

# PHILOSOPHICAL TRANSACTIONS.

November 22. 1675.

## The CONTENTS.

*Some Experiments made in the Air-pump at Paris. A particular given by an Anonymous French Author, to shew, that the Rain and Snow-waters are sufficient to make Fountains and Rivers run continually. A relation of Mr. Jessop of Broom-hall in Yorkshire, containing a further account of Damps in Mines; promised in Numb. 117. An Account of some Books: I. A Philosophical Discourse of Earth, relating to the Improvement of it for Vegetation and the Propagation of Plants, as it was lately presented to the R. Society by J. Evelyn Esq;. II. A Description of the Islands of Feroë, by Lucas Jacobson Debes, M. A. III. The Gentleman's Recreation in four Parts, viz. Hunting, Hawking, Fowling, Fishing, &c.*

*Some Experiments made in the Air-pump by Monsieur Papin, directed by Monsieur Hugens, (as appears in the Discourse printed at Paris, 1674.)*

**T**O mingle divers Liquors together by means of the Air-pump, there were employed two small Glasses, whereof the one could enter into the other, and the least of the two was fastened to the hook of an Iron-wire, and the greater put under it, and the said Wire was so ordered, that these two Glasses were a little distant one from another, until the Recipient <sup>†</sup> were eva-

<sup>†</sup> The Recipient, which was employ'd in this Engin, was of a Cylindrical figure, of which one end is all open, to be fastned to the cement of this Pump; the other is all closed, except a small hole, having a little edge or brim; through which hole you pass the hook'd Iron-wire, mentioned in the discourse, and tie an Eel-skin close about the same and three or four inches higher. The same skin is also to be tyed about the Iron-wire, to keep the external Air from entering into the Recipient, and yet without taking away the liberty to stir therein what you will by means of the Iron-wire, that hath a Communication inwards and outwards. For this purpose you must chuse that part of the Eel-skin that is next to the head, the other part being pierced with many holes with valves that do not always shut well.

To be the more sure, that no Air enters by the ligatures of the Eel-skin, you may apply a Tube on the Recipient with cement, and pour water into this Tube until the Eel-skin be quite cover'd therewith. Care also must be had, that the whole be exactly fill'd up by the Iron-wire; for, if it were too big, the Eel-skin would be thrust into it with great violence, and so hinder the liberty of raising and sinking it.

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cuated of Air. Whereupon, by means of the Iron-wire, the lesser Glass was let down into the greater, until the Liquors, they contain, did mingle themselves. Thus some *Aqua fortis* was poured into the upper Glass, and *Spirit of Wine* into the lower, and the Recipient was so well exhausted of the Air, that the *Spirit of Wine* boyled up with great bubbles (as usually it doth,) and the *Aqua fortis* cast some small bubbles. After that both these Liquors were well purged of Air, the upper Glass was sunk into the lower, so as that the *Spirit of Wine* was mingled with the *Aqua fortis*; at which instant there was yet seen a very considerable Ebullition.

Now to know, whether the *Aqua fortis* gave to the *Spirit of Wine* some new vigor or force to make it bubble; we mixed *without* the Recipient some *Aqua fortis* with *Spirit of wine*; the quantity of the former being somewhat more than that of the later. This mixture being put in *vacuo*, instead of boyling up more strongly than the *Spirit of Wine*, (as 'twas thought it would have done,) it only cast up some few bubbles: Which shew'd, that the Ebullition, which was seen when they were mixed *within the vacuum*, is of the same nature with all those that are made of Acids and Alcalies. For, in the very instant that they are mixed they make great ebullitions, but soon after they mortifie one another, and loose the proprieties they had before. 'Tis also probable, that the *Aqua fortis* and the *Spirit of Wine* would boyl always, when they are ming'ed, but that the pressure of the Air keeps this ebullition from being sensible, and appears only when that pressure is taken off.

When you employ rectified *Spirit of Wine* instead of *Aqua vita*, there is required a greater quantity of *Aqua fortis* to mortify it.

It was also experimented, that the solution of *Common Salt* boyls also with *Spirit of wine*, being mixed *in vacuo*, and the solution of *Salt-peter* yet more. The same Experiment was also made with common water, and it's ebullition with *Aqua vita*, purged of Air, was also found to be very great, when mixed *in vacuo*.

Further, it is somewhat remarkable, that *common Water* doth not mortify *Spirit of Wine*, as *Aqua fortis* doth, though they make ebullition with it almost of the same degree. The Experiment of it is easy: For, making *without* the Recipient, a mixture of *common Water* and *Aqua vita*, this, being put *within the vacuum*, bubbles up very well, though the *common Water* be there in greater quantity than the *Aqua vita*; whereas a mixture of *Aqua fortis* and *Aqua vita* did not there bubble up at all.

After

After this, the Experimenter being desirous to see, whether these Ebullitions did make new Air; he put in the Recipient a *Gage* (that is a glass tube fill'd either with Water freed of air, or with Mercury, serving to measure the quantity of the Air in the Recipient) which was four Inches long, and observ'd, that at the instant when the Liquors were mingled together, the water in the Gage rose very nimble to the top of the gage; and then drawing out this new Air that was made, he made the gage-water subside again by degrees, in like manner as when the common Air is drawn out: And by this means, it was seen, that all these kinds of ebullition make an Air which expands it self like common Air \*.

\* On this occasion, I am obliged to take notice, that (as 'tis recorded in the

Journal-Book of the R. Society, A. 1668. April 30.) the honourable Mr. Boyle gave an account to the said Society of the Experiments, he had then made about generating new Air, or extricating that Air which was lurking before in several bodies: At which time he mention'd also some ways of examining, whether the substance thus produced be *true* Air or not.

And long before that time, *viz.* A 1664 the 15th. of March, (witness the same Journal) Mr. Boyle mention'd to the R. Society, that Corals or Oyster-shells pounded, and put into distilled Vinegar, might prove fit Substances to produce Air wholesome for Inspiration. At which time he also propos'd, that some fit animal might be put into a Receiver of his Exhausting Engin, and the Air pumped out till the creature grew sickish, and that then some new Air might be produced in the Receiver by a contrivance of making distill'd Vineger work upon the substances before mention'd; to see, whether by this means the Animal would recover.

About which time Sir Chr. Wren also suggested, to put a fermenting liquor in a glass-ball, and to fit a stop-cock to it, and ty a bladder about the top of the stop-cock, by which means the Air, to be generated by the fermenting liquor, would pass into the bladder, and upon the turning of the stop-cock be kept there in the form of Air. Mr. Hook also mention'd several liquors, which by their working upon one another would produce an Air; as *Oyl of Tartar* and *Vitriol*; *Spirit of Wine* and *Turpentine*. And the same made before the R. Soc. the following Experiment: He took a common glass-viol with two Pipes, and some pounded Oyster-shells and *Aqua fortis*; and as soon as the latter was by one of those pipes powred upon the former, and the hole stop't with good cement, the Ebullition, cauſed by the shells being corroded by the *Aqua fortis*, did in a very little time blow up the bladder, tyed on to the other pipe, so as to swell it very plump with Air; which expansion remained till the Society rose, after they had order'd the said vessel to be carefully lock't up till their next meeting, which being the week after, the bladder was then found somewhat shrunk. The like Experiment was made with *bottled* Air, supposed to yield a more wholesome Air for respiration, &c.

Yet here is something that seems to be very remarkable: which is, that the Air which is made by these ebullitions, is not of the same nature. For, it hath been found experimentally, that the Air formed by the mixture of *Aqua fortis* and *Copper* remains alwaies Air, and alwaies keeps up the water in the Glass at that height to which it raised it; but on the contrary, that Air which hath been produced by the mixture of *Oyl of Tartar* and *Oyl of Vitriol*, is al-

most all destroyed of it self in the space of twenty four hours, insomuch that in the Recipient, twenty four hours *after* that the ebullition had been there made, there was not found much more Air than there was *before* the same was made.

One day we mingled equal parts of *Aqua fortis* and *Aqua vita*, and having put two equal quantities of this mixture in two small Glasses with two equal bits of *Iron*, one into each ; one of these Glasses was included *in vacuo*. Then there was seen a very great Ebullition, and the liquor became black, whilst that was left *without* the Recipient wrought al'most nothing, but remained alwaies transparent, and rather white than black. After these two Glasses had thus stood twelve hours, that which was *in vacuo* was taken out, and found, that the Iron was almost all dissolved, whereas the other was very little diminished. This Experiment succeeds quite contrary when 'tis made with *Aqua fortis* alone and *Copper* ; for then the dissolution is less *within the vacuum*, than *without* it.

We made some other mixtures of divers liquors, which make no ebullition at all *in vacuo*, no more than they do in the open Air. *Oyl of Olives* makes none neither with *Vinegar*, nor with *Spirit of Wine* at the instant that they are mingled ; neither doth the said *Oyl* mortifie the *Spirit of Wine*. Only this we observed one day, that having mingled together, *without* the Recipient, some of that *Oyl* and *Vinegar* and *Spirit of Wine*, and put this mixtnre *in vacuo* ; it did not boyl up so soon as when there was no *Oyl* ; but then the bubbles which it made afterwards were bigger, and they began to appear again from time to time, so that some of them were seen a quarter of an hour after the Recipient had been evacuated. Possibly this may come to pass, because that the *Oyl*, swimming on the top, retains the more volatil parts of the *Spirit of Wine*, which else would flie away as soon as the Air is begun to be pump'd out, and at the same time it hinders the surface of the liquor below from easily rising up into bubbles, because, to make them do so, the parts of the *Oyl* that stick close to one another, must be separated. When therefore the volatil parts are gather'd together in a sufficient quantity, able to surmount the resistance which the *Oyl* makes to it, they issue out with much more violence, than if nothing had retained them.

All these Ebullitions, hitherto spoken of, are greater *in vacuo* than in the open Air : But with *Lime* it is not so. For, taking two equal Glasses with two equal quantities of Water, and putting the

one of them in *vacuo*; the other in the free Air, there was let fall into both at the same time two equal parcels of *Lime*, one into each; and it appear'd, that that which was in *vacuo* did indeed throw up some big bubbles, but yet fewer of them than that which was in the Air: And having taken it, an hour after, out of the Recipient, and stirr'd the *Lime*, it was found to have only the consistence of Dirt, whereas the other had the consistence of sleeked Lime. The reason of which may perhaps be, that the Volatil Salts of the *Lime* do exhale whilst the Recipient is emptying.

There was also some Plaister of *Paris* sleeked in *vacuo*, and the Ebullition of it did there appear much more than it doth in the open Air. When it is not touched, the bubbles that issue out leave great holes in it, and then it settles very un-even; but taking care to stir it until the bubbles be come forth, and pressing it when it begins to settle, it becomes very smooth, and hath not so many little holes as the common Plaister.

*A particular account, given by an anonymous French Author in his book of the Origin of Fountains, printed 1674 at Paris; to shew, that the Rain and Snow-waters are sufficient to make Fountains and Rivers run perpetually.*

**I**N order to give a gross Estimat of the quantity of Rain\*, compared with the quantity of Water running away in Springs and Rivers; it will be necessary first to agree of the way of measuring these two sorts of Water. Those that make profession of governing and conveying Spring-waters, say, that a cubick inch of water yields in twenty four hours 144 *muids*, (the name of a *French* measure, holding 280 *French* pints;) others say, it yields but 70 of that measure. For my part, I have reason to believe, that it yields 83 of this measure, and follow those that say, that a Vessel of two foot deep, long and broad, holds one *muid* of Water.

\* The like to which hath been attempted here, and proposed to the R. Society, some years since, by Sr. Chr. Wren, who by the contrivance of a Rain-bucket had taken an account of all the Water that fell for a considerable time; and by his Weather-clock had, among other particulars, not only taken in the measure

ring of the quantity of Rain that falls, but also the time when it falls, and how much at each time. Which Instrument, if put into practise, would be of excellent Use, forasmuch as it may also serve, by some additions made thereto by M. *Hooke*, to record the weight of the Air, the drought, moisture, heat and cold of the Weather, the Sun-shine, the quarters and strength of the Winds: And all this to be performed by one only motion, driving all the parts of the Instrument; which is therefore the more considerable, that it self records its own effects.