Fig : I

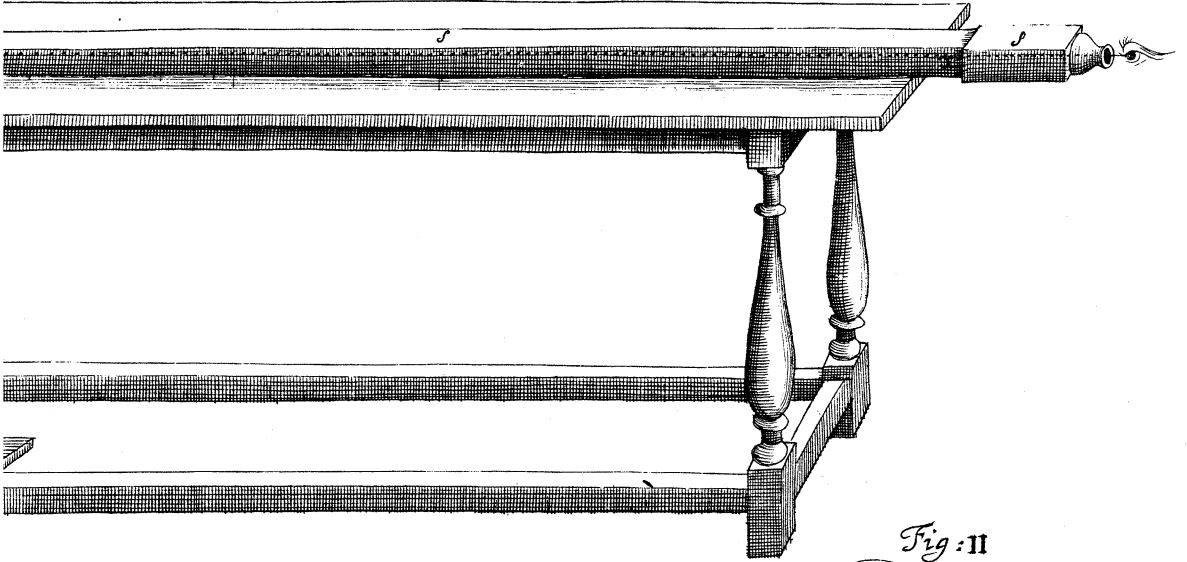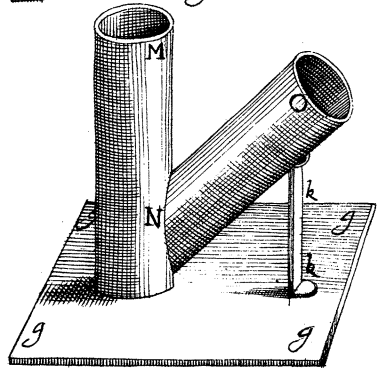Fig : III

III

s

s

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Fig: II

M

O

N

k

g

g

g

PHILOSOPHICAL

TRANSACTIONS.

For the Month of *October*, 1699.

The CONTENTS.

I. *An Experiment of the Refraction of the Air made at the Command of the Royal Society*, Mar. 28. 1699 *By* J. Lowthorp. A. M.

WE took a Cylinder of Caft-Brafs Fig. I. ABCD; and cut one end of it CD perpendicular to the Axis *ax*, the other end AB enclin'd to it at an Angle of about 27° 30'. and therefore the Perpendicular to this enclining plain, *pc*, and the Axis of the Cylinder *ax* comprehended an Angle *pca* of about 620. 30d. Thefe ends were groun'd very true upon a Glafs-Grinder's Brafs-Tool, and each of them was compaft about with a narrow Ferule of thin Brafs *bbbb*. Into the upper fide of the Cylinder at E was folder'd the Brafs pipe EF, and into the under fide at 6 the other Brafs pipe GH; the former of thefe Pipes being about 3 inches long and the late 6 inches. Upon the plate *ddd* were fixt two other plates LL Perpendicular to it and parallel to each other. Each of thefe two plates had an Arch of a Circle (equal to the Circumference of the Cylinder) cut out of its upper Edge, fo that when the pipe GH was let through a hole near the middle of the plate *dad*, the Cylinder fell into the Arches; and being

faften'd

faften'd there with Soder, the Axis *ax* laid Parallel to the Plate *ddd* and about an inch and half above it. The Perpendicular End of the Cylinder DC was clos'd with an Object Glafs of a 76*th*. Foot Telefcope, *oo*; and the other End AB, with a well polifht flat Glafs *ff*; which was carefully chofen to tranfmit the Object diftinct enough notwithftanding its Obliquity to the Vifual Rays. The Ferules were well fill'd with Cement round about the Edges of the Glafs, and they laid flat and every where toucht the fmooth Ends of the Cylinder, that they might firmly refift the preffure of the Excluded Air.

Inftead of a Ciftern (as in the Torricellian Experiment) we made ufe of the Inverted Siphon of Brafs Fig. II. MNO, foder'd to the Plate *ggg*. One of the fides MN ftood Perpendicular to the plate, and the other fide NO Enclin'd to it, and was fupported near the upper End O with a little prop *kk*.

We then plac'd the Cylinder (as in Fig. III.) upon a Table which was well faften'd to a firm Flore; The pipe GH was let through a Hole, and the Axis laid almoft parallel to the fides of the Table, and the Plate *ddd* was nail'd down to it. The Tube of the Telefcope *ff* with the Eye glafs was apply'd to the Object Glafs, and a Hair fixt within it at the common Focus of both glaffes in the Axis of the Cylinder continu'd, *x*. Upon the floore (under the Cylinder) we nail'd the plate *ggg* with the inverted Siphon upon it, and join'd M to H by the Infection of the Glafs Tube T. The joints were very carefully clos'd with Cement : And then they were cover'd over with pieces of a bladder and wrapt hard with ftrong thread. There was alfo a bladder ty'd below each joint at *m*, and when it was fill'd with Water it was ty'd above it at *n*; So that no Air could come to the Cement or infinuate it felf through it's pores or fiffures if any happen'd to be left unclos'd.

It is not (I think) an unneceffary trouble, that in this account of the Apparatus I have mention'd fo many minute Circumftances, for we found it difficult enough to exclude the Air, and almoft Impoffible to difcover the very little holes through which fo fubtil a fluid would freely enter and poffefs the fpaces deferted by the fubfiding Mercury. But with all this precaution the experiment fucceeded at laft, as I wifht, after this manner.

We plac'd the Object *a* (which was a black thread fliding in a little frame over a piece of white paper) in the Axis of the Cylinder *cx* continu'd to it; We fill'd the Pipes and Cy-

linder

linder with Mercury; and having ftopt the uppermoft Pipe at F with the little Iron ftopple K and clos'd it at the other joints, we let the Mercury run out gently at O into the bladder *v*, till it remain'd fufpended at the ufual height (as in the Barometre) leaving the fpace above it between the glaffes *o* and *ff* void of Air. We then found the Object, which before appear'd in the Axis at *x*, rais'd confiderably above it, and we reduc'd it to appear at *x* by removing it from *a* to *x*. The Axis therefore, of the vifual Ray *xa* (which was alfo the Axis of the Cylinder) *xa*, falling Perpendicularly on the void fpace in the Cylinder paft through it without any Refraction: But emerging obliquely into the Air, it was Refracted towards the Perpendicular *pc*, and there receiv'd a new direction to *x*. And therefore the fpace *ax* fubftended the Angle of Refraction *acx*; which we meafur'd and found as follows.

The height of the Object above the Axis of vifual Ray *ax* the unrefracted ——— inches depths 0, 425

The Diftance of the Object from the Refracting Plain, &c. about 51 feet or 612

Therefore the Angle of Refraction *acx* was 0. 2'. 23'

The Angle of Emerfion *pca* (by the conftruction of the Cylinder) was 62. 30.

Therefore the Angle of Incidence *pcx* = (= *pca* + *acx*) was 62. 27. 37.

And therefore univerfally (according to the known Laws of Refraction)

The fines of the Angles of Incidence being 100000

The fines of the Angles of Emerfion are 100036

And the Refractive Power of the Denfe Air 36

By the Refractive Power of a Pellucid body I mean that Properly in it whereby the Oblique Rays of Light are diverted from their direct Courfe; and which is meafur'd by the Proportional Differences always Obferv'd between the fines of the Angles of Incidence and Emerfion.

This *Property* is not always proportional to the *Denfity* (at leaft not to the *Gravity*) of the Refracting Medium. For the Refractive power of Glafs to that of Water is as 55 to 34. whereas its Gravity is as 87 to 34; that is, the fquares of their Refractive *Powers* are (very near) as their refpective Gravities. And there are fome fluids which tho lighter than Water yet

yet have a Greater *Power* of Refraction ; thus the Refractive *Power* of Spirit of Wine (according to Dr. *Hooks* Experiments) Microg. p. 220) is to that of Water as 36 to 33 and it's Gravity reciprocally as 33 to 36 or 36½. But the Refractive *Powers* of Air and Water seem to observe the simple *Proportion* of their Gravities, directly; as I have compar'd them in the following Table. The Numbers there Expressing the Refraction of Water are taken from the mean of *9 Observations at so many several Angles of Incidence made *Jan.* 25. 164⁰⁄₉ by Mr. *Gascoigne* the Ingenious Fire Inventor of the Micrometer, and the ways of measuring Angles by Telescopes and those of Air are produc'd by the Experiment above related, &c.

* *I am Indebted for them to Mr.* Flamsteed, *who had cover'd them with his Observations, and several passages relating to them , from his Letters to Mr.* Crabteer *which were happily preserv'd in the time of our Civil War by Sr.* Jonas Moor *and Mr.* Christopher Towneley ; *and are now in the Hands of Mr.*RichardTowneley *of* Towneley *in* Lancashire, *by whom they were imparted to him.*

	Water.	Air.
The (assum'd) sines of the Angles of Incidence through	100000:	100000
The sines of the correspondent Angles of Emersion out of	134400.	100036
The Refractive power of	34400	36
The Specifick Gravity (if as 900 to 1) at the time of the Experiment) of	34400	38
or (if as 850 to 1) of		40

From hence it seems very probable that their Respective Densities and Refractive Powers are in a just simple proportion: And if this should be confirm'd by succeeding Experiments made at different Angles of Incidence and with Cylinders continuing Exhausted through several Changes of the Air it would be more than probable that the Refractive Powers of the Atmosphere are every where, at all heights above the Earth, proportional to it's Densities and Expansions. And here it would be no difficult matter to trace the Light through it, thereby to terminate the shadow of the Earth ; and (together with proper Expedients for measuring the Quantity of Light Illuminating an Opaque Body) to Examin at what distances the Moon must be from the Earth to suffer Eclipses of the Observ'd *Duration*. This Limitation is considerable enough in Astronomy, abundantly to recompense the trouble of Prosecuting such a New Experiment.

II *An*

Fig: III

Fig: I

Fig: II

T