CHAPTER V.

Concerning Pressures arising from the Weight of the Air.

What has been shown generally in Chapters I. and II. of this second book, concerning the pressures of all kinds fluids, is required to be understood with regard to air also, as anyone understands that as air is heavy, and thus must be subjected to the laws of fluids by the action of its weight. Therefore with the deduction of the particular phenomena arising from the weight of air being omitted, and that above elicited by us, we might have been able to leave that to the industry of the reader, unless it may be considered that outstanding arguments vindicate a deduction of this kind.

312. It is believed beyond all doubt that air has weight, since all the more exceptional experiments demonstrate its weight invincibly. Such experiments are described clearly in the works of Galileo, Boyle, Mariotte, Borell and others, which hence can be consulted. Concerning this, the Celeb. James Bernoulli also produced a paper published in the *Actis Lip*s. 1685, page 430 [some page numbers are repeated, which is confusing], where he had discovered a most ingenious manner of weighing the air, deduced with some success in the work.

313. The oldest experiment of testing the weight of the air is considered to be that of Aristotle, where the philosopher *inflated a bladder and considered it to pull [down] more when compressed than when flaccid*, ['For all things, even air itself, have gravity in their own place, except fire : of which this is a sign, that bladders when inflated are heavier than when empty.' From Thomas Taylor's translation of Aristotle's *Physics*.] and after him and also by the more recent philosophers, none of whom before James Bernoulli saw how to recognize a fallacy of the experiment, even if all judged the same experiment of equal accuracy. Further Bernoulli in the *Actis Lips*. 1685 page 436 showed more clearly, and deduced from the principles of hydrostatics : *The hide bag or bladder weighs less when deflated, and we may assume the air not to be free from weight*. It is a wonder nobody before had themselves seen, or at least themselves had been made aware from these observed happenings, which were brought about by the weight of the air, or providing an account of its weight ; since an account of that even lightly may be shown to be attended to well enough, and able to be explained in a few words. For since an inflated bladder shall be weighed with the air included, that acts together with an air column pressing on the scales, thus so that the weight acting on one pan of the scales shall be this column of air, and the weight of the bladder ; if later the bladder may be weighed again with the air expressed or expelled from the bladder, as the pan will be pressed by the same column of air as before, thus so that likewise in this case the weight acting on the pan is going to be the same as the first column of air and the weight of the bladder ; And thus in each case, either with the bladder swollen, or compressed and flaccid, always the same weight must be attached to the scales as found necessary, or if as it may happen that after we have expressed the air from the bladder, its weight may be found to be a little less than before, the decrease of the weight of this manner must not be attributed to the weight of the air expelled, but due to the particles depicted as repeatedly striking each other and compressing the bladder from these glancing impacts, or from other causes of

air removal. But so that I may embrace all this in a word or two, the weight of the air with the help of the bladder, itself likewise may be had, as if someone were going to investigate the weight of a phial of water including initially the weight of the phial to be weighed, and then with the water poured out from the pan of the scales, of which the weight of the water poured out and the weight of the phial may be found from the same scales, no one is going to see the same weight found in each case, either with the phial with the water poured in, or also with the phial empty, unless the water, which it held, has been poured out on to the pan, and it may be weighed at the same time?

[The point being, which is actually correct but not for the reasons given, that the vessel must maintain the same shape before and after the exclusion of the contained air, rather than pumping in extra air and so changing its shape, really so that the upthrust of the surrounding air is the same ; one presumes that Bernoulli's criticism of Aristotle's experiment being that there was little difference if the air column was inside an inflated bladder, or outside a deflated bladder, as there was still a column of air pressing down on the scale pan; not taking into account that the compressed air had a greater density than the ambient air, and so weighed more, etc. ; we need to remind ourselves that these experiments were performed before a true knowledge of the kinetic theory of gases and the gas laws was available: at this stage people generally believed the air pressure was due to the weight of the atmosphere pressing downwards, the pressure mechanism had not been explained in terms of particle collisions involving the weights of the particles, the concept of temperature was still rather hazy, etc.]

314. Therefore if the manner of weighing the air shall be freed from error, *it is required that the volume of the vessel after the expulsion of the air does not change*, and from that the weight of the air ejected will be known accurately enough. Hence towards this end, the Cel. Johann [presumably this was actually James] Bernoulli by taking the air from a large glass vessel, as much as could happen, carefully removed and permitting water to enter in place of the air; from which experiment he verified the weight of air to water to be nearly as 1 to 740. But elsewhere later [*Paris Ephemera*, 1685, as reported in *A.E.* above], and that with greater accuracy, by an experiment through the condensation of the air in a large vessel, in conjunction with a large copper vessel [and a vacuum pump], Jas. Bernoulli verified the weight of air to water to be as 1 to $774\frac{6}{45}$. Hence, because this accounting of the ratio is approximately equal to 1: 800, henceforth we will use this latter number on account of the more convenient numbers in place of the other $1 : 774\frac{6}{45}$, for expressing the ratio of the specific gravity of air to that of water.

The weight of air also is accustomed to be approved in the phenomena of barometers. But so that the strength of the argument may be comprehended better, I shall admit first the following easy proposition, from which then the particular properties of the phenomena of barometers, and likewise Ctesibian pumps [*i.e.* the pumps of Ancient Greece and Rome, called after their assumed inventor], reflex siphons and of other instruments of this kind I may deduce in the manner of corollaries. And finally in an attached scholium I will propose the construction of a new barometer thought out by Cel. Joh. Bernoulli, by which the variations of atmospheric pressure are able to be indicated sensibly, more than by any other barometer.

PROPOSITION XVIII. THEOREM.

315. *If in the large vessel MON full of some liquid as far as MN, there may be lowered a small vessel BE containing quicksilver, with each end of the glass tube AB standing open and perpendicular to the small vessel BE ; but thus yet, so that the opening of its aperture A always stands out above the liquid MON, the quicksilver ascends through the lower opening of the tube B, as far as while its height in the tube CD shall be to the height PC of the liquid above the surface of the remainder of the mercury in the small vessel, as the specific gravity of the liquid MON to the specific gravity of the mercury.* Fig. 73.

That is, with the liquid MON put to be water, fourteen times lighter than quicksilver, the height DC of the mercury in the tube AB constantly will be a fourteenth part of the height of the water PC.

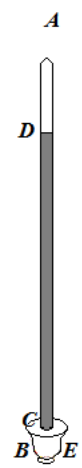


Fig. 72

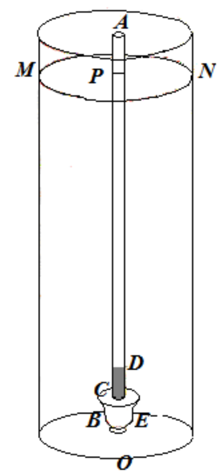


Fig. 73

This proposition is only a special case of the Proposition V. of this second book, and agrees with corollary IV. of the same Proposition, in which there is shown the pressures of homogeneous liquids within themselves ; but to be equal to the pressures of heterogeneous liquids between each other, and thus liquids themselves remain in turn in turn in equilibrium within themselves, as long as equal heights of these are made of the same specific gravity, and thus the heights will be reciprocally proportional to the specific gravities. Thus, because (following the hypothesis) the quicksilver in the tube AE at the height CD is balanced by the pressure of the liquid at the height MO, the height of the mercury (§. 262.) CD to the height of the liquid encircling the tube MO, shall be as the specific gravity of this liquid to the specific gravity of the quicksilver. Q.E.D.

COROLLARY I.

316. Fig. 72. Since the liquid of the tube AB may be able to represent the weight of any encircling fluid MON, we may put that to represent the air of the atmosphere, and the opening of the tube above A stands outside the atmosphere ; or , because this condition is impossible in practice, we will assume another, which may be equivalent to this, by supposing the tube AB with one end A itself to be hermetically sealed, thus so that with its open orifice B turned upwards and with the tube filled with mercury through this orifice, and afterwards with the same blocked off by the fleshy part of a finger, and with mercury sent into the small vessel CE to become at rest, after withdrawing the opening finger from the lower opening B within the quicksilver, no external air enters the upper part of the tube AD with the descent of the mercury as far as the remainder may advance to D, and now with this agreed upon the aim of the condition prevails, from which it is

required in the proposition that the end opening A may jut out beyond the liquid MON from that end only, so that the encircling liquid may not be able to enter the tube ; with which in place, and because the quicksilver in the tube AB remains suspended at a height of around 28 inches of Parisian ft.
[Evidently Hermann had become confused with his units, as he talked about digits where inches are meant, which we have used here instead, and in the following Corollary; He does obtain the correct final answer, so that the errors may have been introduced at the printing stage; digits and lines as lengths are defined in § 324 below], the weight of the atmosphere is required to be equivalent to the pressure of the mercury itself suspended from a height of 28 inches, and indeed only if air evidently has not observed within the tube raised to the height AB; but in the same tube the surface ends on the mercury of the dish CE; clearly in the same manner, as by which the quicksilver is not drawn up to any height CD in the tube AB of figure 73, evidently if there were no surrounding liquid, which be able to be weighed by the mercury in the dish CE.

COROLLARY II.

3I7. So that it may be known, at what height of a head of water the pressure may be equivalent to the atmospheric pressure, it must be assumed in the case of the present proposition and to be understood that the water MON is fourteen times lighter than mercury, and clearly it is to be observed, how far the tube AB must be submerged in the dish CE of the vessel MON, so that the Mercury may rise in the open tube to a height of 28 inches. Now because (§. 315.) with the dish submerged to a depth of 28 inches below the surface of the water MN the mercury rises in the tube AB to a height CD of 2 inches [one digit in the original text]; the dish CE will be required to be submerged in the liquid or the water MON to a depth of fourteen times 28 inches, that is to a depth of 391 inches, that is, a little less than 33 feet, so that the mercury will rise to a height of 28 inches. Therefore the *atmospheric pressure is equivalent to the pressure of water at a height of around 33 feet*.

And as a consequence, if the air of the atmosphere were uniform and to be of a uniform density everywhere, the height of the atmosphere would be 26400 feet ; but it will be taken to be much greater since where the air is higher, there also it is much rarer.

COROLLARY III.

318. Fig. 74. From these principles an account of the phenomena of Roman [Ctesibian] pumps is desired. This pump is constructed from a wooden or also often from a metal cylinder BA hollowed out, indeed with an opening at each end, but the lower opening B of the pump having a narrower opening of the water emerging. To this cavity there is forced in, with the aid of an iron rod, a leather piston CD, requiring to be raised and depressed in turns, which must be squared off so very skillfully through the whole length of the cavity of the pump, so that all of the air from the upper part of the cavity shall be precluded from passing through into the lower part. A repeating mechanical device of this kind is called a *suction* or *aspirating pump*, because in that a certain kind of attraction may be considered to be raising the water. But the reason why the water rises is the same, clearly the atmospheric *pressure,* which holds the mercury suspended in barometers. For

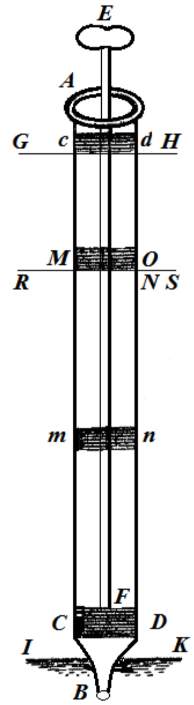


Fig. 74

with the piston CD retracted to *mn*, it is necessary the water enters the pump through the opening B with the vigor of this atmospheric pressure and the cavity *m*B*n* devoid of air is filled up, if indeed (following the hypothesis) the air from the upper part of the pump A*mn* is unable to pass through into the cavity *m*B*n*, hindered by the piston *mn*, nor hence is there any in the space *m*B*n*, because the water resists it intruding though the opening because of the external air pressure. Hence, when the piston will be raised higher, also with that higher the water, itself following behind, will rise into the pump ; as far as with the piston moved in MO to a distance from the water IK of around 33 feet, the height of the water above IK would be just as many feet, thus so that by the preceding corollary its pressure may be equivalent to the atmospheric pressure. For if you wish to raise the piston some greater amount to *cd* , the water thus will not be brought forth higher, but it will remain at its height of 33 feet, which height is the maximum limit of water, which was of concern to a certain water diviner Galileo, as which is equivalent to the atmospheric pressure.

COROLLARY IV.

319. Fig. 75. Because concerning reflex siphons, the forces of these will be deduced conveniently from the preceding. ABC shall be a tube of this kind of unequal legs bent at B AB and CB ; and it is commonly known, because the shorter leg AB sent into the vessel EF, to be filled with water or some other liquid, if water may be elicited with the aid of suction from the longer arm BC, so that the flow of water or of a liquid along ABC will be continued from the shorter to the longer arm for some time, until the dish EF will be completely emptied, provided the shorter leg AB does not exceed a height in water of around 33 feet, but the same shall be less, and the opening C of the leg BC shall be lower than the opening A of the other leg AB. An account of this phenomena will be at once apparent by considering this siphon to be nothing other than twin barometers, each leg of which shall act in turn as a simple barometer. And indeed by understanding the leg AB in the dish full of water EF likewise to be standing full of water, BAEF is taken as a simple barometer, and the leg CB equally upright I have filled with water in the dish GCH full of water, effecting another barometer BCGH. Now KL represents a column of water 33 feet equivalent to the atmospheric pressure, and in that there are taken KM = AB to be the shorter leg and KN = CB to be the longer leg. Now, because the weight of

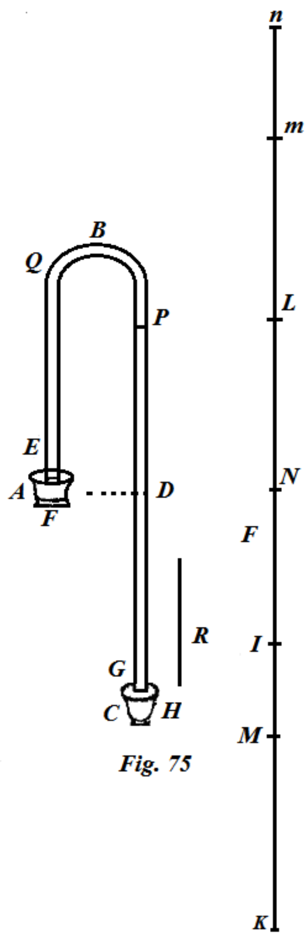


Fig. 75

the atmosphere on the water EF is KL, and the weight of the water BA in the leg of the smaller siphon is only KM, the external air pressure KL will prevail over the internal pressure of the water in the tube BA, which is KM, by the force LM, as thus henceforth we will call the raising *force* of the atmosphere in the tube BA, because by precisely so great a force the pressure of the atmosphere is trying to raise the water AB in the smaller leg of the siphon. By the same argument LN will be the raising force of the atmosphere in the longer leg BC, for this raising force is the excess of the external pressure KL over the internal pressure BC; which from the construction is KN, and thus the water in the tube BC actually will be raised, or perhaps the atmospheric pressure will be trying to raise by that force LN. Truly, because the force trying to raise water in the tube AB is LM, and the force raising water in the tube BC is LN, and the smaller must concede to the greater, it is clear water actually is going to be forced up in the tube AB by the force MN, to be equal to the difference of the raising forces LM and LN. Hence therefore the difference MN to be called the *motive force* of the water in the along the direction AQBC in the bent tube ; therefore it will flow from the dish EAF along the bent back tube ABC, and will be unloaded through the opening C itself, and flow out, until the whole dish EAF shall be empty.

COROLLARY V.

320. Because MN is the motive force of the water circulating in the siphon ABC ; Fig. 75 & this force MN is the difference between KN and KM, that is between BC and BA, that is DC, clearly by making $BD = BA$.

Hence 1°. The motive force is zero, nor hence can the water flow in the siphon along ABC, when the legs BA and BC are level.

2°. Nor can it flow, when the shorter leg AB will be greater than or equal to a height of 33 equivalent to the atmospheric pressure. Indeed K*m* shall be greater than KL and equal to AB, and $Kn = BC$, and because now the internal pressure of the water BA is *m*K ; truly the external pressure is that of the atmosphere LK, the internal prevails over the external by the force *m*L, which now is the *extrusion force*, because by this force *m*L the water is moved to another place from the tube BA and is pushed out in this case, so much is removed, as long as the external pressure of the air may exert a force raising the water as in the preceding corollary ; also *n*L itself is the force pushing out the water from the tube BC. And thus these extruding forces will effect, that the water in the lesser leg itself may drop as far as to Q thus so that now QA is equal to LK itself, and likewise PC in the other leg, with the water itself in that dropping to P; clearly as far in each leg to that point, where the extruding forces have vanished.

COROLLARY VI.

321. But if AB were less than 33 feet and BC much greater ; indeed the water will flow from the smaller AB through the greater BC, but except for that, so that in the whole tube the flow shall be continuous, but at the top a vacuum will be formed repeatedly. For at first KL shall be 33 feet, AB or KM less than KL and BC, to which K*n* shall be equal, greater than KL; with which in place, if L*n* were greater than LM plus the outflow of the water from the tube BC than the inflow possible from the leg AB, and thus at the peak B

there will be an empty space, nor hence will there be water flowing between the adjoining parts through the whole siphon. For because K*n* in this case expresses the pressure of the water in the tube BC and KL the lower pressure of the atmosphere, N*l* sets out the force required extruding the water from the tube BC ; truly in the other AB, LM is the force raising the water LM, therefore the force *n*L pushing out the water will be greater than the raising force LM, and thus more water will be going out and expelled from the tube BC, than is entering in the tube AB. Therefore where the flow led through remains at rest, an empty space will be left at the peak BP equal to the excess, by which the pushing out force *n*L exceeds the raising force LM, or equally $n\mathrm{L}-\mathrm{LM}$. Therefore with $n\mathrm{L}-\mathrm{LM}=0$, or with the pushing out force equal to the raising force, the water in the siphon will be continuous.

COROLLARY VII.

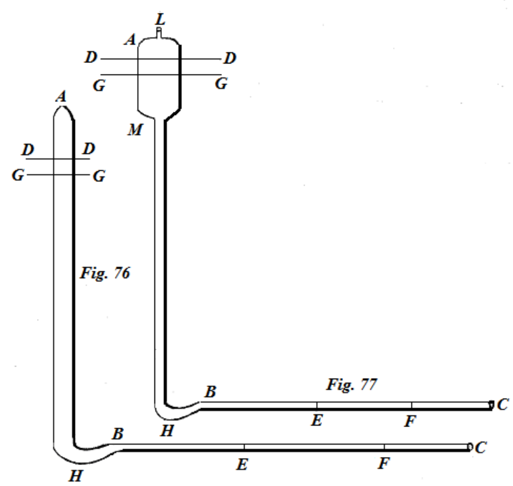
322. The solution of the following problem now will be derived easily with the aid of the preceding corollaries. *With the lesser leg AB of the siphon given to find the length of the greater BC, so that water flowing in the siphon may leave a space BP at the top of the siphon of given size R*. For with KM put equal to the lesser leg, KL to the pressure of the atmospheric or 33 feet, and with K*n* equal to the greater leg, by corollary 6 of this chapter the water flowing through the siphon ABC leaves the empty space $\mathrm{BP}=n\mathrm{L}-\mathrm{LM}$, from which since this space must be equal to R, there will be $n\mathrm{L}-\mathrm{LM}=\mathrm{R}$, or $n\mathrm{L}=\mathrm{R}+\mathrm{LM}$, hence $n\mathrm{K}=\mathrm{LK}+\mathrm{R}+\mathrm{LM}=2\mathrm{LK}+\mathrm{R}-\mathrm{MK}$, that is, the greater leg BC must be equal to the remainder of the lesser leg AB taken away from twice the atmospheric pressure increased by the given R. And thus, if AB were 16 feet and R 10 feet, BC will be equal to 60 feet. But in a case of this kind it being usual to take away the water from the air, as much as can be done ; otherwise the air transpiring across from the water and itself very slowly collecting in the space BP free will impede the free flow of water from the leg AB into the other BC.

SCHOLIUM.

323. Although above it may be said in ordinary barometers of mercury with the height of certain places to remain at a height between 27 or 28 inches, yet that is not required to be accepted as mathematically rigorous as if the quicksilver of the barometer, always set up at the same place, constantly may stick at the same height ; for the heights of this kind of mercury change repeatedly, and from these changes whatever variations in atmospheric pressures can be discerned. I say *whatever*, for as the Cel. *C. Wolff* noted usefully in his *Aërometria*, the variations of barometers do not indicate accurately enough the difference of the weight of the atmosphere, and therefore, because other barometers are accustomed to be called instruments, it may be considered merely to be dignified by the name *baroscope*, the name barometer will be reserved for that instrument, if that at some time may be able to be invented, which will show the weight of the air most accurately. Amongst other failures, from which the common baroscopes labour, the following is perhaps the most outstanding, that the variations of these are resolved readily: because of this the most outstanding philosophers Huygens, De la Hire, & Joh. Bernoulli have thought out other constructions of baroscopes, with which instruments the smallest changes in the weight of the air are able to be expressed to the senses; hence two kinds

have arisen, which are called the Huygens' & La Hire's barometers, now I will not tarry in explaining the constructions of these, since the composition of the Huygens barometer may be found described in the French Journals, and in the works of other authors everywhere acting on these matters, and the baroscope of the Cel. Hires thought out by himself also is published in the *Acta Academiae Regiae Paris. Scient*., 21st March, 1708. But because the barometer, which the acutest geometer Johann Bernoulli now had worked out many years ago but had not yet published, nor to be considered lightly from its simplicity, its description has been kindly communicated to me by the most ingenious author, it will be a pleasure to present here; thus the construction of the Bernoulli barometer follows.

324. Fig. 76. ABC shall be a tube made from two branches of unequal diameters, carrying the figure of a pointer before it ; the diameter of the horizontal branch BC at the opening C does not exceed a line or twelve Parisian digits [Note: an inch was $\frac{1}{12}^{th}$ of a foot; a line was $\frac{1}{12}^{th}$ of an inch, and a digit was $\frac{1}{12}^{th}$ of a line in these old units]; truly the diameter of the vertical branch AB at the top of the blocked off highest point is of 4 lines or greater still, so that the degree of the variations in this barometer are expressed with more perception, and the height of this branch shall be, such as in more common baroscopes, 30 or 31 inches ; the true length of the horizontal branch BC, which depends on the proportion of the diameters of the branches, must be a minimum of 3 feet. If mercury may be poured into the tube thus prepared, and the branch of its horizontal part shall be full of mercury nearly as far as to the central point E, with the air present of medium consistency, a barometer will be had, which will show variations in turn 16 times more sensitive than ordinary barometers. For it is apparent, because with the mercury falling in the vertical branch through a distance of one inch, it will move forwards in the horizontal branch from E to F through a distance of 16 inches; for the vertical root is nothing other than a simple or common baroscope.



Because if indeed the horizontal branch were made narrower or the vertical branch to become wider, anyone can see that the variations increase in the square ratio of the diameters, thus so that these variations are able to be returned greater and greater indefinitely. But because it is accustomed always to be inconvenient to draw out such ratios in practice from that, which extreme narrowness of the horizontal branch makes the success of this theory difficult to bring about, because the pressure of the air does not act well enough in an extremely narrow tube, nor is the mercury moved easily in that. Therefore the diameter attributed to the horizontal branch must be scarcely less than that of one line. Therefore, in place of the reduction of its diameter, it is better to assume a vertical branch of a larger size, indeed not through its whole length, but only at the highest point, clearly by adding the glass capsule AM to the tube BM, which can be of the same thickness as in common barometers, in which the mercury likewise as in the Huygens double barometer will ascend and descent. Truly with this extra wide region present, distinguished from the length of the horizontal branch, which is required in this case, an awkward instrument of little use and application may be made available, unless a remedy can be prepared for its inconvenience, the branch requiring to be bent into a horizontal spiral or driven back in some other way of bending that into a smaller space, as figure 78 shows, while these bends remain in the horizontal plane.

Towards making this barometer more suitable not from matters noted by the author, if the vertical branch AB may end at the opening of the tube L, thus so that through its opening the quick silver may be poured in, while the opening of the horizontal branch C, may be held closed. With both branches filled up with this agreed upon the opening L is hermetically sealed and stopped up, by which the opening C, was being blocked off, requiring to be removed, so that the quicksilver in the vertical tube AB according to the custom in more common barometers will be able to drop clearly to the end D, and the excess mercury will be able to flow out from the horizontal branch ; but because by this method the horizontal branch will remain full, a part of that is required to be withdrawn by suction or with the aid of a capillary tube attached to the larger ampoule AM, which heated and intrudes into the horizontal tube and there being cooled down the mercury will be drawn into its cavity. By this method the barometer will be constructed and prepared for use.

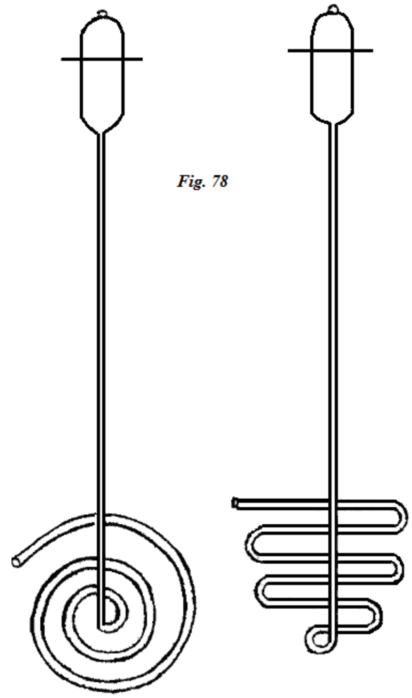


Fig. 78

Otherwise it will not be useful, if the vertical tube in place, where it is connected to the horizontal, it may be constructed with an extremely small curvature in place to the receptacle H, there being an impediment for the entrance of the air from the horizontal into the vertical branch, either perhaps when the horizontal mercury might cease to be available, or perhaps from the pressure of the atmosphere, or from the oscillations of the mercury arising from moving the barometer from place to place, which latter inconvenience arising if not carried properly, which at least can be minimized by closing the opening C.

Besides the simplicity, by which the Bernoulli barometer commends itself, by other prerogatives in addition it may be considered to be outstanding compared with the barometers invented to date. For the Bernoulli barometers, the ease of preparation and also of the tube being filled, nor the liquids in that may be noticeably used by going into vapors, by which the performance of the barometer usually may be changed a great deal. For in the baroscope described by us mercury alone is used, which is not noticeably released as vapour. Truly the twin barometer of Huygens, except that the tubes it may require being scarcely procurable and filled with liquids with difficulty, the liquids demanded liable to evaporation, to which inconvenience the most celebrated De la Hire also had thought out cleverly and now set out in the place indicated above in the *Actis Acad. Reg. Paris. Scient*., and besides he had drawn out another inconvenience with it, because it required liquids of the same specific gravity but immiscible, otherwise its variations would not be able to be increased indefinitely, but stand between certain limits which they are unable to transgress. For by calling the specific gravity of the quicksilver *m*, and from the liquids used in the same barometer having greater and lesser specific gravities *t* and *p*; the diameter of the glass capsule *a*, the diameter of the narrower tube *b*; found after the enlightened Bernoulli, the variations in the De La Hire barometer themselves to the variations in the ordinary or common barometer are found to be as the quantities maa to $2mbb,+\left(aa-bb.t-p\right)$. Now where *b* is less than *a*, there it approaches this ratio, to the ratio *m* to $t-p$, which expresses the limit, within which the variations of the barometer invented by the cel. De la Hire collate with the variations encountered by the common barometer, which give the ratio *m* to $t-p$ the shall be in the infinite case only, where $t=p$, this is therefore in the case, when the liquids on the La Hire barometer have used the same specific gravity, but which in turn are immiscible.

After the description of the Bernoulli barometer had been read in person to a meeting of the French Royal Academy of the Sciences, the news to the celebrated author of that being that a similar construction of barometer had been thought out now many years before by the most celebrated astronomer Giovanni Dominico Cassini, but later abandoned and laid aside by him; because in practice it could not be successful because of the air, which it is written from the mercury in the tube or horizontal branch itself to have been mixed with the air, and to have impeded the free flow of that [*i.e.* an air lock]. But because in this matter the man shall be struggling to be praised, for nowhere had he produced records, nor had Bernoulli heard anything said about these attempts, praise of the invention itself cannot be denied, especially since with its success made in Belgium it can be a danger to testify [against this]; and that inconvenience, which hindrance Cassini had added, it is considered to be removed, by filling up the horizontal tube by suction ; even if by compressing the pouch of a certain leather full of quicksilver and the mercury applied to the opening of the horizontal tube intruding and trying to ascend as far as to the top of the vertical tube, having the upper aperture uncovered ; with this intrusion of the mercury performed, and with the opening of the top of the vertical tube stopped up, the leather pouch being removed from the horizontal tube, so that the quicksilver in the vertical tube shall be able to fall down to the customary height. Finally so that the flow of the mercury in the horizontal tube may occur conveniently, the size of the tube is required to be just as great as need to that the mercury may be contained in that, without flowing out from that.

CAPUT V.

De Pressionibus Aeris ex Gravitate.

Quae Capitibus I. & II. hujus libri secundi circa pressiones omnis generis fluidorum generaliter ostensa sunt, etiam de *Aëre* in *specie* intelligenda esse nemo non videt , quandoquidem etiam Aër gravis est, atque adeo legibus fluidorum gravitate sua agentium subjeci debet. Propterea supersedere particulari deductione phaenomenorum ex aeris gravitate provenientium, eamque ex superioribus a nobis adductis Lectoris industriae eliciendam relinquere potuissemus, nisi argumenti praestantia ejusmodi deductionem vendicare sibi videretur.
312. Aëra gravem esse extra omne dubitum est positum, cum experimenta omni exceptione majora gravitatem ejus invincibiliter adstruant. Talia experimenta apud Galilaeum, Boylium, Mariottum, Borellum & alios dilucide describuntur, qui proinde consuli possunt. Huc etiam facit schediasma Celeb. Jac. Bernoulli Actis Lips. 1685 pag . 430 insertum, quo peringeniosum ponderandi aeris modum aperuit cum successu aliquando in opus deductum.
313. Antiquissimum probandae gravitatis aeris experimentum Aristotelis illud videtur esse, quo Philosophus *Utrem inflatum plus trahere quam compressum & flaccidum existimavit*, & post eum plerique etiam ex recentioribus Philosophis , quorum nemo ante Jac. Bernoullium experimenti fallaciam cognovisse videtur, tametsi omnes idem experimeritum parum accuratum judicarunt. Ast Bernoullius in Actis Lips. 1685 pag. 436 luculenter ostendit, atque deduxit ex principiis hydrostaticis, *Utrem seu vesicam inflatam non esse gravioris ponderis, quam complicatam, licet aërem gravitate haud destitui praesupponas*. Quod mirum est ante ipsum neminem videsse, aut saltem a se observatum monuisse illis occasionibus, quibus de aëris gravitate ejusve probandae rationibus agebatur; cum illius ratio vel leviter attendenti satis manifesta sit, atque duobus verbis explicari possit. Nam cum vesica tumida cum aëre incluso ponderatur, id contingit in aëre cujus columna lancibus imminet, adeo ut pondus in unam trutinae lancem agens fit haec columna aërea, & vesicae pondus; si postea expresso seu expulso e vesica aëre vesica denuo ponderatur, lanci eadem ac prius columna aërea imminebit, adeo ut & hoc quoque casu pondus in lancem agens futurum sit eadem ac prius columna aërea atque vesicae pondus ; Adeoque utroque casu, sive tumida sive compressa & flaccida vesica trutinae appendatur semper idem pondus ut reperiatur necesse est, vel si quando contingat ut postquam aërem e vesica expressimus, ejus pondus tantillo minus quam ante reperiatur, ejusmodi ponderis decrementum non aëris expulsi gravitati debet tribui, sed particulis pinguibus inter contrectandum & comprimendum vesicam ab ea abrasis, vel alia de causa exhalantibus. Sed ut haec omnia verbo complectar, aëris ponderatio ope vesicae, perinde se habet, ac si quis aquae phialae inclusae pondus exploraturus primum phialam cum inclusa aqua ponderet, & deinceps effusa in lancem trutinae aqua, hujus aquae effusae & phialae pondus eadem trutina conjunctim quaereret, quis non videt idem pondus utroque casu repertum iri, sive phiala cum infusa aqua, sive etiam vacua phiala, sed aqua, quam capiebat, lanci infusa, simul ponderentur?
314. Idcirco si ponderandi aëris modus fallacia vacare debet, *oportet vasis volumen post expulsum aërem non mutari*, & deinde aeris ejecti pondus satis accurate innotescet. Ad

hoc proinde Cel. Joh. Bernoullius ex amplo recipiente vitreo aërem, quantum fiere potest, diligenter eduxit & aquae in aëris expulsi locum ingressum permisit; quo experimento comperit gravitatem aëris ad aquam esse ut 1 ad 740 circiter. Sed alio postea, eoque magis accurato, experimento per condensationem aëris in amplo vase, aeneo tentato invenit gravitatem aëris ad aquam, ut 1 ad $774\frac{6}{45}$. Hinc, quia haec ratio rationi 1: 800 proxime aequatur, ob numerorum commoditatem hanc posteriorem loco alterius I : $774\frac{6}{45}$ deinceps adhibebimus, ad exprimendam rationem specificae gravitatis aëris ad gravitatem aquae.

Aëris gravitas etiam probari solet, & recte, phaenomeno Barometrorum. Sed ut argumenti vis melius capiatur, sequentem propositionem facilem praemittam, ex qua deinde praecipuum Barometri symptoma, item & Antliae Ctesibianae, Siphonum reflexorum, aliorumque ejusmodi instrumentorum phaenomena, per modum corollariorum, deducam. Et denique in Scholio annexo Barometrum novae constructionis a Celeb. Joh. Bernoullio excogitatum proponam, quo atmosphaerae variantes pressiones, magis quam ullo alio barometro, sensibiliter indicari queunt.

PROPOSITIO XVIII. THEORUMA.

315. *Si in vase amplo MON liquoris cujuscunque pleno, usque ad MN demittatur vasculum BE argentum vivum continens, cum tubo vitreo AB utraque sui extremitate aperto & vasculo BE perpendiculariter insistente; sed ita tamen, ut orificium ejus apertum A semper extra liquorum MON extet, hydrargyrus per orificium tubi inferius B ascendet, usque dum altititudo ejus in tubo CD, sit ad altitudinem PC liquoris super superficie residui in vasculo Mercuri, ut specifica gravitatas liquoris MON ad specificam gravitatem Mercurii.* Fig. 73.

Id est, posito liquorem MON aquam esse, decies quater argento vivo leviorem, altitudo DC Mercurii in Tubo AB constanter decima quarta pars erit altitudinis aquae PC.
Haec propositio tantum casus est particularis Propositionis V. hujus secundi libri, & coincidit cum coincidit cum corollario IV. ejusdem Propositionis, in quo indicatur pressiones liquorum homogeneorum in se ; sed heterogeneorum inter se aequales fore, atque adeo liquores ipsos in se invicem gravitantes in equilibrio consistere, quoties facta eorum altitudinibus in specificas eorum gravitates aequalia, atque adeo altitudines specificis gravitatibus reciproce proportionales fuerint. Unde, quia (secundum hypothesin) argentum vivum in tubo AE in altitudine CD pressioni liquoris in altitudine MO aequilibratum est, erit (§. 262.) altitudo Mercurii CD ad altitudinem liquoris tubum ambientis MO, sicut hujus liquoris specifica gravitas ad gravitatem specificam hydrargyri. Quod erat demonstrandum.

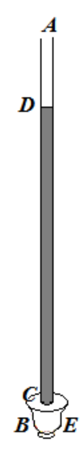


Fig. 72

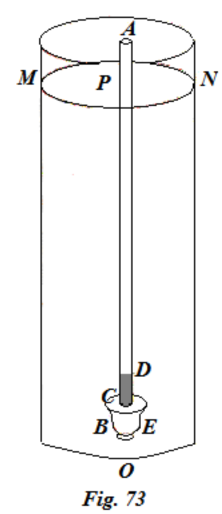


Fig. 73

COROLLARIUM I.

316. Fig. 72. Cum tubi AB liquor ambiens MON quodcunque fluidum grave repraesentare possit, ponamus eum significare aërem atmosphaerae, tubique foramen superius A extra atmosphaeram extare ; vel, quia haec conditio in praxi impossibilis est, sumemus aliam, quae ipsi aequivaleat, supponondo tubum AB una suiextremitate A hermetice sigillatam esse, adeo ut orificio ejus aperto B sursum converso tubo Mercurio impleto per hoc orificium, posteaque eodem digiti pulpa obstructo, atque Mercurio in vasculo CE stagnanti immisso, post retractum digitum orificium inferius B intra argentum vivum vasis CE obstruentem, nullus aër forinsecus adveniens tubi partem superiorem AD a Mercurio descendente ad D usque relictam ingredi possit, & hoc pacto jam obtinetur scopus conditionis, qua requiritur in propositione ut orificium apertum A extra liquorem MON promineat eo solo fine, ut liquor ambiens fistulam ingredi nequeat; quibus positis, & quia argentum vivum in fistula AB ad altitudinem plus minus 18. digitorum pedis Parisiensis suspensus haeret, oportet atmosphaerae gravitationem aequivalere pressioni isti Mercurii ad altitudinem 28. suspensi, etenim si aër gravis non esset in nulla prorsus intra fistulam AB altitudine elatus conspiceretur; sed in eadem cum Mercurio vasculi CE superficie terminatus; eodem plane modo, quo argentum vivum in fistula AB figurae 73 plane ad nullam altitudinem CD attolleretur, si nullus esset liquor ambiens, qui in Mercurium vasculi CE gravitate possit.

COROLLARIUM II.

3I7. Ut sciatur, in qua altitudine pressio aquae aequivaleat pressioni atmosphaerae, resumi debet casus propositionis praesentis & per liquorem MON intelligenda est aqua decies quater levior quam Mercurius, atque dispiciendum est, quousque tubus AB cum vasculo CE vasi MON debeat demergi, ut Mercurius in fistula utrinque aperta assurgat ad altitudinem 28. digitorum. Jam quoniam (§. 315.) demerso vasculo ad profunditatem 28. pollicum infra superficiem aquae MN Mercurius assurgit in tubo AB ad altitudinem CD unius digiti ; demergendum erit vasculum CE in liquore seu aqua MON ad profunditatem quater & decies 28. pollicum id est ad profunditatem 391. pollicum, hoc est, paulominus quam 33 pedum, ut Mercurius ad altitudinem 28 pollicum elevetur. Igitur *pressio atmosphaerae aequivalet pressioni aquae in altitudine 33 pedum circitur*.
Ac per consequens, si aër atmosphaerae uniformis ubique densitatis esset, altitudo atmosphaerae foret 26400 pedum; sed multo major erit quandoquidem aër quo altior est eo etiam rarior deprehenditur.

COROLLARIUM III.

318. Fig. 74. Ex hisce principiis peti etiam debent rationes phaenomenorum antliae Ctesibianae. Haec antlia consistit in Cylindro ligneo vel subinde etiam metallico BA cylindrice excavato, ab utraque parte aperto quidem, sed inferius orificium B aquae immergendum non nihil angustius habens cavitate antliae. Cavitati huic intruditur, ope virgae ferreae, embolus coriaceus CD, attollendus per vices atque deprimendus, qui per totam antliae longitudinem antliae cavitati tam affabre quadrare debet, ut omnem aëri ex

superiori cavitatis parte in inferiorem transitum praecludat. Ejusmodi organon *antlia suctoria* vel *Aspirans* subinde vocatur, quod in ea quadam attractionis specie attolli aqua videatur. Sed ascensionis aquae causa eadem est, quae Mercurium etiam in Barometris suspensum tenet, *pressio* scilicet atmosphaerae. Nam retracto embolo CD in *mn*, necesse est aquam vigore hujus atmosphaerae pressionis per orificium B antliam ingredi & cavitatem *m*B*n* ab aëre vacuam implere, siquidem (secundum hypothesin) ex superiore antliae parte A*mn* aër embolo *mn* impeditus in cavitatem *m*B*n* transire nequit, nec proinde quicquam est in spatio *m*B*n*, quod externae aëris pressioni aquam per orificium intrundenti resistat. Hinc, quo altius attolletur embolus, eo altius etiam aqua, ipsum pone insequens, in antlia assurget; usque dum embolo delato in MO ad distantiam ab aqua IK 33 pedum circiter, aquae altitudo super IK totidem pedum fuerit, adeo ut per corollarium praecedetis ejus pressio aequivaleat pressioni atmosphaerae. Nam si embolum quantum voles ulterius eleves in *cd* , aqua non ideo altius enitetur, sed in altitudine sua 33. pedum subsistet, quae altitudo aquae maxime limitata est, ut aquilex quondam Galileo retulit, utpote quae atmosphaerae pressioni aequivalet.

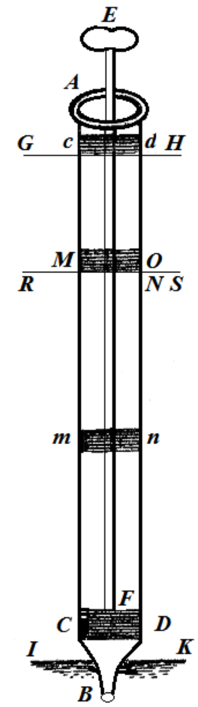


Fig. 74

COROLLARIUM IV.

319. Fig. 75. Quod ad siphones reflexos attinet, eorum vires ex praecedentibus commode deducentur. Sit ABC ejusmodi tubus in B inflexus inaequalium crurum AB & CB ; & in vulgus notam est, quod immisso breviori crure AB vasculo EF; aquae aliusve liquoris pleno, si suctionis ope aqua ex longiore brachio BC eliciatur, fore, ut aquae aut liquoris fluxus juxta ABC ex breviore in longius brachium tamdiu continuetur, donec vasculum EF penitus exhaustum fuerit, modo crus brevius AB altitudinem in aqua 33. pedum circiter non superet, sed eadem minus fit, & orificium C cruris BC humilius sit orificio A alterius cruris AB. Hujus phaenomeni ratio statim apparebit considerando hunc siphoidem aliud non esse, quam geminum barometrum, cujus utrumque crus simplicis barometri vices obeat. Etenim cogitando crus AB aquae plenum in Vasculo EF itidem aquam continenti insistere, concipitur barometrum simplex BAEF, & crus CB aquae plenum in vasculo GCH aqua pariter implero erectum, efficit alterum barometrum BCGH. Repraesentet nunc KL columnam aquae 33. pedum aequivalentem atmosphaerae pressioni, & in ea sumantur $KM = AB$ cruri minori, & $KN = CB$ cruri majori. Jam, quia gravitatio atmosphaerae in aquam EF est KL, & gravitatio

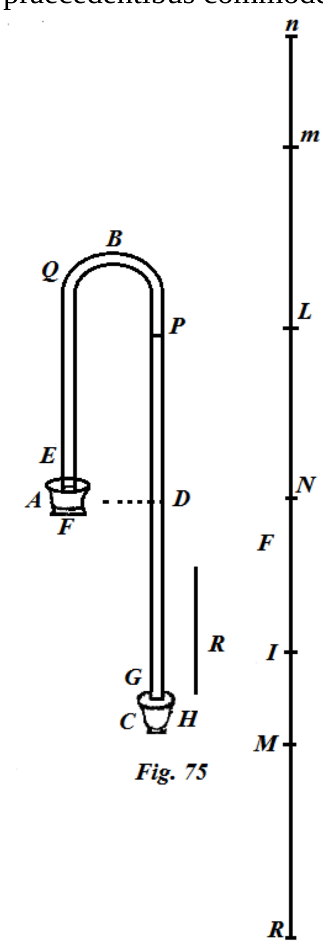


Fig. 75

aquae BA in crure siphonis minoris est tantum KM, praevalebit externa aëris pressio KL internae pressioni
aquae in tubo BA, quae est KM, vi LM, quam vim ideo *attollentem* atmosphaerae in tubo BA deinceps dicemus, quia tanta praecise vi atmosphaerae pressio aquam AB in crure minori siphonis elevare conatur. Eodem argumento erit LN vis, attollens atmosphaerae in crure longiori BC, nam haec vis attollens est excessus pressionis externae KL supra internam BC; quae est KN ex constructione, atque adeo aqua in tubo BC revera attolletur, aut saltem pressio atmosphaerae attollere conabitur, vi illa LN. Verum, quia vis attollere conans aquam in tubo AB est LM, & vis attollen aquam in tubo BC est LN, & minor majori cedere debet, liquet aquam revera in tubo AB in altum coactum iri vi MN, aequali differentiae virium attollentium LM & LN. Hanc ergo differentiam MN appellare *vim motricem* aquae in tubo reflexo juxta ordinem AQBC; propterea ex vasculo EAF per tubum recurvum ABC fluet, & per orificium C sese exonerabit, & effluet, donec totum vasculum EAF depletum fuerit.

COROLLARIUM V.

320. Quia MN est vis motrix aquae in siphone ABC circulantis; Fig. 75. & haec vis MN est differentia inter KN & KM, id est inter BC & BA, hoc est DC, facta scilicet $BD = BA$.

Hinc 1°. vis motrix nulla est, nec proinde aqua in siphone juxta ABC fluere potest, ubi crura BA & BC aequantur.

2°. Nec fluere potest, cum crus brevius AB excesserit vel aequaverit altitudinem 33. pedum atmosphaerae pressioni aequipollentem. Sint enim K*m* major quam KL & aequalis AB, & $Kn = BC$, & quia nunc interna pressio aquae BA est *m*K ; externa vero atmosphaerae est LK, praevalebit externae interna vis *m*L, quae nunc est *vis extrudens*, quoniam hac vi *m*L aqua aliquousque ex tubo BA hoc casu extrudetur, tantum abest, ut externa aëris pressio vim habeat attollendi aquam ut in corollario antecedenti; sic etiam *n*L est vis extrudens aquam ex tubo BC. Adeoque hae vires extrudentes efficient, ut in crure minori aqua se demittat usque in Q ita ut QA nunc aequetur ipsi LK, perinde ac PC in altero crure, aqua in eo sese demittente in P; scilicet in utroque crure eousque, quo vires extrudentes evanuerint.

COROLLARIUM VI.

321. Sed si AB fuerit minus 33. pedum & BC multo majus ; fluet quidem ex minori AB per majus BC, sed absque eo, ut in toto tubo aqua concinua sit, sed in summitate formabitur subinde vacuum. Sit enim ut prius KL, 33 pedum, AB vel KM minor quam KL & BC, cui aequalis sit K*n* major quam KL; quibus positis, si L*n* major fuerit quam LM plus aquae effluet ex tubo BC quam influere potest per crus AB, atque adeo in summitate B erit vacuum, nec proinde aqua inter fluendum per totum siphonem contigua erit. Nam quia K*n* hoc casu exprimit pressionem aquae in tubo BC & KL pressionem atmosphaerae minor, N*l* exponit vim extrudentem aquam ex tubo BC ; in altero vero AB, vis attollens est LM, major ideo erit vis extrudens *n*L vi attollente LM, atque adeo plus aquae egredietur atque expelletur ex tubo BC, quam ingreditur in tubum AB. Idcirco ubi fluxus ad statum manentem perductus fuerit, relinquetur in summitate vacuum BP

aequale excessui, quo vis extrudens nL superat vim attollentem LM, seu aequale $n\mathrm{L}-\mathrm{LM}$. Idcirco existente $n\mathrm{L}-\mathrm{LM}=0$, vel vi extrudente aequali vi attollenti, aqua in siphone contigua erit .

COROLLARIUM VII.

322. Ope corollarii praecedentis jam facile derivabitur solutio sequentis Problematis. *Dato minore siphonis crure AB invenire longitudinem majoris BC, ut aqua in siphone fluens in summitate siphonis vacuum BP relinquat datae magnitudinis R.* Nam positis KM cruri minori, KL atmosphaerae pressioni seu 33. pedum , & Kn cruri majori aequalibus, per corollarium 6 hujus aqua per siphonem ABC fluens relinquet vacuum $\mathrm{BP}=n\mathrm{L}-\mathrm{LM}$, unde cum hoc vacuum debeat esse aequale R, erit $n\mathrm{L}-\mathrm{LM}=\mathrm{R}$, vel $n\mathrm{L}=\mathrm{R}+\mathrm{LM}$, hinc $n\mathrm{K}=\mathrm{LK}+\mathrm{R}+\mathrm{LM}=2\mathrm{LK}+\mathrm{R}-\mathrm{MK}$, hoc est, crus majus BC aequari debet residuo detracti minoris cruris AB ex dupla atmosphaerae pressione data R aucta. Adeoque, si AB fuerit 16. pedum & R, 10. pedum, erit $\mathrm{BC}=60$. pedum. Sed in ejusmodi casu adhibenda foret aqua ab aëre, quantum fieri potest, purgata; alias aër ex aqua transspirans ac sese in spatio BP sensim sensimque colligens liberum aquae fluxum ex crure AB in alterum BC impediet.

SCHOLION.

323. Quanquam supra dictum sit in Barometris ordinariis Mercurium altitudine 27. vel 28. pollicum certorum locorum respectu subsistere, id tamen non in mathematico rigore est accipiendum quasi argentum vivum barometri, in eodem semper loco constituti, in eadem altitudine constanter haereret ; nam ejusmodi Mercurii altitudines subinde variant, & ex hisce variationibus variationes in atmosphaerae pressionibus utcunque dignoscuntur. Dico *utcunque*, nam ut Celeb. *Wolfius* in sua *Aërometria* optime notavit, variationes Barometrorum non satis accurate diversitatem gravitationis atmosphaerae indicant, & propterea, quae alias barometra vocari solent instrumenta, duntaxat *Baroscopii* appellatione digna cenfuit, Barometri nomen instrumento illi reservaturus, si quod unquam inveniri possit, quod aëris gravitationes accuratissime monstret. Inter alios defectus, quibus communia baroscopia laborant, forte praecipuus est, quod variationes eorum non satis sensibiles sunt: hanc ob rem eximii Philosophi Hugenius, De la Hire, &c Joh. Bernoullius alias baroscopiorum constructiones excogitarunt, quibus instrumentis minimae in aëris gravitate mutationes sensibiliter exprimerentur ; hinc nata sunt gemina, quae vocantur barometra Hugenii & Hirei, quorum constructionibus explicandis nunc non immorabor, cum Hugenii barometrum compositum in Ephemeridibus Gallicis descriptum habeatur, & apud alios passim Autores de rebus hisce agentes , & Celeb. Hireus baroscopii a se excogitati descriptionem etiam tradiderit in Actis Academiae Regiae Paris.Scient. 1708. d. 21 Martii. Sed quia barometrum, quod Acutiss. Geometra Joh. Bernoullius jam a multis retro annis excogitavit publico nondum innotuit, nec a simplicitate sua contemnendum est, ejus descriptionem, ab Ingeniosiss. Autore mihi benigne communicatam, hoc loco afferre non pigebit; constructio itaque barometri Bernoulliani ita habet.

324. Fig. 76. Sit ABC tubus e duobus ramis inaequalium diametrorum compositus, figuram gnomonis prae se ferens ; rami horizontalis BC in C aperti diameter lineam seu

duodecimam digitis Parisini partem non excedat; rami vera verticalis AB in summitate obstructi diameter esto 4 linearum vel amplius adhuc, prout variationum gradus in hoc barometro magis sensibiles sunt exprimendi, & rami hujus altitudo sit, qualis in baroscopiis communioribus, 30 aut 31. pollicum; longitudo vera rami horizontalis BC, quae a proportione diametrorum ramorum pendet, 3. pedum minimum esse debet. Si tubo sic parato Mercurius infundatur, & ramus ejus horizontatis pariter plenus sit Mercurio ad medietatem usque E circiter, aëre existente mediae consistentiae, habebitur barometrum, quod 16. vicibus magis sensibiles exhibebit variationes, quam ordinaria barometra. Liquet enim, quod, descendente Mercurio in ramo verticali ex spatio unius pollicis, progredietur in ramo horizontali ex E in F per spatium 16. pollicum; nam ramus verticalis aliud non est, quam simplex seu commune baroscopium.

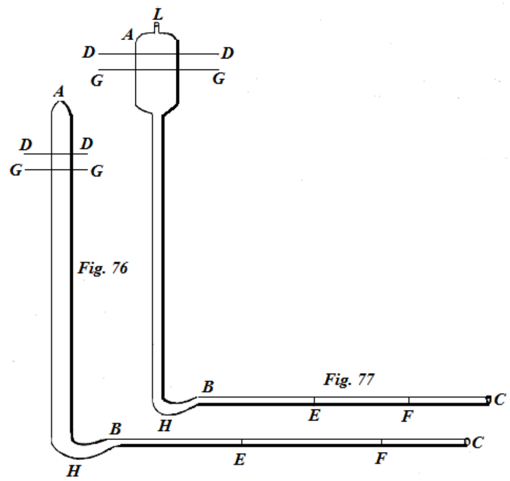


Fig. 76
Fig. 77

Quod si vero ramus horizontalis angustior aut verticalis amplior fieret, nemo non videt fore, ut variationes crescant in duplicata ratione diametrorum, adeo ut hae variationes in infinitum magis magisque sensibiles reddi queant. Sed quia praxis talia semper incommoda secum trahere solet, quae theoriae successum difficilem efficiant, nimia est fugienda horizontalis rami angustia, quia aëris pressio non satis commode agit in tubo valde angusto, nec in eo Mercurius facile movetur. Horizontali igitur ramo vix minor quam unius lineae diameter tribui debet. Propterea, loco imminutionis ejus diametri, satius est verticalem ramum majoris amplitudinis assumere, non quidem per totam ejus longitudinem, sed tantum in summitate, addendo scilicet tubo BM, qui ejusdem ac in vulgaribus barometris crassitiei esse potest, capsulam vitream AM, in qua Mercurius perinde ac in Hugenii geminato descendet atque ascendet.Verum existente hac capsula valde laxa, insignis rami horizontalis longitudo, quae hoc casu requiritur, instrumentum inconcinnum usuique parum accommodatum redderet, nisi incommodo isti promptum esset remedium, contorquendo ramum horizontalemin spiralem vel quoquo alio modo in minus spatium redigendo flexuris illis, quas figura 78. exhibet, dummodo hae flexurae omnes in eodem plano horizontali existant.

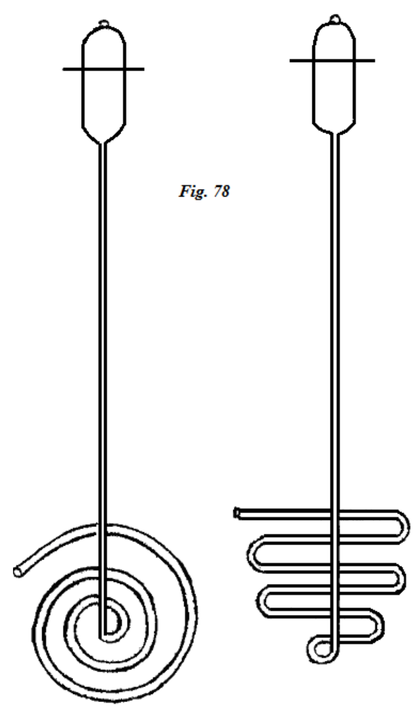


Fig. 78

Ad commodiorem hujus Barometri impletionem non abs re fore notat Autor, si ramus perpendicularis AB in exiguum tubulum in L apertum desinat, ita ut per ejus orificium argentun vivum infundi possit, dum orificium rami horizontalis C, obstructum tenetur.

Ambobus ramis hoc pacto impletis orificium L hermetice est sigillandum & obturamentum, quo orificium C, obstruebatur, demendum, ut argentum vivum in verticali tubo AB ad consuetam in communioribus barometris altitudinem se demittere possit scilicet ad terminum D, & ex horizontali ramo superfluus effluere hydrargyrus; sed quia hac ratione ramus horizontalis Mercurii plenus manebit, suctione pars ejus conveniens est adimenda vel beneficio tubi capillaris ampullula instructi, quae calefacta atque tubo horizontali intrusa atque in eo refrigescens Mercurium in suam cavitatem trahet. Hac ratione barometrum constructum usuique paratum erit.

Caeterum non in utile fuerit, si tubus verticalis in loco, quo horizontali jungitur, exigua curvatura instar receptaculi H instruatur, ad impediendum ex horizontali in verticalem ramum aëris ingressum, si quando horizontalem forte Mercurius deficeret, aut fortasse ex atmosphaerae pression seu a vibrationibus Mercurii ex translatione barometri de loco in locum orta, quod postremum inconveniens si non tolli penitus, saltem obstruendo orificium C, minui potest.

Praeter simplicitatem, qua Bernoullianum istud barometrum se commendat, aliis insuper praerogativis praestare videtur barometris compositis hactenus inventis. Nam tubi pro Bernoulliano & facile parantur facileque etiam implentur, nec liquores in eo adhibeatur in vapores sensibiliter abeuntes, quibus barometri effectus mirum quantum alterari soleat. Nam in baroscopio a nobis descripto solus adhibetur Mercurius, qui in vapores sensibiliter non solvitur. Geminatum vero Hugenii barometrum, praeterquam quod tubos requirat aegre parabiles & difficillime liquoribus implenios, liquores deposcit evaporationi obnoxios, cui incommodo illud etiam quod Celeberrimo De la Hire ingeniose excogitatum & in Actis Acad.Reg. Paris. Scient. loco jam supra indicato subjectum est, aliudque praeterea incommodum secum trahit, quod liquores ejusdem specificae gravitatis sed impermiscibiles requirat, alioqui variationes ejus non indefinite augeri poterunt, sed intra certos terminos consistent quos transgredi nequeunt. Nam vocando specificas gravitates argenti vivi, & ex liquoribus in barometro isto adhibendis gravioris scilicet & levioris *m*, *t*, *p*; capsularum vitrearum diametrum *a*, diameterum tubi angustioris *b*; invenio post Claris. Bernoullium, variationes in barometro Hireano se habere ad variationes in barometro ordinario seu communi, ut quantitas maa ad $2mbb,+\left(aa-bb.t-p\right)$. Jam quo minor est *b* quam *a*, eo propius accedit haec ratio, rationi *m* ad $t-p$, quae limitem exprimit, intra quem variationes barometri a Cl. De la Hire inventi collatae cum variationibus Barometri communis continentur, quae data ratio *m* ad $t-p$ eo solum casu infinita sit, quo $t=p$, hoc est eo casu, quo liquores in Hireano barometro adhibiti ejusdem sunt specificae gravitatis, sed qui invicem permisceri nequeant.

Posteaquam descriptio Bernoulliani barometri coram Concilio Academiae Scientiarum Regiae Parisiensis praelectae fuit, nuntiarum est Celeb. ejus Autori similem barometri constructionem jam ante complures annos excogitatam fuisse a Celeberrimo Astronomo Joh. Dominico Cassino, sed postea neglectam ab ipso jacuisse; quod in praxi non successisset ob aërem, qui Mercurio in tubo seu ramo horizontati se miscuisse ejusque liberum fluxum impedisse scribitur. Sed quia, quid hac in re laudatus Vir molitus sit, nusquam memoriae proditum sit, nec Bernoullius de ejus tentaminibus quicquam fando audiverit, inventionis laus ipsi denegari non potest, maxime quod ejus cum successu in Belgio factum esse periculum testari potest; & incommodum illud, quod Cassino remoram injecit, tolli posse arbitratur, tubum horizontalem suctione implendo ; vel etiam si compressione crumenae cujusdam coriaceae argenti vivi plenae tubique horizontalis orificio applicatae Mercurius tubo intrusus ascendere cogatur usque ad summitatem tubi verticalis, orificium superius apertum habentis; hac Mercurii intrusione peracta, & obturato summo verticalis tubi orificio, crumena a tubo horizontali est removenda, ut argentum vivumin tubo verticali ad consuetam altitudinem delabi possit. Denique ut Mercurii fluxus in tubo horizontali commode fiat, tanta tubo isti amplitudo est tribuenda, quanta opus est ut Mercurius in eo contineatur, absque eo ut diffluat.