereof it ows to Body according to the common notion thereof: Which is, that

Body

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [13] - 7
PUBLIC DOMAIN

Body is ſomewhat that doth perfectly fill a determinate quantity of ſpace or extenſion ſo as neceſſarily to exclude all other bodies from being comprehended within the ſame Dimenſions.

I do therefore define a ſenſible Body to be a determinate Space or Extenſion defended from being penetrated by another, by a power from within.

To make this the more intelligible, Imagine a very thin plate of Iron, or the like, a foot ſquare, to be moved with a Vibrative motion forwards and backwards the flat ways the length of a foot with ſo ſwift a motion as not to permit any other body to enter into that ſpace within which it Vibrates, this will compoſe ſuch an eſſence as I call in my ſenſe a Cubick foot of ſenſible Body, which differs from the common notion of Body as this ſpace of a Cubick foot thus defended by this Vibrating plate doth from a Cubick foot of Iron, or the like, throughout ſolid. The Particles therefore that compoſe all bodies I do ſuppoſe to owe the greateſt part of their ſenſible or potential Extenſion to a Vibrative motion.

This Vibrative motion I do not ſuppoſe inherent or inſeparable from the Particles of body, but communicated by Impulſes given from other bodies in the Univerſe. This only I ſuppoſe, that the Magnitude or bulk of the body doth make it receptive of this or that peculiar motion that is communicated, and not of any other. That is, every Particle of matter according to its determinate or preſent Magnitude is receptive of this or that peculiar motion and no other, ſo that Magnitude and receptivity of motion ſeems the ſame thing: To explain this by a ſimilitude or example. Suppoſe a number of muſical ſtrings, as A B C D E, *&c.* tuned to certain tones, and a like number of other ſtrings, as *a*, *b*, *c*, *d*, *e*, &c. tuned to the ſame ſounds reſpectively, A ſhall be receptive of the motion of *a*, but not of that of *b*, *c*, nor *d*; in like manner B ſhall be receptive of the motion of *b*, but not of the motion of

of *a*, *c* or *d*. And ſo of the reſt. This is that which I call *Congruity* and *Incongruity*.

Now as we find that muſical ſtrings will be moved by Uniſons and Eighths, and other harmonious chords, though not in the ſame degree; ſo do I ſuppoſe that *the particles of matter* will be moved principally by ſuch motions as are Uniſons, as I may call them, or of equal Velocity with their motions, and by other harmonious motions in a leſs degree.

I do further ſuppoſe, A ſubtil matter that incompaſſeth and pervades all other bodies, which is the Menſtruum in which they ſwim which maintains and continues all ſuch bodies in their motion, and which is the medium that conveys all Homogenious or Harmonical motions from body to body.

Further I ſuppoſe, that all ſuch particles of matter as are of a like nature, when not ſeparated by others of a differing nature will remain together, and ſtrengthen the common Vibration of them all againſt the differing Vibrations of the ambient bodies.

According to this Notion I ſuppoſe the whole Univerſe and all the particles thereof to be in a continued motion, and every one to take its ſhare of ſpace or room in the ſame, according to the bulk of its body, or according to the particular power it hath to receive, and continue this or that peculiar motion.

Two or more of theſe particles joyned immediately together, and coaleſcing into one become of another nature, and receptive of another degree of motion and Vibration, and make a compounded particle differing in nature from each of the other particles.

All bulky and ſenſible bodies whatſoever I ſuppoſe to be made up or compoſed of ſuch particles which have their peculiar and appropriate motions which are kept together by the differing or diſſonant Vibrations of the ambient bodies or fluid.

According to the difference of theſe Vibrative motions of the Incompaſſing bulks. All bodies are more or leſs powerful in preſerving their peculiar ſhapes.

All bodies neer the Earth are incompaſſed with a fluid ſubtil matter by the differing Velocity of whoſe parts all ſolid bodies are kept together in the peculiar ſhapes, they were left in when they were laſt fluid. And all fluid bodies whatſoever are mixed with this fluid, and which is not extruded from them till they become ſolid.

Fluid bulks differ from ſolids only in this, that all fluids conſiſt of two ſorts of particles, the one this common Menſtruum near the Earth, which is interſperſed between the Vibrating particles appropriated to that bulk, and ſo participating of the motions and Vibrations thereof: And the other, by excluding wholly, or not participating of that motion.

Though the particles of ſolid bodies do by their Vibrative motions exclude this fluid from coming between them where their motions do immediately touch, yet are there certain ſpaces between them which are not defended by the motion of the particles from being pervaded by the Heterogeneous fluid menſtruum.

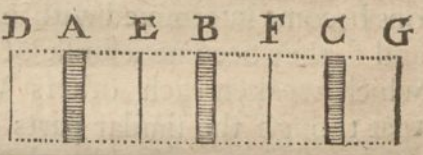
Theſe ſpaces ſo undefended by the bodies and Vibrative motion of the particles, and conſequently pervaded by the ſubtil incompaſſing Heterogeneous fluid are thoſe we call the inſenſible pores of bodies.

According to the bigneſs of the bodies the motions are, but in reciprocal proportion: That is, the bigger or more powerful the body is, the ſlower is its motion with which it compounds the particles; and the leſs the body is, the ſwifter is its motion.

The ſmaller the particles of bodies are, the nearer do they approach to the nature of the general fluid, and

and the more eaſily do they mix and participate of its motion.

The Particles of all ſolid bodies do immediately touch each other; that is, the Vibrative motions of the bodies do every one touch each other at every Vibration. For explication, Let A B C repreſent three bodies, each of theſe bodies I ſuppoſe to have a Vibrative motion on either ſide of it, A between D and E, B between E and F, and C between F and G. I ſuppoſe then that B in every one of its Vibrations doth meet A at E, and C at F, and ſo the motions are continually interchanged: That is, B communicates its motion to A at E, and A at the ſame time and place communicates its motion to B, which returning to F meets there with C, and communicates its received motion to C, which at the ſame inſtant and place communicates its own motion to B, which returns it back to E: So that the Velocity of theſe bodies is always the ſame, and each body impreſſeth on the contiguous bodies ſuch a determinate number of pulſes within a certain ſpace of time. Suppoſe for inſtance, in every ſecond of time B communicates to A and to C one million of pulſes, and hath received as many from each of them, by which means each of them doth preſerve its own ſpace of Vibration, according to the power of its Vibration, that neither of the contiguous bodies can enter into it. The extreme particles A and C are repercuſſed by the motion of the ambient Heterogeneous fluid, whereof though the bodies are of differing magnitudes, yet the body and motion of the one are equivalent to the body and motion of the other, ſo that whatever the body be leſs, the motion is quicker; and where the body is bigger, the motion is leſs. But the Particles of fluid



bodies do not immediately touch each other, but permit the mixture of the other Heterogeneous fluid near the Earth, which ſerves to communicate the motion from particle to particle without the immediate contact of the Vibrations of the Particles.

All ſolid Bodies retain their ſolidity till by other extraordinary motions their natural or proper motions become intermixed with other differing motions, and ſo they become a bulk of compounded motions, which weaken each others Vibrative motions. So that though the ſimilar parts do participate of each others motions, whereby they indeavour to joyn or keep together, yet do they alſo participate of an Heterogeneous motion which endeavours to ſeparate or keep them aſunder. And according to the prevalency of the one or the other is the body more or leſs fluid or ſolid.

All bodies whatſoever would be fluid were it not for the external Heterogeneous motion of the Ambient.

And all fluid bodies whatſoever would be unbounded, and have their parts fly from each other were it not for ſome prevailing Heterogeneous motion from without them that drives them more powerfully together.

Heterogeneous motions from without are propagated within the ſolid in a direct line if they hit perpendicular to the ſuperficies or bounds, but if obliquely in ways not direct, but different and deflected, according to the particular inclination of the body ſtriking, and according to the proportion of the Particles ſtriking and being ſtruck.

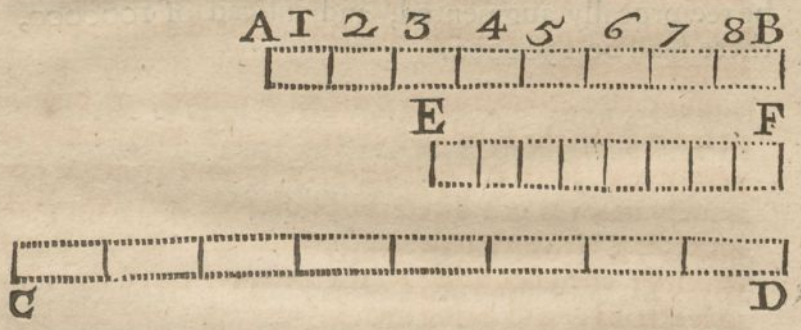
All ſpringy bodies whatſoever conſiſt of parts thus qualified, that is, of ſmall bodies indued with appropriate and peculiar motions, whence every one of theſe particles hath a particular Bulk, Extenſion, or Sphere of activity which it defends from the ingreſs of any other incompaſſing Heterogeneous body whilſt in

in its natural eſtate and balance in the Univerſe. Which particles being all of the ſame nature, that is, of equal bodies, and equal motions, they readily coaleſce and joyn together, and make up one ſolid body, not perfectly every where contiguous, and wholly excluding the above mentioned ambient fluid, but permitting it in many places to pervade the ſame in a regular order, yet not ſo much but that they do wholly exclude the ſame from paſſing between all the ſides of the compounding particles.

The parts of all ſpringy bodies would recede and fly from each other were they not kept together by the Heterogeneous compreſſing motions of the ambient whether fluid or ſolid.

Theſe principles thus hinted, I ſhall in the next place come to the particular explication of the manner how they ſerve to explain the Phænomena of ſpringing bodies whether ſolid or fluid.

Firſt for ſolid bodies, as Steel, Glaſs, Wood, &c. which have a Spring both inwards and outwards, according as they are either compreſſed or dilated beyond their natural ſtate.



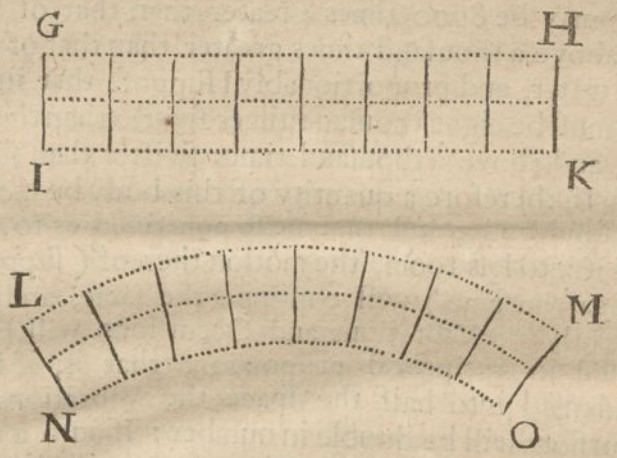
Let A B repreſent a line of ſuch a body compounded of eight Vibrating particles, as 1, 2, 3, 4, 5, 6, 7, 8, and ſuppoſe each of thoſe Particles to perform a million of ſingle Vibrations, and conſequently of occurſions with each other in a ſecond minute of time,

their motion being of ſuch a Velocity impreſſed from the Ambient on the two extreme Particles 1 and 8. Firſt, if by any external power on the two extremes 1 and 8, they be removed further aſunder, as to C D, then ſhall all the Vibrative Particles be proportionably extended, and the number of Vibrations, and conſequently of occurſions be reciprocally diminiſhed, and conſequently their endeavour of receding from each other be reciprocally diminiſhed alſo. For ſuppoſing this ſecond Dimenſion of Length be to the firſt as 3 to 2, the length of the Vibrations, and conſequently of occurſions, be reciprocally diminiſhed. For whereas I ſuppoſed 1000000 in a ſecond of the former, here can be but *666666* in this, and conſequently the Spring inward muſt be in proportion to the Extenſion beyond its natural length.

Secondly, if by any external force the extreme particles be removed a third part nearer together than (the external natural force being alway the ſame both in this and the former inſtance, which is the ballance to it in its natural ſtate) the length of the Vibrations ſhall be proportionably diminiſhed, and the number of them, and conſequently of the occurſions be reciprocally augmented, and inſtead of 1000000, there ſhall be 1500000.

Having

Having thus explained the moſt ſimple way of ſpringing in ſolid bodies, it will be very eaſie to explain the compound way of ſpringing, that is, by flexure, ſuppoſing only two of theſe lines joyned



together as at G H I K, which being by any external power bended into the form L N N O, L M will be extended, and N O will be diminiſhed in proportion to the flexure, and conſequently the ſame proportions and Rules for its endeavour of reſtoring it ſelf will hold.

In the next place for fluid bodies, amongſt which the greateſt inſtance we have is air, though the ſame be in ſome proportion in all other fluid bodies.

The Air then is a body conſiſting of particles ſo ſmall as to be almoſt equal to the particles of the Heterogeneous fluid medium incompaſſing the earth. It is bounded but on one ſide, namely, towards the earth, and is indefinitely extended upward, being only hindred from flying away that way by its own gravity, (the cauſe of which I ſhall ſome other time explain.) It conſiſts of the ſame particles ſingle and ſeparated, of which water and other fluids do, conjoyned and compounded, and being made of particles exceeding

exceeding ſmall, its motion (to make its ballance with the reſt of the earthy bodies) is exceeding ſwift, and its Vibrative Spaces exceeding large, comparative to the Vibrative Spaces of other terreſtrial bodies. I ſuppoſe that of the Air next the Earth in its natural ſtate may be 8000 times greater than that of Steel, and above a thouſand times greater than that of common water, and proportionably I ſuppoſe that its motion muſt be eight thouſand times ſwifter than the former, and above a thouſand times ſwifter than the later. If therefore a quantity of this body be incloſed by a ſolid body, and that be ſo contrived as to compreſs it into leſs room, the motion thereof (ſuppoſing the heat the ſame) will continue the ſame, and conſequently the Vibrations and Occurſions will be increaſed in reciprocal proportion, that is, if it be Condenſed into half the ſpace the Vibrations and Occurſions will be double in number: If into a quarter the Vibrations and Occurſions will be quadruple, *&c.*

Again, If the conteining Veſſel be ſo contrived as to leave it more ſpace, the length of the Vibrations will be proportionably inlarged, and the number of Vibrations and Occurſions will be reciprocally diminiſhed, that is, if it be ſuffered to extend to twice its former dimenſions, its Vibrations will be twice as long, and the number of its Vibrations and Occurſions will be fewer by half, and conſequently its indeavours outward will be alſo weaker by half.

Theſe Explanations will ſerve *mutatis mutandis* for explaining the Spring of any other Body whatſoever.

It now remains, that I ſhew how the conſtitutions of ſpringy bodies being ſuch, the Vibrations of a Spring, or a Body moved by a Spring, equally and uniformly ſhall be of equal duration whether they be greater or leſs.

I have

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [22] - 16
PUBLIC DOMAIN

I have here already ſhewed then that the power of all Springs is proportionate to the degree of flexure, *viz.* one degree of flexure, or one ſpace bended hath one power, two hath two, and three hath three, and ſo forward. And every point of the ſpace of flexure hath a peculiar power, and conſequently there being infinite points of the ſpace, there muſt be infinite degrees of power.

And conſequently all thoſe powers beginning from nought, and ending at the laſt degree of tenſion or bending, added together into one ſum, or aggregate, will be in duplicate proportion to the ſpace bended or degree of flexure; that is, the aggregate of the powers of the Spring tended from its quieſcent poſture by all the intermediate points to one ſpace (be it what length you pleaſe) is equal, or in the ſame proportion to the ſquare of one (ſuppoſing the ſaid ſpace infinitely diviſible into the fractions of one;) to two, is equal, or in the ſame proportion to the ſquare of two, that is four; to three is equal or in the ſame proportion to the ſquare of three, that is nine, and ſo forward; and conſequently the aggregate of the firſt ſpace will be one, of the ſecond ſpace will be three, of the third ſpace will be five, of the fourth will be ſeven, and ſo onwards in an Arithmetical proportion, being the degrees or exceſſes by which theſe aggregates exceed one another.

The Spring therefore in returning from any degree of flexure, to which it hath been bent by any power receiveth at every point of the ſpace returned an impulſe equal to the power of the Spring in that point of Tenſion, and in returning the whole it receiveth the whole aggregate of all the forces belonging to the greateſt degree of that Tenſion from which it returned; ſo a Spring bent two ſpaces in its return receiveth four degrees of impulſe, that is, three in the firſt ſpace returning, and one in the ſecond; ſo bent three ſpaces it receiveth in its whole return nine

degrees of impulſe, that is, five in the firſt ſpace returned, three in the ſecond, and one in the third.

So bent ten ſpaces it receives in its whole return one hundred degrees of impulſe, to wit, nineteen in the firſt, ſeventeen in the ſecond, fifteen in the third, thirteen in the fourth, eleven in the fifth, nine in the ſixth, ſeven in the ſeventh, five in the eighth, three in the ninth, and one in the tenth.

Now the comparative Velocities of any body moved are in ſubduplicate proportion to the aggregates or ſums of the powers by which it is moved, therefore the Velocities of the whole ſpaces returned are always in the ſame proportions with thoſe ſpaces, they being both ſubduplicate to the powers, and conſequently all the times ſhall be equal.

Next for the Velocities of the parts of the ſpace returned they will be always proportionate to the roots of the aggregates of the powers impreſſed in every of theſe ſpaces; for in the laſt inſtance, where the Spring is ſuppoſed bent ten ſpaces, the Velocity at the end of the firſt ſpace returned ſhall be as the root of 19. at the end of the ſecond as the Root of 36. that is, of 19 + 17. at the end of the third as the Root of 51. that is of 19 + 17 + 15. At the end of the fourth as the Root of 64. that is of 19 + 17 + 15 + 13. at the end of the tenth, or whole as the Root of 100. that is as $\sqrt{19 + 17 + 15 + 13 + 11 + 9 + 7 + 5 + 3 + 1}$, equal to 100.

Now ſince the Velocity is in the ſame proportion to the root of the ſpace, as the root of the ſpace is to the time, it is eaſie to determine the particular time in which every one of theſe ſpaces are paſſed for dividing the ſpaces by the Velocities correſponding the quotients give the particular times.

To explain this more intelligibly, let A in the fourth figure repreſent the end of a Spring not bent, or at leaſt coun-

counterpoiſed in that poſture by a power fixt to it, and movable with it, draw the line A B C, and let it repreſent the way in which the end of the Spring by additional powers is to be moved, draw to the end of it C at right Angles the Line C *d* D *d*, and let C D repreſent the power that is ſufficient to bend or move the end of the Spring A to C, then draw the Line D A, and from any point of the Line A C as B B. Draw Lines parallel to C D, cutting the Line D A in E, E, the Lines B E, B E, will repreſent the reſpective powers requiſite to bend the end of the Spring A to B, which Lines B E, B E, C D will be in the ſame proportion with the length of the bent of the Spring A B, A B, A C.

And becauſe the Spring hath in every point of the Line of bending A C, a particular power, therefore imagining infinite Lines drawn from every point of A C parallel to C D till they touch the Line A D, they will all of them fill and compoſe the Triangle A C D. The Triangle therefore A C D will repreſent the aggregate of the powers of the Spring bent from A to C, and the leſſer Triangles A B E, A B E will repreſent the aggregate of all the powers of the Spring bent from A to B, B, and the Spring bent to any point of the Line A C, and let go from thence will exert in its return to A all thoſe powers which are equal to the reſpective ordinates B E, B E, in the Triangles, the ſum of all which make up the Triangles A B E, A B E. And the aggregate of the powers with which it returns from any point, as from C to any point of the ſpace C A as to B B, is equal to the Trapezium C D E B, C D E B, or the exceſſes of the greater Triangles above the leſs.

Having therefore ſhewn an Image to repreſent the flexure and the powers, ſo as plainly to ſolve and anſwer all Queſtions and Problems concerning them, in the next place I come to repreſent the Velocities appropriated to the ſeveral powers. The Velocities then being always in a ſubduplicate proportion of

the powers, that is, as the Root of the powers impreſſed, and the powers impreſt being as the Trapezium or the exceſs of the Triangle or ſquare of the whole ſpace to be paſt above the ſquare of the ſpace yet unpaſſed; if upon the Center A, and ſpace A C, (C being the point from which the Spring is ſuppoſed let go) a Circle be deſcribed as C G G F, and ordinates drawn from any point of C A the ſpace to be paſt, as from B, B, to the ſaid Circle, as B G, B G, theſe Lines B G, B G, will repreſent the Velocity of the Spring returning from C to B, B, *&c.* the ſaid ordinates being always in the ſame proportion with the Roots of the Trapeziums C D E B, C D E B for putting A C = to a, and A B = b, B G will always be equal to $\sqrt{aa-bb}$, the ſquare of the ordinate being always equal to the Rectangle of the intercepted parts of the Diameter.

Having thus found the Velocities, to wit, B G, B G, A F, to find the times correſponding, on the Diameter A C draw a Parabola C H F whoſe Vertex is C, and which paſſeth through the point F. The Ordinates of this Parabola B H, B H, A F, are in the ſame proportion with the Roots of the ſpaces C B, C B, C A, then making G B to H B as H B to I B, and through the points C I I F drawing the curve C I I I F, the reſpective ordinates of this curve ſhall repreſent the proportionate time that the Spring ſpends in returning the ſpaces C B, C B, C A.

If the powers or ſtiffneſs of the Spring be greater than what I before ſuppoſed, and therefore muſt be expreſſed by the Triangle C d e A. then the Velocities will be the Ordinates in an Ellipſe as C γ γ N, greater than the Circle, as it will alſo if the power be the ſame, and the bulk moved by the Spring be leſs. Then will the S-like Line of times meet with the Line A F at a point as X within the point F. But if the powers of the Spring be weaker than I ſuppoſed, then will C δ e e A repreſent the powers, and C γ γ O the Ellipſis of Velocity,

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [26] - 20
PUBLIC DOMAIN

Velocity, whoſe Ordinates B γ, B γ, A O will give the particular Velocities, and the S-like Line of time will extend beyond N. The ſame will happen ſuppoſing the body (moved by the Spring) to be proportionately heavy, and the powers of the Spring the ſame with the firſt.

And ſuppoſing the power of the Spring the ſame as at firſt, bended only to B 2, and from thence let go B 2 E A is the Triangle of its powers, the Ordinates of the Circle B g L are the Lines of its Velocity, and the Ordinates of the S-like Line B i F are the Lines of time.

Having thus ſhewed you how the Velocity of a Spring may be computed, it will be eaſie to calculate to what diſtance it will be able to ſhoot or throw any body that is moved by it. And this muſt be done by comparing the Velocity of the aſcent of a body thrown with the Velocity of the deſcent of Gravity, allowance being alſo made for the Reſiſtance and impediment of the medium through which it paſſes. For inſtance, ſuppoſe a Bow or Spring fixed at 16 foot above a Horizontal floor, which is near the ſpace that a heavy body from reſt will deſcend perpendicularly in a ſecond of time. If a Spring deliver the body in the Horizontal line with a Velocity that moves it 16 foot in a ſecond of time, then ſhall it fall at 16 foot from the perpendicular point on the floor over which it was delivered with ſuch Velocity, and by its motion ſhall deſcribe in the Air or ſpace through which it paſſes, a Parabola. If the Spring be bent to twice the former Tenſion, ſo as to deliver the body with double the Velocity in a Horizontal Line, that is, with a Velocity that moves 32 foot in a ſecond, then ſhall the body touch the floor in a point very near at 32 foot from the aforeſaid perpendicular point, and the Line of the motion of the body, ſo ſhot ſhall be moved in a Parabola, or a Line very near it, I ſay very near it, by reaſon that the

Impediment of the medium doth hinder the exactneſs of it. If it be delivered with treble, quadruple, quintuple, ſextuple, *&c.* the firſt Velocity it ſhall touch the floor at almoſt treble, quadruple, quintuple, ſextuple, *&c.* the firſt diſtance. I ſhall not need to ſhew the reaſon why it is moved in a Parabola, it having been ſufficiently demonſtrated long ſince by many others.

If the body be delivered by the Spring at the floor, but ſhot by ſome Angle upwards, knowing withwhat Velocity the ſame is moved when delivered, and with what Inclination to the Perpendicular the ſame is directed, and the true Velocity of a falling body, you may eaſily know the length of the *Jactus* or ſhot, and the time it will ſpend in paſſing that length.

This is found by comparing the time of its aſcent with the time of the deſcent of heavy bodies. The aſcent of any body is eaſily known by comparing its Velocity with the Angle of Inclination.

Let *a b* then in the fifth Figure repreſent 16 foot, or the ſpace deſcended by a heavy body in a ſecond minute of time. If a body be ſhot from *b*, in the Line *b f* with a Velocity as much ſwifter than that equal motion of 16 foot in a ſecond, as this Line *b f* is longer than *a b* the body ſhall fall at *e*; for in the ſame ſpace of time that the oblique equal motion would make it aſcend from *b d* to *a c*, will the accelerated direct motion downward move it from *a c* to *b d*, and therefore at the end of the ſpace of one ſecond, when the motions do equal and balance each other, the body muſt be in the ſame Horizontal Line in which it was at firſt, but removed aſunder by the ſpace *b e*, and for the points it paſſeth through in all the intermediate ſpaces this method will determine it.

Let the Parallelogram *a b p q* then repreſent the whole Velocity of the aſcent of a body by an equal motion of 16 foot in a ſecond, and the Triangle *p q r* repreſent the whole Velocity of

of the accelerated descending motion, *p b* is then the Velocity with which the body is shot, and *p* is the point of rest where the power of Gravity begins to work on the body and make it descend. Now drawing Lines parallel to *a q r*, as *s t u*, *s t* gives the Velocity of the point *t* ascending, and *t u* the Velocity of the same point *t* descending.

Again, *p b s t* signifies the space ascended, and *p t u* the space descended, so that subtracting the descent from the ascent you have the height above the Line *b d*, the consideration of this, and the equal progress forwards will give the intermediate Velocities, and determine the points of the Parabola.

Now having the *Jactus* given by this Scheme or Scale, appropriated to the particular Velocity, wherewith any body is moved in this or that line of Inclination, it will be easie to find what Velocity in any Inclination will throw it to any length; for in any Inclination as the square of the Velocity thus found in this Scale for any inclination is to the square of any other Velocity, so is the distance found by this Scale to the distance answering to the second Velocity.

I have not now time to inlarge upon this speculation, which would afford matter enough to fill a Volume, by which all the difficulties about impressed and received motions, and the Velocities and effects resulting would be easily resolved.

Nor have I now time to mention the great number of uses that are and may be made of Springs in Mechanick contrivances, but shall only add, that of all springy bodies there is none comparable to the Air for the vastness of its power of extention and contraction. Upon this Principle I remember to have seen long since in *Wadham* Colledge, in the Garden of the learned Dr. *Wilkins*, late Bishop of *Chester*, a Fountain so contrived as by the Spring of the included Air to throw up to a great height a large and lasting

stream

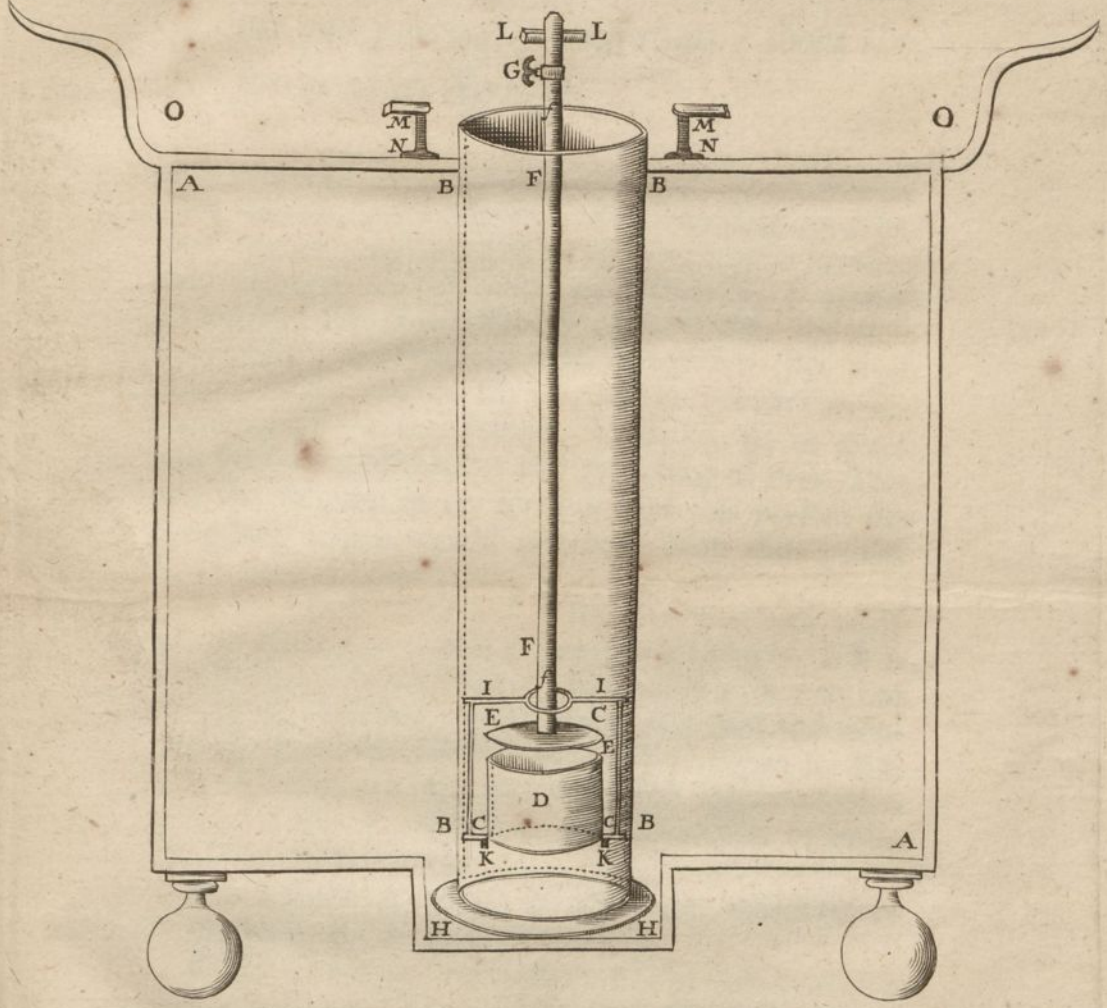
ſtream of water: Which water was firſt forced into the Leaden Ciſtern thereof by two force Pumps which did alternately work, and ſo condenſe the Air included into a ſmall Room. The contrivance of which Engine was not unknown to the Ancients, as *Hero* in his *Spiritalia* does ſufficiently manifeſt, nor were they wanting in applying it to very good uſes, namely, for Engines for quenching fire: As *Vitruvius* (by the help of the Ingenious Monſieur *Claude Perraults* interpretation) hath acquainted us in the Twelfth Chapter of his Tenth Book, where he endeavours to deſcribe *Cteſibius* his Engine for quenching fire. Not long ſince a German here in *England* hath added a further improvement thereof by conveying the conſtant ſtream of water through Pipes made of well tanned and liquored Leather, joyned together to any convenient length by the help of brazen Screws. By which the ſtream of water may be conveyed to any convenient place through narrow and otherwiſe inacceſſible paſſages.

The ingenious Dr. *Denys Pappin* hath added a further improvement that may be made to this *Cteſibian* Engine by a new and excellent contrivance of his own for making of the forcing Syringe or Pump, which at my deſire he is pleaſed to communicate to the Publique by this following Deſcription, which he ſent me ſome time ſince.

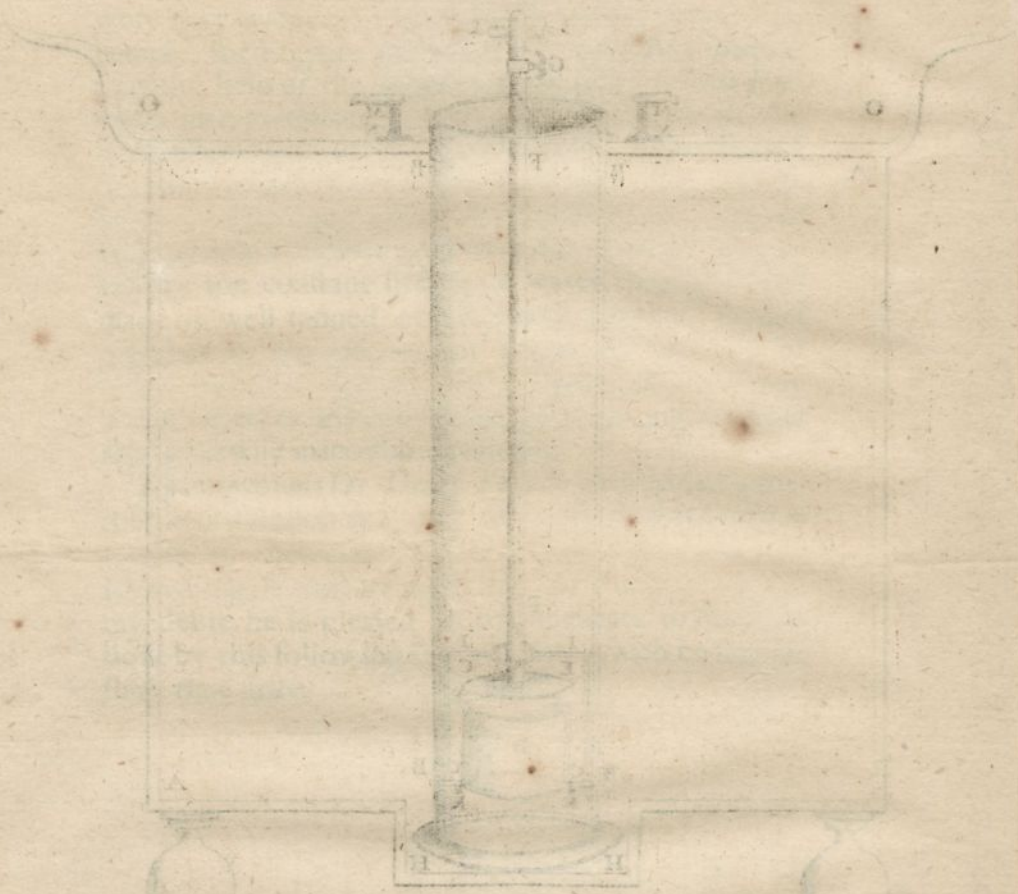
Dr. *Pappins*

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [30] - 24
PUBLIC DOMAIN

Pag: 25.



GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [31] - -
PUBLIC DOMAIN



GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK

Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [32] - -

PUBLIC DOMAIN

Dr. Pappins *Letter containing a Deſcription of a Wind-Fountain, and his own particular contrivance about the forcer of its Syringe.*

SInce the Artificial Fountain you have ſeen at Mr. *Boyles* (which was of my making upon his deſire) hath been ſo pleaſing to you as to make you deſire to ſee my deſcription thereof, I cannot doubt but the ſame will be as grateful alſo, and well received by the Publick, eſpecially when they ſhall therein find a remedy for one of the greateſt inconveniences of forcing Pumps, which are of ſo great uſe for raiſing of water, and quenching of fires. This was the occaſion of my ſending you this preſent deſcription, which would not have been thus prolix had it been only for your ſelf.

In the Figure then A A is the Receptacle or body of the Fountain careful ſodered in all places, B B is the Pump, C C the Plug or forcer, D a Pipe in the middle of the Plug, which is perfectly ſhut and ſtopped when the Plate E E is forced down upon it, E E is the Plate with a hole in the middle, upon which is ſodered a Pipe F, which ſerves for a handle to move the Plug up and down.

G is a Cock at the top of the Pipe, which ſerves to moderate the Jetto or ſtream.

H H is a Valve at the bottom of the Pump, which openeth outward for the paſſage of the water out of the Pump into the Fountain or Receptacle.

I I is a Croſs at the top of the Plug to hinder the Plate E E from being drawn or ſeparated too far

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [33] - 25
PUBLIC DOMAIN

from the hole D in working it to and fro.

K K are two Pins ſerving both to force down and keep open the Valve H H.

L L are two Appendices ſodered unto the top of the Pipe F F, ſerving both for a handle to the Rod of the forcer, and alſo to keep down the forcer.

M M are two other appendices or buttons faſtned at the top of the two ſmall pillars N N, ſo as to turn upon the ſame, and ſerve to haſp or button down the ends L L of the handle of the forcer that it be not driven up again.

O O is the Baſin for receiving the water that falls from the Jet or ſtream from which it may be forced again into the Fountain or Receptacle.

For charging this Machine the Baſin O O muſt firſt be filled with water, and then the Pump muſt be worked to and fro. In doing of which, when the Plug is drawn upwards the water in the Baſin runs in through the croſs (through which the Rod F F paſſes,) where finding the hole D open it fills the ſpaces of the bottom of the Pump; then the Pump being thus filled, the Plug is to be forced downwards, whereby the Plate E E being cloſely applied to the brims of the hole D hinders the water from returning back again through the ſame, but is forced through the valve H H into the Fountain A A. And by repeating this operation all the water of the Baſin O O is eaſily forced into the aforeſaid Fountain, whereby all the Air that was therein contained is compreſſed more or leſs according as more or leſs water is forced in, and kept in that compreſſion by the valve H H, which hinders the water that it cannot return through the ſame.

But when you deſire to have it return, you force down the Plug hard againſt the bottom or plate, which by the help of the aforeſaid Pins or Appendices K K force, and keep open the valve H H, and the Rod F being kept faſt down in this poſture by the aforeſaid

aforeſaid Buttons or Haſps M M, upon opening the Cock G the water returneth through the valve HH, ſo kept open, through the hole D, and through the whole length of the Pipe F.

This way of putting a valve into the Plug of forcing Pumps will be of great uſe for all ſuch as ſerve for ſupplying Towns with water, and for quenching of fire, as preventing a great inconvenience to which the common Pumps are uſually ſubject from the Air which is apt to be generated within them, which Air upon working the ſaid Pump remaining below the forcer, and by its Expanſion when the Plug is drawn upwards, hindring the water from filling the whole Cavity beneath it, and by its Condenſation when the Plug is forced downwards, loſing a great part of the ſtrength of the force, much of the effect of the ſaid Machine is fruſtrated.

For preventing of which Inconvenience care is to be taken that the water in all theſe forcing Pumps be admitted by the top thereof as in the preſent Machine, whereby whatever Air ſhall be generated below the Plug, will readily riſe into the hole D as being the higheſt place next the Plate E E, from whence when by the drawing up of the Plug the Plate is lifted from the brims of the hole D the Air will readily ſlip up, and the water as readily deſcend and fill all the parts of the Pump below the Plug. As I have often experimented in this preſent Machine.

Some Perſons may object againſt theſe kind of valves, asſuppoſing the preſſure of the water to be on the wrong ſide thereof. But it is eaſie to be noted that this objection is groundleſs, ſince it is the ſame thing whether the Plate be preſſed againſt the Rim of the valve, or the Rim of the valve againſt the plate. In common valves the Preſſure of the water forceth the Plate againſt the Rim: But in this the Rim againſt the Plate; for the remaining ſolid Rim of the valve, being made thrice as big as the hole or Cavity thereof,

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [35] - 27
PUBLIC DOMAIN

the preſſure of the water againſt that Rim forceth the ſaid Rim againſt the Plate in the middle three times harder than if the preſſure of the water lay only on the plate of the value, the ſame would be preſſed againſt the Rim.

To this Diſcourſe of an Artificial Fountain I thought it not improper to add an ingenious Diſcourſe of M. *James Young* of *Plimouth* conteining his own Obſervations and Opinion concerning natural Fountains and Springs.

SIR,

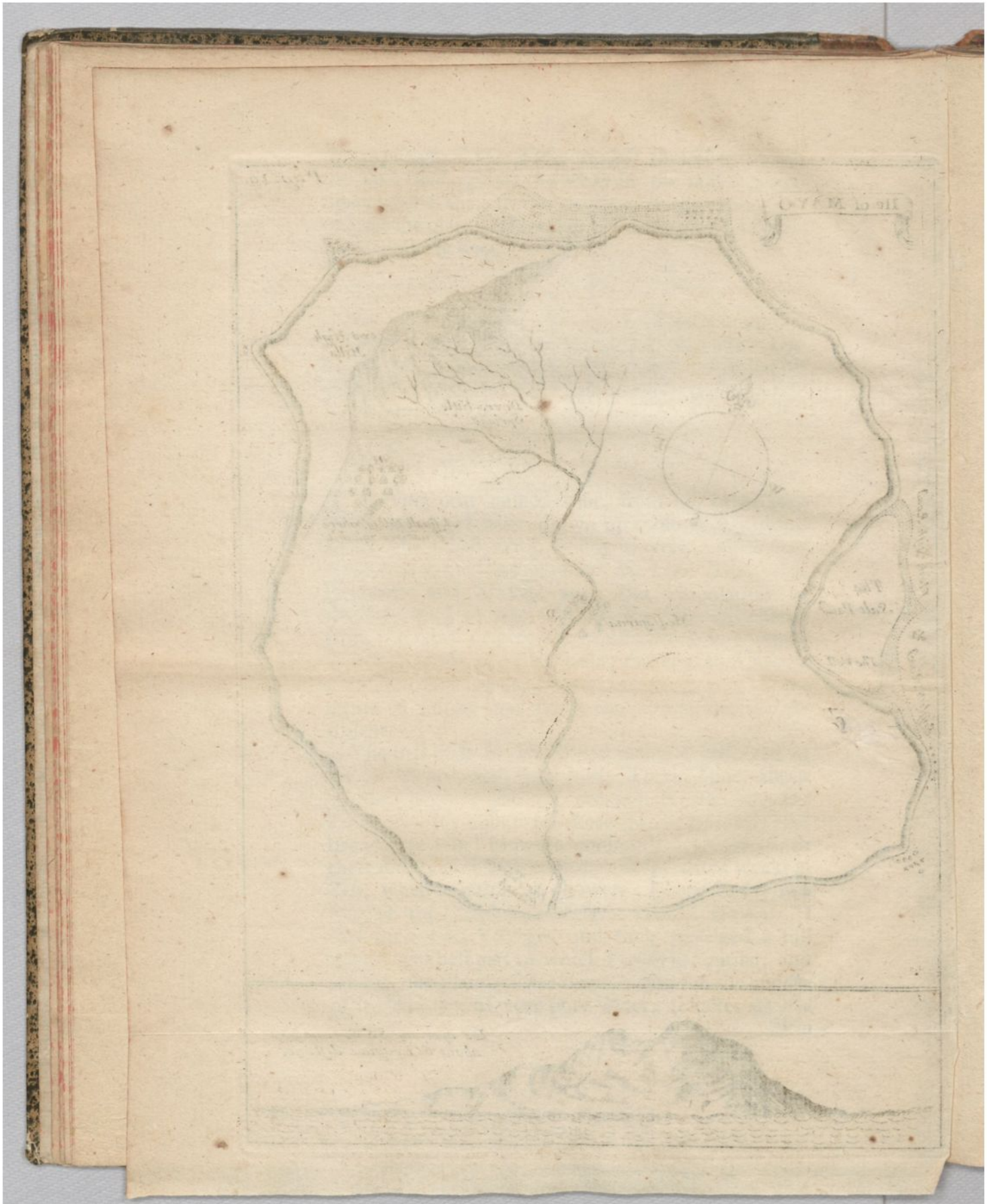
HAving now gained time, from my other avocations, I have drawn up thoſe obſervations. I told you I had made in my travels, which had confirmed in me the opinion of my Lord *Bacon*, that Fountains and Springs were the Percolation of the Sea; not (as your ſelf, Mr. *Ray*, *&c.* do aſſert) from the rains deſcent into the Earth, I now repreſent them to your conſideration, rather as an Apology (becauſe they ſeem rational) to excuſe, than Arguments to juſtifie and avow the preſumption of my diſſent.

The firſt ſhall be the Phænomena, I obſerved at Iſle *de Mayo*, which lieth in the Torrid Zone, about thirteen degrees and 30 minutes, North from the Equator. It's about ſix Leagues long, and four broad, the wind bloweth conſtantly North Eaſt, or thereabout, and without rain, except three weeks in *July*, when it hath many ſhowers; I here ſend you a Map of the Iſland, as exactly as I could draw it. I was there two Voyages, and each remained a full month, the beſt part of which I ſpent in hunting, and ranging the Iſland; there runneth through the middle of it a Rivulet, of very pure water; It takes its riſe

from



GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [37] - -
PUBLIC DOMAIN



GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK

Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [38] - -

PUBLIC DOMAIN

from the bottom of two Hills, which lie on the North East end; The ſtream at the place marked D, is about fourteen foot wide and two deep; other than which there is no freſh water on the whole Iſland, except what our people dig out of the ſand between the Ocean and the ſalt Pond.

The ſaid Pond is in a large Bay, at the Weſt ſide of the Iſland, which hath from one point to another a bank of Sand, about two or three foot above water, covering the Bay like a ſtring to a Bow, the ſaid bank in the Flemiſh Road is about 150 foot wide, at the Engliſh Road it is as broad again; there is never any ſenſible ebbing or flowing of the Sea, only at full Moons, or a day before. It riſeth in high Billows, which break over the Bank, at the North end of the Pond, where it is loweſt: By which means the Pond is repleniſhed with water, which condenſeth into Salt in two days.

The Sand dividing the ſaid Pond and the Sea is very fine and looſe. Now becauſe the before-mentioned Rivulet diſembogues far from the Roads at an inconvenient place for Boats, they are conſtrained to dig Wells, in the midſt of the bank of Sand, between the Pickle of the ſalt Pond and the Sea, the manner thus: They firſt dig a pit about eight foot deep, and therein lay two Hogſheads, the one on the top of the other, the head out of both ſave the lowermoſt of the deepeſt; the ſides of both are alſo full of Gimlet holes, and the ſand laid cloſe to them: After twenty four hours they have three or four foot of very clean water in them, which being dipped out, you plainly ſee the new water ſtrain gently through thoſe holes in the ſides of the Cask: After which, in a days time, one man attending it, may draw about ten Hogſheads or more of water, a little taſting of Salt, not ſo much but that it is drinkable, and very fit to boyl meat in, and is uſed by thoſe that come there to load Cattle, for their

common drink. I have in the Map placed the Sign O where our Well was made.

The next obſervations, pertinent to this ſubject I made at the Iſland *Lipari*, near *Sicily*, about ſixteen Leagues from *Meſſina*; it is famous for the beſt Raiſins in the *Mediterranean*; there is on it a large Caſtle, a ſmall Town, many Vineyards, and about one hundred Families, beſides ſome *Religioſe*. I judge it wants a fifth part of the bigneſs of the Iſle *de Mayo*, it is moſtly very high Land, eſpecially one Mountain, on which ſtands a Watch Tower, whence a man may ſee a monſtrous diſtance at Sea, as is confirmed by *de Ruyter*. In the relation he gives the States of *Holland*, wherein he tells them, that from that place they diſcerned the French Fleet's approach long before they could from any other part, either of their own or the other Iſland. I am ſure it is much higher than either that at the Iſle *de Mayo*, or any I have ſeen in *England*, and yet on this fair fruitful Iſland ſprings not one drop of water, the Inhabitants ſtoring themſelves with rain, which falling very frequently, they are careful to preſerve in Ciſterns, divers eſſays have been made in the moſt promiſing part of it to find Springs by digging Wells, one of thoſe which I ſaw was without doubt the deepeſt in *Europe*, I remember not the exact profundity as they related it, but I have not forgot, that throwing in a ſtone it was long ere it got to the bottom, and then returned ſuch a noiſe as it had been the diſcharge of a Muſquet.

The cauſe of this drineſs was by the people thought to be ſubterranean heats, abſuming the water, but no ſuch thing appearing, to the ſenſe of thoſe that digged the Wells, I gave no faith to that perſuaſion; they fancy ſuch heats partly from the want of water, but moſtly becauſe the four adjacent Iſlands, *Stromboli*, *Vulcano*, *Vulcanella*, and *M. Ætna*, are conſtantly burning, and very near them.

The

The obvious earth of this place is looſe, and in all apparent qualities very good, but by the heaps that had been thrown up, in digging the Wells, I ſaw the inferiour earth was clammy, or like clay, that had ſome greaſie gummous matter commixed, This the Religious told me was the very kind of Sulphur which conſtantly boyled out of the burning Cranny on *Vulcanella*; and wherewith all thoſe Iſlands abounded, not excepting their own, though it were not yet kindled.

For my third obſervation, I will go no farther than the place of my preſent abode, *Plimmouth*, in which on a kind of Piazza, commonly called the *New-key*, (a plat of ground got in from the Sea) is a Well, which (before the ever famous Sir *Francis Drake* by cutting a Rivulet of thirty miles procured us water in great plenty) was of common uſe, having (as at this day) a Pump in it; about ſeven years ſince (being before the Key was inlarged) the Well was not above eight foot from the edge thereof, over which the Sea would frequently flow, when a high outwind and a Spring Tide concurred, I ſay this Well, though ſo near the Sea, yieldeth clean water, and as ſweet as a mixture of three parts freſh and one of ſalt water would be. About an hundred yards from that, on ground a little riſing, is a very large Well, which ſupplieth three or four Brew-houſes, by whoſe drink it is evident that the water hath not wholly quitted its ſalt. It is to be noted, that *Plimmouth* lieth on a Peninſula three miles long, and two broad, the Iſthmus about two thirds of a mile wide, and not very high from the ſurface of a full Sea. There are many Wells in it, thoſe near the Sea are ſaltiſh, thoſe farther from it the leſs ſo.

My fourth obſervation I take from the late famous French Traveller Monſieur *Taverner*, who in his firſt Volume, diſcourſing of the Coaſt of *Coromandel*, &c. he ſaith they there want freſh water, and are conſtrained

ſtrained to make pits of two foot deep in the ſand by the Sea to find it.

The fifth obſervation, and which I would call the moſt ſignificant, were I aſſured of its truth, I had from a very ingenious Chirurgeon, who had uſed the *Weſt Indias*, that there is in that Sea an Iſland called *Rotunda*, of a figure agreeable to its name, which, though very ſmall, hath on it, ariſing in the middle, a Spring of a very large ſtream of water, at which our Ships frequently furniſh themſelves in their Navigation, he affirmed that it raineth there but once a year, as at the Iſle *de Mayo*; ſaying withal, that the Iſland is ſo ſhort of a proportion big enough for the ſtream, that if it conſtantly rained, it could not be ſupply enough to maintain ſo large an Efflux.

My ſixth and laſt, is the relation of Dr. *Downes* concerning *Barbadoes*, *viz.* that all their Springs were formerly very near the Sea; that up in the Country they ſupplied themſelves from the rains by digging pits in the earth, able to contain great quantities, and there preſerving it; which they did a very long time (the rains being there as unfrequent as at the Iſle *de Mayo*) and that without any ſenſible diminution by penetrating and deſcending into the earth; and to prevent the loſs thereof by the exhalations of the Sun they covered it with leaves, *&c.* but that now by digging deeper they find Springs ſo plenty that no Plantation is without one.

From all theſe obſervations the following conſectaries do mechanically reſult.

From the firſt it appeareth that ſome Springs have manifeſtly their ſource from the Sea; that ſand ſweetens tranſcolated Sea-water, and that even pickle ſtrained through it loſeth much of its ſaltneſs thereby, all which is evident from the Well therein mentioned, whoſe water could not poſſibly be other than what ſoaked in from the Pond and the Ocean.

Hence

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [42] - 32
PUBLIC DOMAIN

Hence alſo is manifeſt, that conſtant and large Fluxes of water may be made for eleventh months without rain to refill the ſubterranean Ciſterns, ſuppoſed by you to ſupply them; this appears from the River running through the Iſland, by whoſe banks I found (it being *April* when I was there, at which time they had been ten months without rain) thſh after their ſhowers it could run but little larger that it did after ſo tedious a want of them. I had forgot to intimate in the relation, that thoſe two Hommets, A. are craggy Rocks, whereon live a great number of Goats, and are consequently very unfit, if not incapable, either to receive, or contain the Magazine for the ſupply of the Rivulet.

From the ſecond it is manifeſt, that higher Mountains of earth, and conſequently more likely to receive and contain ſufficient quantity of rain-water to beget and ſupply Springs and Rivers have not always that effect, although there was one great advantage more added here, *viz.* a clammy tyte earth in the bottom to make the ſuppoſed Ciſtern the better able to contain the ſtore. I ſay, that frequent rain to fill, high Mountains to contain, looſe pervious earth to receive, and a well luted bottom to ſupport and retain (being all the qualifications and circumſtances ſuppoſed neceſſary to make and continue Springs according to the modern Hypotheſis) though all here concurred, did notwithſtanding fail of producing that effect.

From the ſame it is alſo manifeſt, that where Springs fail, without want of the cauſes that Hypotheſis ſuppoſeth neceſſary to produce them, the occaſion hath been from an apparent defect in the other (that is the imperviouſneſs of the earth through which the water muſt paſs before a Spring can be produced) both theſe appeared at *Lipary*, where the general effect a Spring or fountain was wanting, together with the cauſes of our Hypotheſis, though thoſe of the other were

manifeſtly exiſtent, and with all the advantages neceſſary: It ſeeming to me a very rational conjecture, that the greaſie clammy Sulphur, wherewith that earth was impregnated, did by oppilating it hinder the inſinuation of the Sea into it.

From the third obſervation you have the firſt deduction confirmed, *viz.* That Springs are ſometimes manifeſtly from the Sea; That earth ſweetens Sea-water by Percolation; And that the nearer Springs are to the Sea, the more they retain of their priſtine ſaltneſs, and loſe it by ſenſible degrees, as they inſinuate farther through it.

By the fourth the ſame is confirmed.

The fifth proveth, that large ſtreams flow without any poſſibility of being ſupplied by rain, both for want of ſuch rain, and of dimenſions to receive and contain it.

The ſixth doth evidence, that rain doth not penetrate the Surface of the earth, even in a very dry parched Country, and in the Torrid Zone, and yet that Springs are under it, which at once proves ours, and refutes the other opinion; the former appears by the water in thoſe made Ponds, lying there for a long time without any ſenſible loſs thereof by its leaking into the earth: The later by the Wells near the Sea, and thoſe found ſince under that impervious Land.

He that is not altogether a ſtranger to the weight, preſſure, and Elaſticity of the air, the aſcenſion of liquors through Filters, and ſome other reſembling Phænomena, would not account the like motion of the tranſcolated water to high hills, to be an objection of any force againſt this Hypotheſis, but ſure ſuch ſolutions are no leſs beyond my ability than deſign.

Finding I have Paper enough left, I will preſume to trouble you with one rare appearance more, that occurred to one Mr. *Braſey* of this Town, an aged and

and very fat man, who by taking Spirit of Vitriol in his mornings draughts (to which he was adviſed as a remedy to aſſwage the exuberance of his belly) found that it had no effect on his body; but that a bundle of Keys, which he uſed to carry always about him, and that wonted to be very ſmooth and bright, of a ſudden became black and ruſty, though he never handled the Spirit,nor carried it in his pocket, ſo that we concurred in opinion that the ſudorous Effluvia of his body, impregnated with the Acid Spirit, had occaſioned it.

If ſo, It's very wonderful, that ſo ſmall a quantity thereof, when diluted with ſo much juice as is contained in ſuch a corpulent man, ſhould even in ſteam and the inſenſible Emanations make impreſſions on ſmooth Iron, mauger the perpetual attrition, by carrying them in his Pocket, whereby ſuch an effect (one would think) ſhould be prevented, or ſoon rubbed of.— I was going to make ſome reflections on this notable accident, but I conſider,*&c.*——

Plimmouth
May 5. 1678.

James Young.

THE Original of Springs is that which hath exerciſed the Pens of many learned Writers, and very various have been the conjectures concerning it. But amongſt all I have met with I conceive none more probable than that which ſeems to fetch its original from the Hiſtory of the Creation mentioned in Holy Writ; that is, that there is a Magazine of waters above as well as a Receptacle of waters upon or beneath the Surface of the Earth: And that the Air is that Firmament which ſeparates between the upper and lower waters, and between theſe two is the circulation of waters (or bloud of the Microcoſm, if I may ſo call it) performed. The water being ſometimes by a particular conſtitution of the Air aſſiſted by heat, rarified and ſeparated into minuter parts, and ſo reduced into the form of Air, and thereby being divided into Particles really ſmaller than thoſe of the air in compaſſing, and agitated with a greater degree of motion, they take up more ſpace, and ſo become lighter than the Ambient, and are thereby elevated and protruded upwards till they come to their place of poiſe or Equilibrium in the Air; At other times by a differing conſtitution of the Air and deficiency of heat they loſe their agitation, and many of them again coaleſce, and ſo having leſs motion they condenſe and revert into water, and ſo, being heavier than the incompaſſing Air, deſcend down again to the Earth in Miſts, Rain, Snow, Hail, or the like.

That there is ſuch a Circulation I think there is none doubts, but ſtill it remains a difficulty (with thoſe perſons that grant this) that all Rivers and Springs ſhould have their original from the water that falls or condences out of the Air.

To perſuade ſuch perſons it may not poſſibly be unſucceſsful to mention:

First,

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [46] - 36
PUBLIC DOMAIN

First, That the great inundations or overflowing of Rivers manifeſtly proceed either from the Rain that immediately falls, or from the melting of Snow or Ice that hath formerly fallen on the more eminent parts of Mountains; to confirm which, Hiſtories enough might be brought were it neceſſary of *Nilus*, *Niger*, &c.

Secondly, That it hath been obſerved and computed that *communibus annis & locis*; there falls water enough from the Sky in actual Rain, Snow, or Hail upon the Surface of *England* to ſupply all the water that runs back into the Sea by the Rivers, and alſo all that may be ſuppoſed to evaporate; nay, though the quantity of the firſt be ſuppoſed twice as much as really it is. This I have been aſſured by thoſe that have both experimented and calculated it.

Thirdly, That there is not yet certainly (that I know or have heard of) any other way of making ſalt water freſh, but by Diſtillation; which, had there been ſuch an Art, it would in all probability have been made uſe of, and ſo there is little probability that the Springs at the top of a high Hill ſhould proceed from the Sea-water ſtrained through the earth. But were there ſuch a filtration known I hinted in my Attempt, publiſhed *anno* 1660 about Filtration, how ſomewhat of that kind might be explained.

Fourthly, That this Operation is conſtantly and moſt certainly performed by Nature both in exhaling and drawing up freſh ſteams and vapours from the Sea, and all moyſt bodies, and in precipitating them down again in Rain, Snow, Hail, but of the other we have no certainty.

Fifthly, I have obſerved in ſeveral places where a Tree hath ſtood upon an high Hill, ſingly and particularly at the brow of Box Hill near *Darking* in *Surry*, that the body of the Tree is continually wet, and at the root ſome quantity of water, which is always ſoaking and gliding down from the Branches and body of the Tree, the leaves, ſprigs, and branches of

the ſaid trees collecting and condenſing continually the moyſt part of the Air, the ſame being indeed a true and lively repreſentation of a River. Nor has it been my obſervation alone, but the ſame is mentioned by divers Authors: And it is affirmed by ſome Authors, that there are ſome Iſlands in the Torrid Zone which have no other water in them than what is condenſed out of the Air by the Trees at the tops of the Hills, and converted into drops of Rain.

Sixthly, That it is generally obſerved, whereever there are high Hills there are generally many Springs round about the bottoms of them of very freſh and clear water, and often times ſome which riſe very near the tops of them, which ſeems to proceed from their great elevation above the other plain ſuperficial parts of the earth, whereby the Air being daſhed and broken againſt them, they help to condenſe the vapours that are elevated into the higher and cooler Regions of the Air, and ſo ſerve like Filtres to draw down thoſe vapours ſo condenſed, and convey them into the Valleys beneath, And hence it is very uſual in Countries where there are high Hills to ſee the tops of them often covered with clouds and miſts, when it is clear and dry weather beneath in the Valleys. And in the paſſing through thoſe clouds on the top I have very often found in them very thick miſts and ſmall rain, whereas as ſoon as I have deſcended from the higher into the lower parts of the Hills, none of that miſt or rain hath fallen there, though I could ſtill perceive the ſame miſts to remain about the top. Conſonant to this Obſervation was one related to me by an ingenious Gentleman Mr. *G. T.* who out of curioſity with other Gentlemen whilſt he lived in the Iſland of *Teneriff*, one of the *Canaries* made a journey to the top of that prodigious high Mountain, called the *Pike*. The ſubſtance of which (to this purpoſe) was, that the *Caldera* or hollow Cavity, at the very top

top thereof he obſerved to be very ſlabby and moyſt, and the earth to ſlip underneath his feet, being a very moyſt ſoft Clay or Lome like mortar. And farther, that at a Cave, not far from the top, there was a great quantity of very freſh water, which was continually ſupplied, though great quantities of Ice were continually fetch'd from thence, and carried down into the Iſland for cooling their Wines. Conſonant to which Obſervation was that which was related to me by the Inquiſitive Mr. *Edmund Hally* made in St. *Helena* whilſt he ſtayed there to obſerve the places of the Stars of the Southern Hemiſphere, in order to perfect the Cœleſtial Globe. Having then placed himſelf upon one of the higheſt Prominences of that ſmall Iſland, which he found to be no leſs than 3000 foot Perpendicularly above the Surface of the Sea next adjoyning, ſuppoſing that might be the moſt convenient place for his deſigned obſervation; He quickly found his expectation much deceived as to that purpoſe for which he choſe it; for being gotten ſo high into the Air the motion of it was ſo violent as much to diſturb his Inſtruments; but which was more, he found ſuch abundance of miſts and moyſture that it unglued the Tubes, and covered his Glaſſes preſently with a Dew; and which was yet more, the foggs and miſts almoſt continually hindred the ſight of the Stars. But upon removing to a lower ſtation in the Iſland he was freed from the former Inconveniences.

I could relate many Hiſtories of this nature, whereby it ſeems very probable, that not only Hills, but Woods alſo, do very much contribute to the condenſing of the moyſture of the Air, and converting it into water, and thereby to ſupply the Springs and Rivulets with freſh water: And I am confident, whoſoever ſhall conſider his own obſervation of this nature, and compare them with this Theory, will find many arguments to confirm it. However, *Nullius in verba*,

verba, Let Truth only prevail, and Theories ſignifie no further than right reaſoning from accurate Obſervations and Experiments doth confirm and agree with them.

Having thus delivered here ſomewhat of my own thoughts concerning Springs and Rivers, finding among ſome of my Papers a Relation, wherein a very ſtrange ſubterraneous Ciſtern is mentioned, I have here ſubjoyned it as I received it from Mr. *Thomas Alcock* from *Briſtol* who together with Sir *Humphry Hooke* was by whilſt Captain *Samuel Sturmy* made this inquiry, and who by interrogatories made to him, penn'd this Relation for him as it follows verbatim.

IN purſuance of His Majeſties Commands to me at the preſenting of my *Mariners Magazine*, I have with much diligence, ſome charge and peril endeavoured to diſcover that great Concavity in the earth in *Gloceſterſhire*, four miles from *Kingrode*, where His Majeſties great Ships ride in the *Severn*. And I find by experience that what has been reported of that place is fabulous, whilſt I thus deſcribe it.

Upon the ſecond of *July* 1669. I deſcended by Ropes affixt at the top of an old Lead Oare Pit, four Fathoms almoſt perpendicular, and from thence three Fathoms more obliquely, between two great Rocks, where I found the mouth of this ſpacious place, from which a Mine-man and my ſelf lowerd our ſelves by Ropes twenty five Fathoms perpendicular, into a very large place indeed, reſembling to us the form of a Horſe-ſhoo; for we ſtuck lighted Candles all the way we went, to diſcover what we could find remarkable; at length we came to a River or great Water, which I found to be twenty fathoms broad, and eight fathoms deep. The Mine-man would have perſwaded me, that this River Ebbed and Flowed, for that ſome ten fathoms above the

the place we now were in we found the water had (ſometime) been, but I proved the contrary by ſtaying there from three hours Floud to two hours Ebb, in which time we found no alteration of this River; beſides, it's waters were freſh, ſweet, and cool, and the Surface of this water as it is now at eight fathom deep, lies lower than the bottom of any part of the *Severn* Sea near us, ſo that it can have no community with it, and conſequently neither flux nor reflux, but in Winter and Summer, as all *Stagna's*, Lakes, and Loughs (which I take this to be) has. As we were walking by this River thirty two fathoms under ground, we diſcovered a great hollowneſs in a Rock ſome thirty foot above us, ſo that I got a Ladder down to us, and the Mine-man went up the Ladder to that place, and walk'd into it about threeſcore and ten paces, till he juſt loſt ſight of me, and from thence chearfully call'd to me, and told me, he had found what he look'd for (a rich Mine;) but his joy was preſently changed into amazement, and he returned affrighted by the ſight of an evil Spirit, which we cannot perſwade him but he ſaw, and for that reaſon will go thither no more.

Here are abundance of ſtrange places, the flooring being a kind of a white ſtone, Enameled with Lead Oare, and the Pendent Rocks were glazed with Salt-Peter which diſtilled upon them from above, and time had petrified.

After ſome hours ſtay there, we aſcended without much hurt, other than ſcratching our ſelves in divers places by climing the ſharp Rocks, but four days together after my return from thence I was troubled with an unuſual and violent Headach, which I impute to my being in that Vault. This is a true account of that place ſo much talk't of, deſcribed by me

Samuel Sturmy.

Having given you a Relation of ſomething very low within the bowels of the Earth, I now ſhall add,

An account of a Journey made to the higheſt part of the earthby my Ingenious Friend Mr.G. T. as I collected it out of the Memorials which he writ at the time of making it; The particulars whereof were,

THat *Auguſt* the twentieth, 1674. about Nine in the morning, in company with Dr. *Sebaſtian de Franques*, Mr. *Chriſtopher Prancis*, Mr. *Thomas Proudfoot*, together with a Guide, and two other men with horſes to carry themſelves and neceſſary proviſion for the Journey, he ſet out from

They paſſed up a Hill, which was very ſteep, till they came to the *Pinal* or Wood of Pines. This Wood lieth very high in the Iſland, and extendeth it ſelf from one end of the Iſland to the other, and is in many places of a great Breadth, and is very frequently covered with a *Bruma*, fog, or miſt, which is ſo thick as to darken and hinder the appearance of the Sun through it, and ſo moyſt as to make one wet in paſſing through it.

Through this Wood they rode by a pretty ſteep aſcent near two Leagues, croſſing it till they came to the further or . ſide, where alighting they reſted themſelves under a Pine, and Dined. And the fog, which had accompanied them through the whole Wood, here left them, and the Sun appeared.

From hence they parted about one in the Afternoon, and after an aſcent of about half a mile of very bad ſtony way they came to a ſandy way, which for about the length of a League was pretty plain; but then they began to aſcend a ſandy hill, which for half a League farther was pretty ſteep, which having paſſed they arrived at the foot of the *Pike*.

Here they alighted, and then reſted themſelves for ſome time, then taking horſe again, they began to

to aſcend the *Pike* it ſelf. This part of it was ſo ſteep that the way up it is made by ſeveral turnings and windings to and fro to eaſe and alleviate the ſteepneſs of the aſcent, which were otherwiſe unpaſſable for horſes. All this part ſeems to be nothing elſe but burnt ſtones and aſhes, which may have formerly tumbled down from the higher parts of the *Pike*.

At this place they alighted, and unloaded their horſes of the Proviſion of Victual and water which they were forced to carry with them for their own accommodation, as alſo of the Provender for their horſes. And preſently ſet themſelves to provide againſt the inconveniences of the enſuing night by getting together in the firſt place a good quantity of the wood of a ſmall ſhrub, called *Retamen*, not much unlike our Engliſh Broom, which grows there pretty plentifully, and when dry burns very well; then, having gotten wood enough, they endeavoured to ſhelter themſelves againſt the piercing cold wind by heaping up a wall of ſtones on the windward ſide, and making a good fire of the dry ſhrubs they had collected to warm themſelves.

But ſo furious was the wind which came pouring down from each ſide of the Mountain that it blew the ſmoak and aſhes into their eyes, and forced them (though much to their Regret by reaſon of the extreme piercing coldneſs of the Air) to remove their fire farther off. And to keep themſelves as warm as they could by lying down upon the ground very cloſe together. Thus they paſſed the night together as well as they could, but with very little ſleep, partly by reaſon of the cold, and partly for the continual expectation they had of the moment when their Guide would call them to be mounting up the *Pike*, which is uſually about two or three hours before day, to the end that they may get up to the top before the riſing of the Sun. For at the riſing of the Sun the Air is the moſt clear, and all the Iſlands of

the *Canaries* round about may be then plainly discovered.

But at two a clock, when they should have been on their Journey, the wind continued to blow with such violence, that their Guide would by no means venter to go up for fear least in the climbing up some steep places the wind should encounter any of them, and hurl them headlong down, so that they were forced to continue and shelter themselves in their bad Lodgings till the Sun arose, and had got some mastery of the wind.

About six a clock therefore they set forwards on their enterprise, having first taken each of them his dish of Chocolatte to fortifie their stomachs the better against the cold, so with their Bottle of Strong-water in their Pockets, and Staves in their hands, they began to mount the *Pike*, the way being just such as they had passed the night before, but much more steep, and continued on till they came to the *Mal pays*, or stony way, which may be about half a mile from the place where they lay; This stony way lieth upon a very steep ascent, and is compounded of abundance of stones which lie hollow and loose, some of them of a vast prodigious bigness, and others of them smaller, in such manner as if they had been thrown up there by some Earthquake, as the Author conjectures with very great probability. In the clambring up these stones they took great care in placing their steps on such of them as were more firm for fear of slipping or tumbling so as to break their Legs or Arms.

With this difficulty they ascended till they came to the Cave which he conjectures to be about three quarters of a mile distant from the beginning of the stony way.

At this Cave they found several persons who were come thither to get out Ice to carry down into the Island, some of which were below in the Cave, digging

digging Ice which was very thick, others remained above. They found the mouth of the Cave about three yards high, and two yards broad; and being all of them desirous to descend into it, by a Rope fastned about their bodies under their armpits they were all one after another let down into it till they came to set their feet upon the Ice, which is about sixteen or eighteen foot from the mouth.

The Cave is not very large, but full of water and Ice, which at the time when they were there lay about a foot under the Surface of the water, though the men that usually go thither said that at other times they found the Ice above the water, which makes many to suppose that it ebbs and flows by means of some secret entercourse that it may have with the Sea, they averring that they have seen it emptying of it self.

But this Gentleman so soon as ever he came down fixt his eye upon a stone that lay just above the Superficies of the water, and observed very diligently but could not in all the space that he staid there, which was half an hour, find it either increase or diminish, which makes him believe that the fulness or emptiness of the water may rather proceed from those thick fogs and mists which are generally on the top, and which hinder the *Pike* from being seen sometimes for twenty, thirty, nay, forty days together, except only just at the rising or setting of the Sun, though at some other times it happens also that the Air is clearer, and the *Pike* may be seen perhaps for a month together. From these mists he conceives at some times much water may be collected at the upper parts of the *Pike*, and soaking down may not only supply, but increase the water in the Cave; and consonant to this Hypothesis he observed whilst he was there, that there was a continual gleeting and dropping of water in six or seven places from the sides of the Cave, which droppings he supposes may be greater or less according as

thoſe fogs do more or leſs encompaſs it, or ſtay about it a longer or ſhorter time; He judges alſo that there may be ſome other more ſecret ways both for the conveying water into and out of the ſaid Cave than thoſe droppings, but ſuppoſes them to proceed from the aforeſaid fogs. Hence he concludes when the Air is clear, and none of thoſe fogs condenſed about the Hill, the water in the Cave muſt neceſſarily decreaſe. And that wich confirmed him the more in this opinion was that when he came to the very top of the *Pike*, he found the earth under him ſo very moyſt, that it was like mud or morter, and might be made into Paſte as by experiment he found which he conjectures could no ways be cauſed by the wind or clear Air, which is rather drying and conſuming of moiſture, but muſt proceed from the fogs or miſts which are above the very top of the *Pike*.

He further took notice in the Cave that upon the ſides and top thereof there grew a ſnow-white furring like Saltpeter, which had a kind of ſaltiſh taſte, ſome of which he gathered and brought back with him to *England* to have it examined.

After about half an hours ſtay in the Cave, which they found warmer than without in the open Air, they were all pulled up again, and proceeded forward in their Journey by continuing to clamber up the ſtony way, which laſted till they came to the foot of that part of the Mountain which is called the Sugar-loaf, by reaſon that at a diſtance from the Iſland it appears of that ſhape, as it doth alſo even when you are at it. The diſtance of this place from the Cave they judged to be about half a mile, but the way much more ſteep and aſcending than the former part of the ſtony way, and extreme troubleſom to paſs, their feet ſinking and ſlipping down again almoſt as much as they could ſtride upwards, ſo that they concluded it the moſt painful of all; however, perſiſting in their endeavours, after many times reſting themſelves, they

gained

gained the top, which they conceive might be about half a mile higher.

The very top they found not plain, but very Rocky and uneven, and in the middle thereof a deep hole; the outside of this top this Gentleman conceived might be about a quarter of a mile round about on the outside.

This hole he conceived to be the mouth of a *Vulcano* which hath formerly been in that place, for even at that time whilst they were there much smoak ascended out of several holes and chinks of the Rocks, and the earth in divers parts was still so very hot as to be very offensive to their feet through their shooes, and he observed Brimstone thrown up in several places, of which he collected some, and brought back with him to *England*.

From this place may be seen in a clear day all the six adjacent Islands, but the weather being then somewhat thick and hazy, they could discover none but the grand *Canaries*, *Palm*, and the *Gomera*, which last, though distant near eight Leagues from the bottom of the *Pike* seemed yet so near unto them as if it had been almost under them. The rest of the Islands they could discover whereabout they lay by means of a kind of white cloud hanging on them, but they could not discern the Islands through those clouds.

Here they tried their Cordial Waters which they carried in their Pockets, but found them not to abate of their usual strength, and become cold and insipid as fair water, as several had positively averred to him that they had found it, but he conceived them to be very much of the same nature and strength that they were of before they were carried up, which he supposes to be by reason of their arriving at the top so late.

After they had stayed on the top about an hour, and satisfied themselves in observing such things as they were able, they descended again with very much facility,

facility, and came to the *Stancia* about eleven of the clock, where they dined, and thence about one in the Afternoon ſet forwards for the *Villa*, where they arrived that afternoon about five that Evening.

After their return they found their faces (by reaſon of the heat of the Sun, and the parching ſubtil wind) to caſt their skins.

He did not meaſure the Perpendicular height of the Hill himſelf, but ſays that he hath been informed by divers skilful Seamen, (who by their beſt obſervation have taken the height of it) that it is between three and four miles perpendicularly above the Sea.

IN this Relation it is very remarkable:

Firſt, that this prodigious high Hill is the Product of an Earthquake, and ſeems heretofore to have been a *Vulcano*, or burning Mountain, like thoſe of *Ætna*, *Veſuvius*, *Hecla*, &c. though at preſent it hath only fire enough left to ſend forth ſome few ſulphureous fumes, and to make the earth of the *Caldera* or hollow pit at the very top thereof in ſome places almoſt hot enough to burn their ſhooes that paſs over it. And poſſibly in ſucceeding Ages even this little fire may be quite extinct, and then no other ſign thereof may be left but a prodigiouſly high Rock or ſpiring Mountain, which in tract of time may by degrees waſte and be diminiſhed into a Hill of a more moderate height.

Now as this Hill ſeems very evidently to be the effect of an Earthquake, ſo I am apt to believe that moſt, if not all, other Hills of the world whatever may have been the ſame way generated. Nay, not only all the Hills, but alſo the Land which appears above the face of the waters. And for this I could produce very many Hiſtories and Arguments that would make it ſeem very probable, but that I reſerve them in the Lectures which I read of this ſubject in *Greſham* Colledge in the years 1664, and 1665, which when I can have time to peruſe I may publiſh.

Therein

Therein I made it probable that moſt Iſlands have been thrown up by ſome ſubterraneous Eruptions. Such is the Iſland of *Aſcenſion*, the *Moluccas*, &c.

Secondly, that moſt part of the Surface of the Earth hath been ſince the Creation changed in its poſition and height in reſpect of the Sea, to wit, many parts which are now dry Land, and lie above the Sea, have been in former Ages covered with it; and that many parts, which are now covered with the Sea, were in former times dry Land. Mountains have been ſunk into Plains, and Plains have been raiſed into Mountains.

Of theſe by obſervations I have given inſtances, and ſhewed that divers parts of *England* have in former times been covered with the Sea, there being found at this day in the moſt Inland parts thereof ſufficient evidences to prove it, to wit, Shells of divers ſorts of Fiſhes, many of which yet remain of the animal ſubſtance, though others be found petrified and converted into ſtone. Some of theſe are found raiſed to the tops of the higheſt Mountains, others ſunk into the bottoms of the deepeſt Mines and Wells, nay, in the very bowels of the Mountains and Quarries of Stone. I have added alſo divers other inſtances to prove the ſame thing of other parts of *Europe*, and have manifeſted, not only that the lower and plainer parts thereof have been under the Sea, but that even the higheſt *Alpine* and *Pyrenean* Mountains have run the ſame fate. Many Inſtances of the like nature I have alſo met with in Relations and obſervations made in the *Eaſt* as well as in the *Weſt Indies*,

Of all which ſtrange occurrences I can conceive no cauſe more probable than Earthquakes and ſubterraneous Eruptions which Hiſtories do ſufficiently aſſure us have changed Sea into Land, and Land into Sea, Vales into Mountains ſometimes, into Lakes and Abyſſes at other times; and the contrary — unleſs we may be allowed to ſuppoſe that the water or fluid

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [59] - 49
PUBLIC DOMAIN

part of the earth which covered the whole at firſt, and afterward the greateſt part thereof, might in many Ages and long proceſs of time be waſted, by being firſt raiſed into the Atmoſphere in vapours, and thence by the diurnal, but principally by the annual motion thereof be loſt into the *æther*, or medium through which it paſſes, ſomewhat like that waſting which I have obſerved to be in Comets, and have noted it in my *Cometa*: Or unleſs we may be allowed to ſuppoſe that this fluid part is waſted by the petrifaction and fixation of ſuch parts of it as have fallen on the Land and Hills, and never returned to fill up the meaſure of the Sea, out of which it was exhaled, for which very much may be ſaid to make it probable that the water of the earth is this way daily diminiſhed.

Or unleſs (ſince we are aſcertained by obſervations that the direction of the Axis of the earth is changed, and grown nearer the Polar Star than formerly; that the Magnetiſm or Magnetical Poles are varied, and do daily move from the places where they lately were, and that there are other great and noted changes effected in the earth) we may be allowed to conceive that the Central point of the attractive or gravitating power of the earth hath in long proceſs of time been changed and removed alſo farther from us towards our Antipodes, whence would follow a receſs of the waters from theſe parts of the world to thoſe, and an appearance of many parts above the ſurface of the water in the form of Iſlands, and of other places formerly above the Sea now in the form of Mountains, ſo to continue till by the libration or otherways returning motion thereof it repoſſeſs its former ſeat and place, and overwhelms again all thoſe places which in the interim had been dry and uncovered with the return of the ſame water, ſince nothing in nature is found exempt from the ſtate of change and corruption.

Further,

Further, it is probable that Earthquakes may have been much more frequent in former Ages than they have been in these latter, the consideration of which will possibly make this Assertion not so Paradoxical as at first hearing it may seem to be; though even these latter Ages have not been wholly barren of Instances of the being and effects of them, to convince you of which I have hereunto subjoyned a Relation and account of one very newly which hapned in the Isle of *Palma* among the *Canaries*.

Next, the clearness of the Air is very remarkable, which made an Island which lay eight Leagues off to look as if it were close by. To this purpose I have often taken notice of the great difference there is between the Air very near the lower Surface of the Earth, and that which is at a good distance from it; That which is very near the earth being generally so thick and opacous that bodies cannot at any considerable distance be seen distinctly through it: But the farther the eye and object are elevated above this thick Air, the more clear do the objects appear. And I have divers times taken notice that the same object seen from the top and bottom of a high Tower hath appeared twice as far off when seen at the bottom as when seen at the top: For the Eye doth very much judge of the distance of Objects according as the Density of the Air between the Eye and Object doth represent them. Hence I have seen men look of Gigantick bigness in a fog, caused by reason that the Fog made the Eye judge the Object much farther off than really it was, when at the same time the visible Angle altered not. This great thickness of the lower Air is sufficiently manifest in the Cœlestial bodies, few of the fixt Stars or smaller Planets being visible till they are a considerable way raised above the *Horizon*.

The third remark about the moistness of the fogs, and the production of water at that height I have be-

fore inſiſted on. Only the almoſt continual fogs that this Gentleman obſerved in the Wood they paſſed is very remarkable for the origine of Springs.

Nor ſhall I ſay any thing concerning the vaſt perpendicular height of the ſame, but for a cloſe of this preſent collection I ſhall add the ſhort account of the Eruption which lately hapned in the *Palma*.

A true Relation of the Vulcanos *which broke out in the Iſland of the* Palma *Novemb.* 13. 1677.

Saturday the thirteenth of *November* 1677. a quarter of an hour after Sun-ſet hapned a ſhaking or Earthquake in the Iſland of St. *Michael de la Palma*, one of the *Canary* Iſlands, from the lower *Pyrenna*, and within a League of the City unto the Port of *Taſſacorte*, which is accounted thirteen Leagues diſtant along the Coaſt, but more eſpecially at or about a place called *Fuencaliente*, being ſeven Leagues from the Town to the Southwards. The trembling of the earth was obſerved to be more frequent and violent than elſewhere, and ſo it continued till *Wedneſday* the 17. *ditto*. The People thereabouts were much affrighted, for beſides the Earthquake there was often heard a thundring noiſe as in the bowels of the earth on a Plain called the *Canios*, which is before you come to the great deſcent towards the Sea, where the hot Baths ſtand, or the holy Fountain; likewiſe at the aſcent from the aforeſaid Plain upwards at the great and weariſom Hill, called *Cueſta Canſada*, and until the Mountain of *Goatyards*, and the ſame day in and about the ſaid places mentioned, the Earth began to open ſeveral mouths, the greateſt of them upon the ſaid *Goat* Mountain, being diſtant from the Sea a mile and an half, and from the ſaid opening came forth a very great

great heat and ſmell of Brimſtone; and the ſame day, an hour before Sun-ſet at one of the mouths of the weariſom Hill was a trembling thereabout with more violence than any of the four days before; and a great and black ſmoak came forth with a terrible thundring noiſe, opening a very wide mouth, and throwing out much fire, with melted Rocks and ſtones; and immediately after at another place eighty paces below hapned the like terrible noiſe and ſight, and in leſs than a quarter of an hour after there opened to the quantity of eighteen mouths towards the foot of the ſaid Mountains, and there iſſued out fire, melted Rocks, and other bituminous matter from all the ſaid mouths, and was preſently formed into a great River of fire, which took its courſe over the firſt mentioned Plain, ſlowly going down towards the ſaid holy Fountain; but it pleaſed God, being come within eight ſpaces of the Brink of the ſaid great deſcent, it turned a little on the right ſide, and took its courſe with a very great fall towards the old Port, which is that which was firſt entred by the Spaniards when they took the Iſlands.

Friday the nineteenth at two a clock in the afternoon in the aforeſaid Mountain of Goats, on the other ſide of *Taſſacorte*, there opened another mouth with much ſmoak and ſtones of fire, and ſo cloſed again. But the next day (the twentieth) it began again to ſmoak, and continued with great trembling and noiſe in the bowels of the Earth until *Sunday* the twenty firſt at noon, when with many flaſhings of fire, and a greater thundring noiſe it finiſhed that opening of that monſtrous birth, caſting up into the Air both fire and ſtones, and at night the ſmoak ceaſing, the thundring noiſe, fire and ſtones increaſed, forcing great fiery ſtones ſo high into the Air as we loſt ſight of them, and with ſuch violence ſent them upwards that according to the beſt judgment they were five times longer in falling down,

which ſtones or Rocks were obſerved to be bigger than a Hogſhead, ; and what was moſt to be admired was, that theſe breaking in the Air, and changing into many ſeveral ſhapes, diſtinctly appearing, yet notwithſtanding did reunite again in falling down.

Munday the twenty ſecond it began again to caſt forth black ſmoak for two hours time, and after to thunder,and throw up fire and ſtones with great violence. *Tueſday* the twenty third at noon it ſmoaked again, and from thence until night there was terrible thundring noiſe, and caſting up of fire and ſtones more fierce than before ; and about nine of the clock at night a very great trembling of the earth was felt, and preſently after followed three great ſtones of fire in the form of Globes which were forced about half a League in height, and then like Granadoes broke in the Air with very great noiſe. *Wedneſday* the twenty fourth it was for an hours time very quiet, and after it began with greater force than ever before, by reaſon that ſome of the lower and firſt mouths were partly ſtopt, with which the aforeſaid River of fire ceaſed from running, after it had dammed up the Bay of the old Port, with burnt and melted Rocks and Stones, and other matter wherewith the ſaid River had run, and had forced the Sea backward above a Muſquet ſhot at random,and near twice as much in breadth. It ran into the Sea above ſixty paces. What fell into the Sea went congealing with a great ſmoak, what came after, forced and ran over that which went before, ſo that the ſmoak was very great many paces within the Sea, as far as ſeven fathoms depth, which cauſed many men to imagine that ſome ſuch like *Vulcano* had opened under the Sea in the ſaid ſeven fathoms depth. This night it caſt up ſome ſtones like great fiery Globes as the former.

Thurſday the twenty fifth it proved yet more violent than ever with thundring noiſe and flaſhes of fire.

fire. *Friday* the twenty ſixth, the mouth that was at the foot of the Mountain began again to caſt up as much fire and ſtones as ever, and formed two other Rivers; the one taking its courſe to Leeward of the firſt River leading toward the Rocks called *de los Tacoſos*; and the other took its way to windward of the firſt, directly towards the Bathes or Holy Fountain; and in this entrance the mouth of the Monntain was obſerved to be more quiet, though it caſt up much aſhes like black ſmall ſand. What dammage appears to have been done from its beginning to this day the twenty ſixth of *November*, being of thirteen days continuance, hath been about nine or ten Country Houſes burnt, beſides Out-houſes, and great Ciſterns for water, which are the poor Peoples only Remedy in thoſe parts, and upwards of three hundred Acres of ground are quite ſpoiled, being covered with Rocks, Stones, and other Rubbiſh and Sand; and if, (which God defend) the ſaid *Vulcano* do longer continue, the damage muſt be far greater, eſpecially if any other mouth ſhould break out higher, as it is much feared, by reaſon the earth in ſome places doth open with appearances as at firſt, ſo that all about that circuit of the *Fuencalliente* will be loſt; and for what already hapned, and yet continues with much terrour, beſides the fears of more in other parts thereabout, the Inhabitants do leave their Habitations, and like poor diſtreſſed people ſeek relief at the City, and many leave the Iſland to ſeek their fortunes in the others.

From the twenty ſixth of *November*, that the aforeſaid Relation was ſent for *Teneriff* by the Chamber of this Iſland unto the General, the ſaid *Vulcano* continueth fierce and without ceaſing, rather more than leſs, with a terrible thundring noiſe, caſting up Fire, Stones, Rocks, and black Aſhes, and the three Rivers of Fire ſtill running into the Sea, and hath now dammed up all the Baths and holy Fountain, to the

the great detriment of the Iſland, that yearly received a great benefit thereby, beſides many damages dayly added to the former. Several other mouths have ſince opened in the like dreadful manner near about the ſame place, we ſee the great ſmoak by day, and hear the thunder and noiſe, like the ſhooting off of many Cannons, and by night ſee alſo much of the fire very high in the Air from this City, which is one and twenty miles from it.

We are now at the eleventh of *December*, and fear we ſhall have more to write to you by the next.

Other Letters of the thirtieth of *December* mention, that it then contined much at one as before; and ſince others of the nineteenth of *January* ſay, it is yet as dreadful as ever, and little likelihood of ceaſing; from the thirteenth of *November* that it began to the nineteenth of *January* is about ten Weeks that it hath burnt; and the laſt Letters mention abundance of Aſhes or black Sand forced into the Air, and carried all over the Iſland, falling thick like Rain, and frequently gathered in the City, in the Streets, Houſes, and Gardens, though ſeven Leagues off.

FINIS.

ERRATA.

PAge 10. *line* 15. *read* the other, *viz.* the vibrating. *l.* 16. participates. *l.*17.& 18. *r.* Vibration thereof, but all Solids do exclude that menſtruum, or participate not of its motion. *p.* 14, *l.*11. *for* length *r.* number. *l.*12. *r.* occaſions will be. *p.*15. *l.*6. *r.* L M N O. *l.* 12. *r.* have of Elaſticity is. *p.* 18. *l.* 29. *r.* equal to ten. *p.*42.*l.*12. *r.* from *Oratava*. *l.*12. *r.* or South-caſt ſide. *p*42. *l.*9. for *Prancis* r. *Francis*.

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK
Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [66] - 56
PUBLIC DOMAIN

1124

GWLB Hannover 35
036 828 386

Niedersächsische Landesbibliothek Hannover

IV 6 C 1124.

4°

Z

GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK

Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [67] - -

PUBLIC DOMAIN



GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK

Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [68] - -

PUBLIC DOMAIN



GOTTFRIED WILHELM LEIBNIZ BIBLIOTHEK
NIEDERSÄCHSISCHE LANDESBIBLIOTHEK

Signatur: Leibn. Marg. 105, Stück 1;Leibn. Marg. 105, [69] · ·