

III. *A Letter to the Reverend John Theoph. Desaguiliers, L. L. D. F. R. S. from Mr. Martin Triewald, F. R. S. Captain of Mechanics, and Military Architect to his Swedish MAJESTY, concerning an Improvement of the Diving Bell.*

Stockholm, Nov. 1. 1732.

Reverend SIR,

HAVING the sole Privilege for diving on all the Coasts in the *Baltic* belonging to his *Swedish Majesty*, no Opportunity has been wanting to make sufficient Trials with the Diving Bell and Air Barrels in several Depths, according to the ingenious Improvement of that worthy Gentleman Dr. *Edmund Halley*, made in the Year 1716, but with some small Additions.

Experience has likewise convinc'd me, that no Invention built upon any other Principles than those of the *Campana Urinatoria*, can be of Use in any considerable Depths; or that the Diver, in any other Invention whatever, can be a single Moment safe. I will not, for Brevity-sake, mention the many Impediments that attend other Inventions, only that of a Water Armour, in which the Man is drowned in an Instant, when such a Machine receives the least Leak: Whereas Experience has shewn, that when such an Accident has happen'd to the Diving Bell, as to my Knowledge it did once, when the Diver was 12 Fa-

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thorn under Water, and a pretty large Hole happen'd to be struck in the Bell, by a Bolt of the Wreck he went upon, at which Time the Air rush'd out of the same with such Violence as astonish'd the Beholders by the excessive boiling on the Surface of the Water, fearing, not without Reason, that the Man in the Bell was drowned; but he clapped his Hand to the Hole or Leak, and gave a Sign to be haul'd up, which was done with all the Ease and Safety as if no Accident had happen'd to him, the Water having only risen about half a Foot into the Bell by this Leak.

The very same Diver that was then in the Bell is 63 Years of Age, and has used the Business of Diving ever since he was 20, in a common Diving Bell, till of late, and is as yet a pretty strong and healthy Man: He declares that never a worse Accident happen'd to him in his Business but once, when the Bell he was in rush'd down at once about a Fathom or more, by the Carelessness of those that work'd the Bell; at which Time the Blood came out of his Nose and Ears, feeling besides an intolerable Pressure on his whole Body; which shews, that when a Man in a Diving Bell is slowly and gradually let down, he at such a Time and by Degrees respiring compress'd Air, which by the Lungs is forc'd into the Blood, cannot feel the external Pressure, tho' of highly compress'd Air, surrounding him, and that of the Water reaching some Parts of his Body, which Convenience no other Invention can yield or afford, where the Diver is to draw his Breath from Air in its natural State.

I have often with a great deal of Pleasure observed, that when I have caus'd the Bell to stop, being lower'd down five Fathom, and the Diver taking in the Air contain'd

contain'd in an Air Barrel, lower'd down a Fathom deeper than the Bell, without opening the Cock for discharging the hot Air; the Water would, by the Access of the Air out of the Barrel, be quite, or to a very small Matter, expell'd out of the Bell; and when the same was again lower'd down five Fathom more, the same Operation with another Air Barrel repeated, and the Bell afterwards haul'd up, it was no small matter of Delight to see, that every Fathom the Bell came up, it would discharge itself of the superfluous and large Quantity of Air, which came up from the Bottom of the Bell in very large Bubbles, as big as Eggs of an *Ostrich*; which Discharge of Air and Phenomenon continued, till the Equilibrium of the Air in the Bell, and Pressure of the Water, was restor'd, and till the Bell came above the Surface of the Water.

At other Times I have observed, when no Air was by the way taken into the Bell, but the same lower'd down the common Way, and haul'd up again after some Time, that the very Instant when the Bell should part with the Surface of the Water, the Strength of two Men more was required at the Capston at that Time, than before and after the Bell hung freely in the Air; from whence I presume it plainly appears, that the Air which passes thro' the Lungs of a living Creature, loses its Elasticity, and that the Lungs of a Man make a kind of a Vacuum in the Bell; for which Reason the Diver feels at the very Instant, when the Bell parts with the Water, a very smart Pressure in his Ears.

The Experience thus has taught me, that no Invention is more safe and useful than the *Campana*

Urinatoria, with the ingenious Improvements of Dr. *Halley*; yet I have likewise found, that this Invention is not to be made use of without considerable Charge, requiring a large Vessel, and Number of Hands, to the working and managing of such a large Diving Bell, and the Air Barrels with their respective Weights for sinking; which Charges, however, according to the Depth of Water, and the Value of what is to be fetch'd up from the Bottom of the Sea, may not be regarded: But since it more frequently happens in these Parts, that Cargoes of a far less Value than the Loadings of *Spanish Galleons*, &c. are to be dived for; then next to the Goodness of the Invention, I have found myself necessitated to think how the Expences might be lessen'd, and that the Diving Bell nevertheless might answer all Intents and Purposes of Dr. *Halley's*; which Improvement I take herewith the Liberty to communicate to you, which is as follows:

The Diving Bell, A B. (*see Fig. I.*) I have caus'd to be made of Copper, and reduc'd the same to a very little Compass in regard to that of Dr. *Halley's*, as you'll see by the Scale under the Draught, by which means it is easily managed by two Hands: Yet I presume that a Diver may not only live in the same for as long a Time, and with as much Ease, at a very considerable Depth of Water, as in a Bell of twice its Capacity, for this Reason, tho' a Man in a large Bell has undoubtedly more Air than in a less, and consequently should be able to subsist a great while longer on a large Quantity of Air than on a small Parcel; yet because his Head for the most part is kept in the upper Part of the Bell, where the hot Air takes up its Place
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and Residence, he receives very little or no Benefit of the Air under his Chin or Breast, tho' never so fit for Respiration; which Air nevertheless in the lower parts of the Bell will remain cool a long time after he has been in the Bell, and with Difficulty drawn his Breath; which cannot be denied, and is very obvious to any body who has been in a *German* Bagnio, and such as are made use of in this Country, where in a single Room all the Degrees of Heat are to be felt, by means of a Contrivance like Stairs to the very Top of the Ceiling, a Man when he places himself on the uppermost Step will feel an excessive Heat, so that any body not very much used to it cannot endure the same, nor draw his Breath, but will faint away; whereas on the first, second and third Steps from the Floor, the Heat is very moderate; nay, sometimes the Air near the Floor pretty cool, when at the same time near the Ceiling the Heat of the same is intolerable. I will not mention many other Instances I could produce.

To encounter this Inconvenience I have caused a spiral Tube of Copper, b, c. to be placed close to the Inside of the Bell, so fixed that the same may be taken out and cleansed at Pleasure, and with Ease; and at the same time not to incumber the Diver when he is in the Bell; at the upper end of this Tube b, a flexible Leather Tube is join'd two Foot long, at the End of which is a turn'd Ivory Mouth-piece, which the Diver (as soon as he perceives the Air to grow hot in the Top of the Bell) keeps constantly in his Mouth, which he is able to do by means of the flexible Tube in whatever Posture he is in, standing, sitting, bowing his Head, &c. And all the while

while he draws his Breath thro' the aforementioned Tube, and the Air from c; by which Contrivance he not only draws continually cool and fresh Air as long as any is in the Bell, but occasions at the same time a Circulation, which is so necessary to the very Being of Air, (especially in a compress'd State) and its Preservation for the use of Animals, which I have found to be of great Consequence; and so much the more necessary, as any body who has been in a Diving Bell for a long Time, without any new Supplies of Air, and has been reduc'd to the last Extremity of breathing in the same, will agree with me, that when at such a Time the Bell begins to haul'd up, and by that means the compress'd Air allow'd to expand and be put into Motion never so little, the Man receives, as it were, a new Life, and incredible Comfort and Ease.

Again, when, in Coal-pits, Levels are drove in the Coal or thro' Dykes, the Air of the Level or Adits growing hot by the Breath and Sweat of the Hewers and Workmen for want of a Circulation of the Air; I have found it to be an excellent Remedy, to place along the side of the Drift or Adit, a square wooden Box, open at both Ends, laid from the Place where the Air is cool and good, reaching as far, by joining one Box close to another, as where the Work is carried on. Thus, by this simple Contrivance, a Circulation of Air is obtain'd, and sometimes to that Degree, that when a Candle is held at the End of the Box where the cool Air enters, the Flame is driven out by the Current of cold Air entring and circulating thro' the Box.

By which Experiment I am apt to think, that tho' the Diver should not keep the End of the flexible Tube

in his Mouth, which he may do with all the Ease in the World, yet that the Air would circulate thro' the Copper Tube, and he receive no small Benefit by it. D D D D are the Weights for sinking the Bell, so contriv'd as with great Ease to be hook'd on the same hanging on the Cable. The Iron Plate E, fixed to the Chains F F F, serves the Diver to stand upon, when he is at work.

The Bell is extremely well tinn'd within all over; and as in all Rivers, and the Coasts of the *Baltic Sea*, the Water is extremely clear and bright, because of no Ebb and Flood, I have plac'd three strong convex Lenses G G G. By these means the Diver can not only see what is under him, but likewise on all sides at a good Distance.

These Glasses have strong Copper Lids like Snuff-boxes, H H H; which Lids are shut, when there is no Occasion to discover any Objects on the Bottom of the Sea, and serve to preserve the Glasses from being broken.

I hope you'll pardon the Liberty I have taken to trouble you with a long Letter, which I might have enlarg'd with an Account of other Inventions, which, if you approve of this, shall in a little time follow; in the interim I beg you'll grant me leave to remain with much Respect,

Most Reverend SIR,
Your most obedient and devoted,
humble Servant,

M. Triewald,
F. R. S. Berl. and Swed.

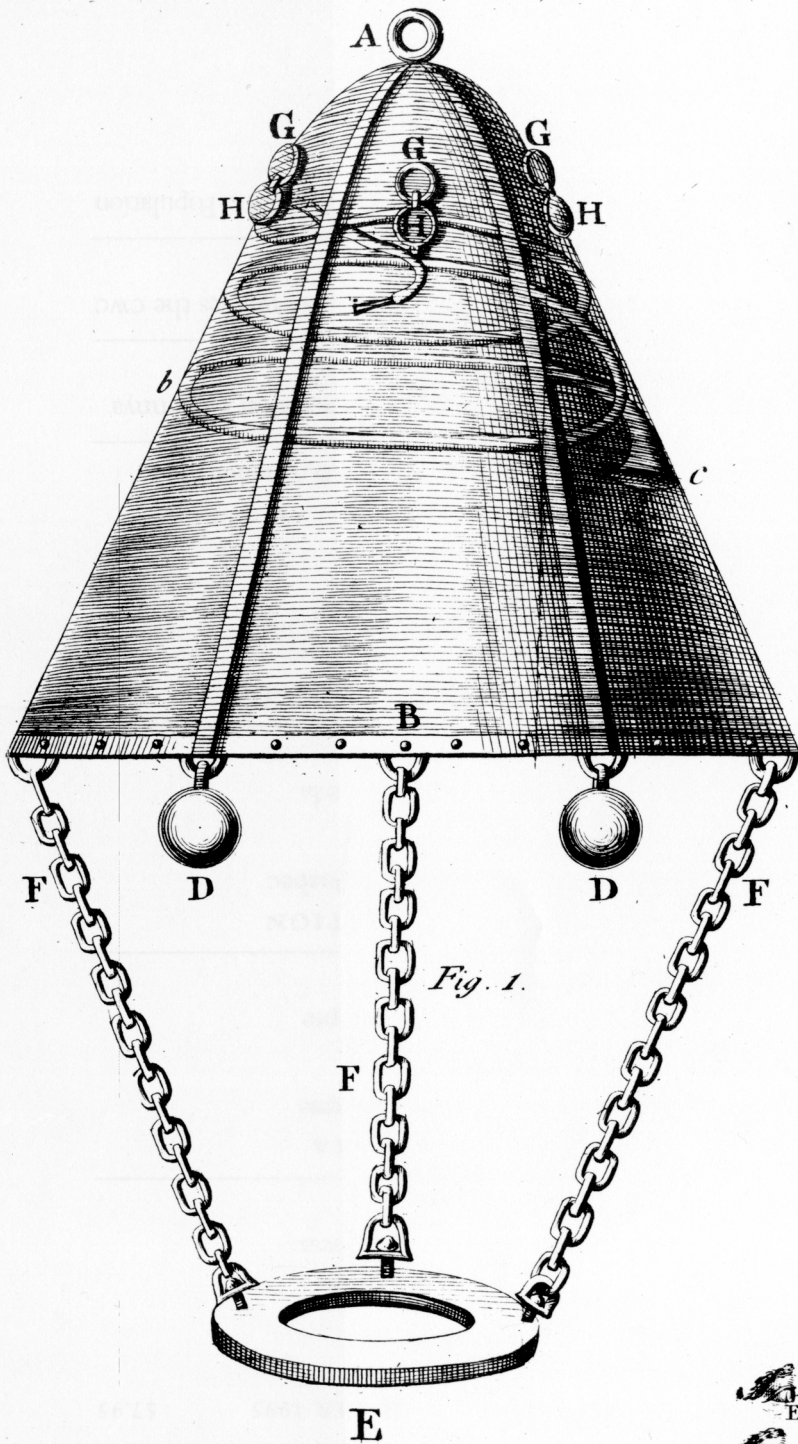


Fig. 2.

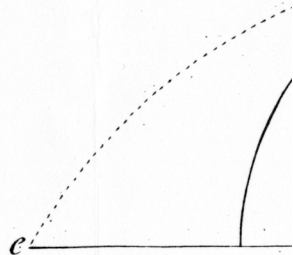
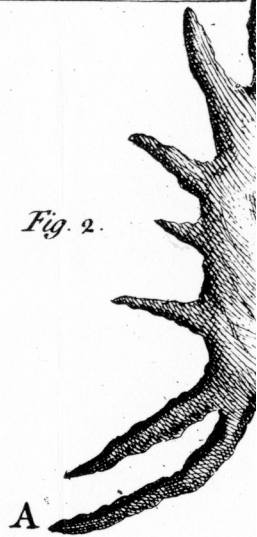
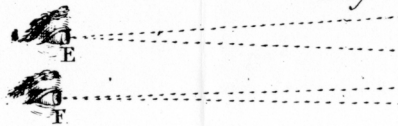


Fig. 3.



Fig. 4.



Scale of 4 English feet.

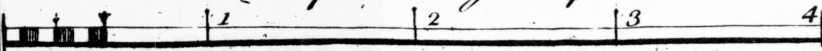


Fig. 2.

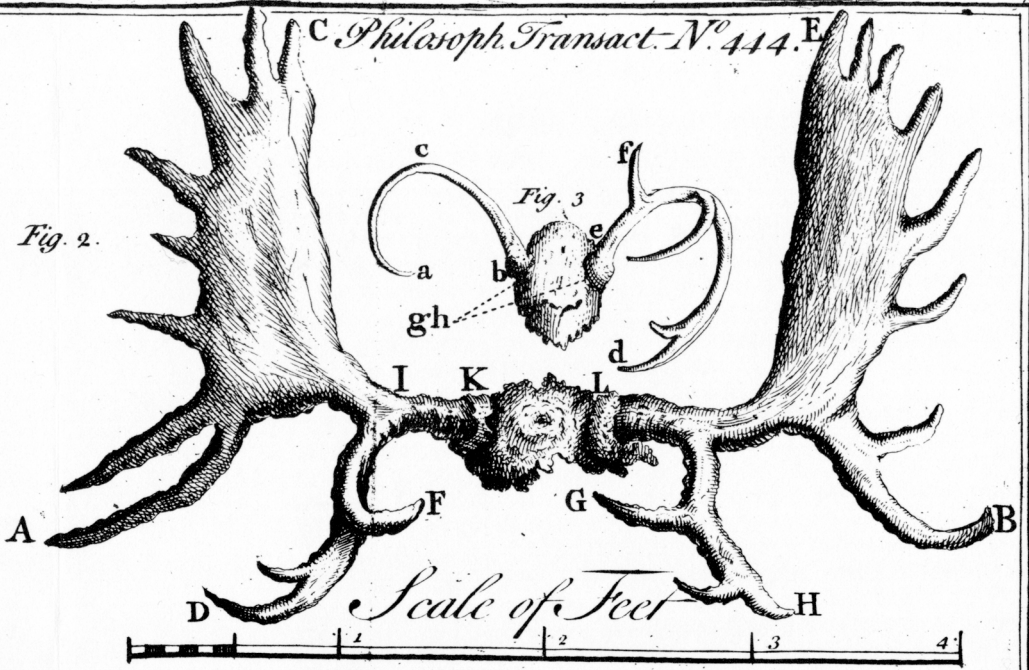


Fig. 4.

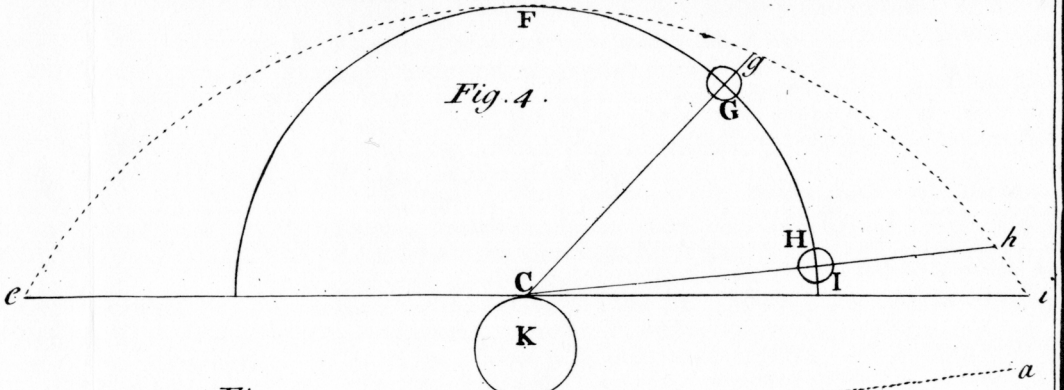


Fig. 5.

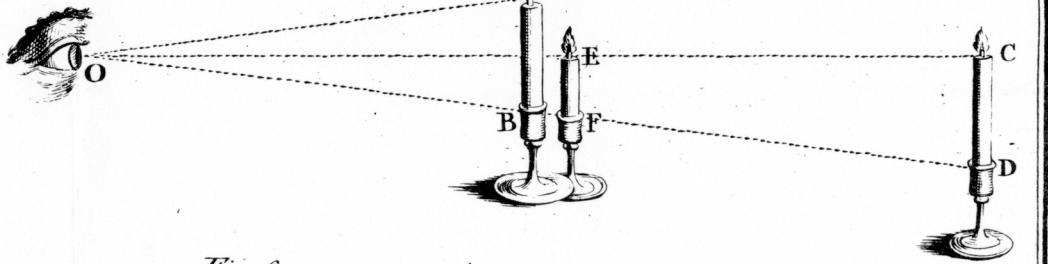
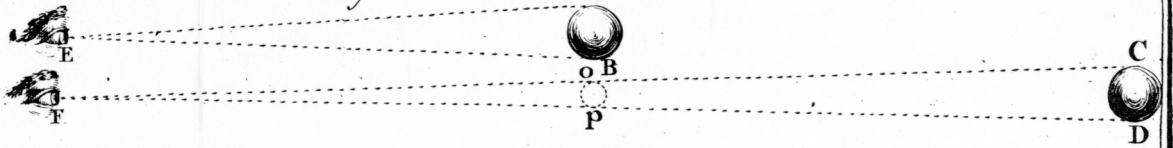


Fig. 6.



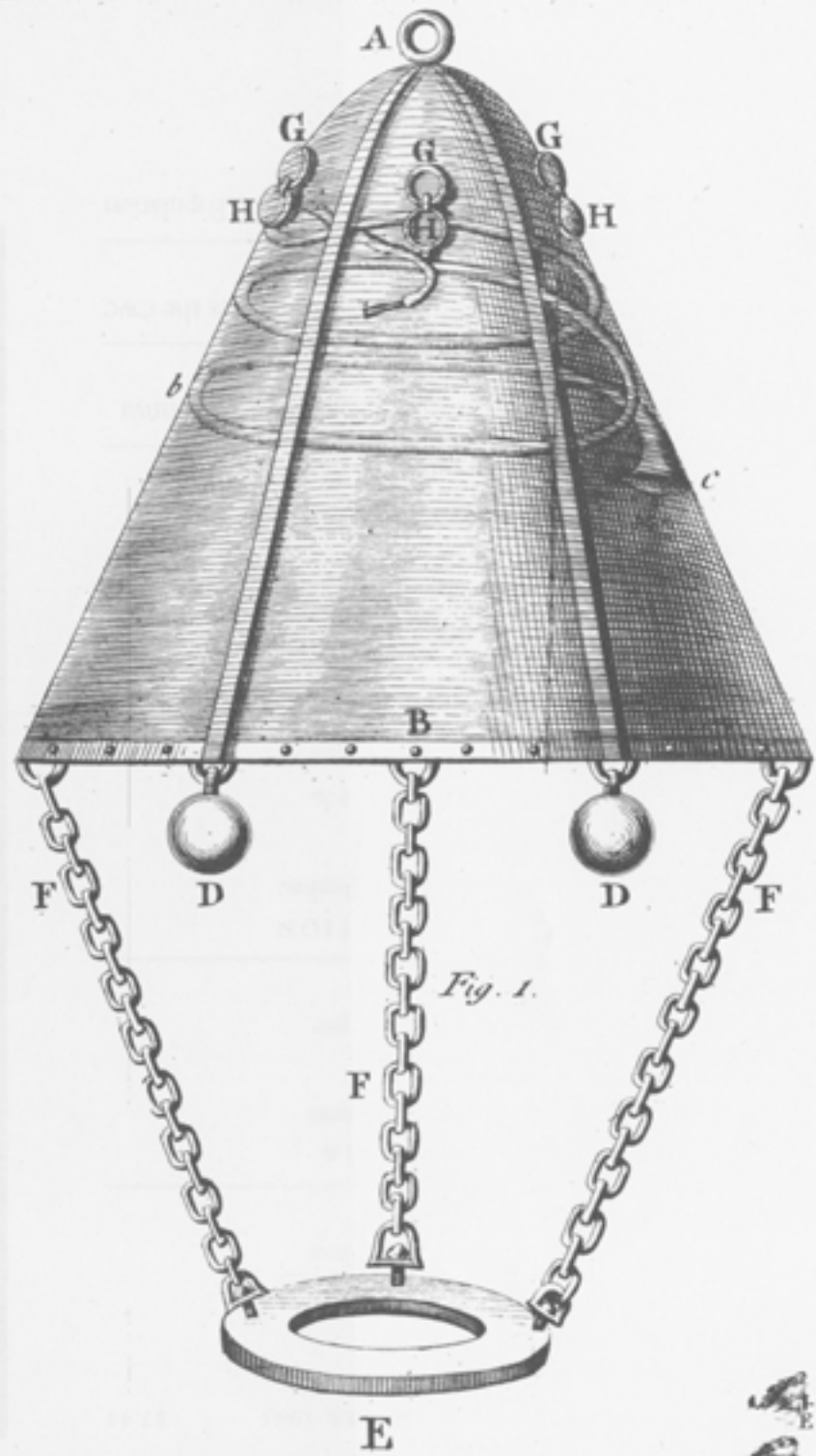


Fig. 1.

Scale of 4 English feet.

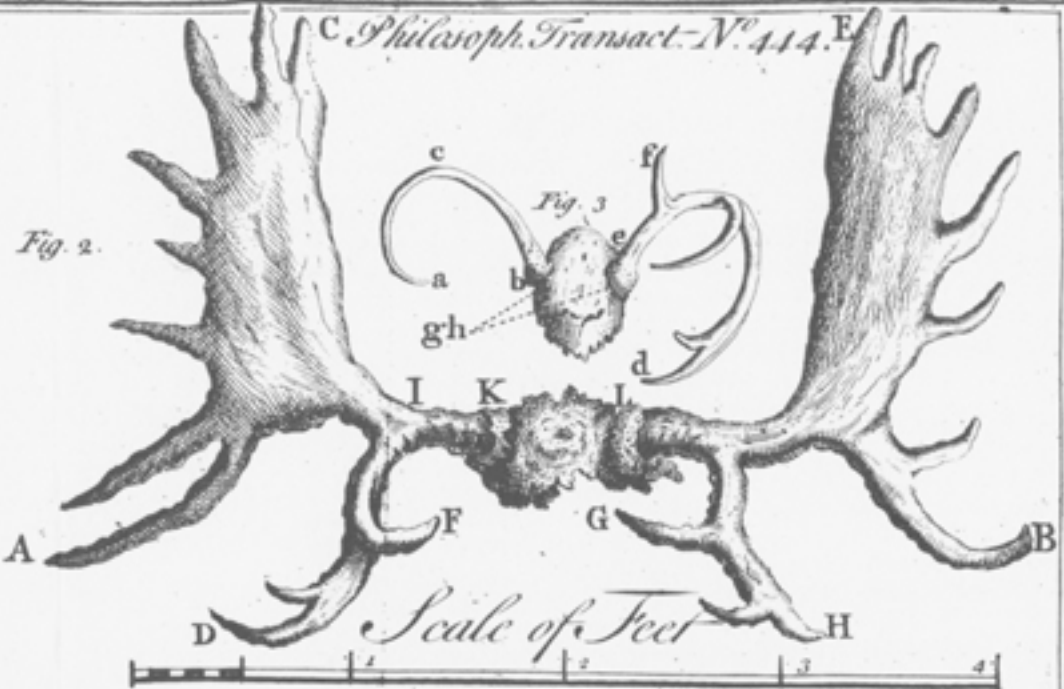
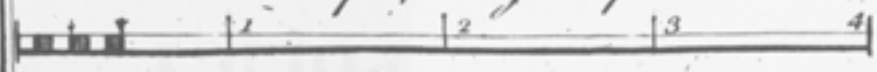


Fig. 2.

Scale of Feet

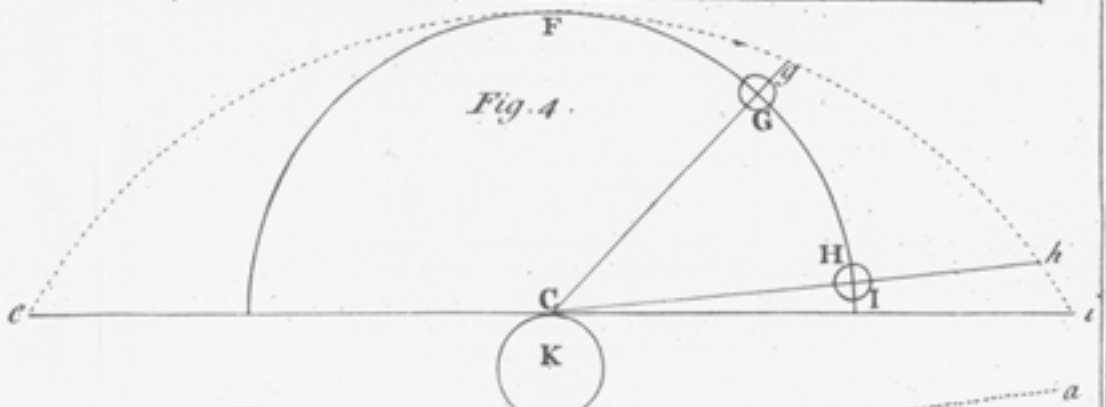


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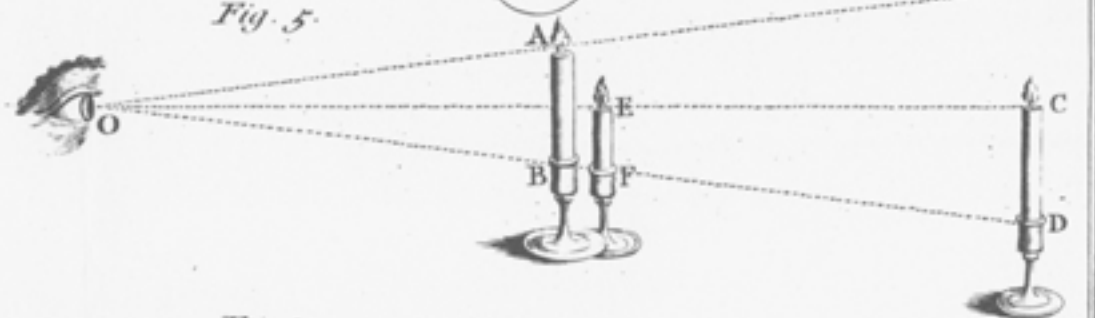


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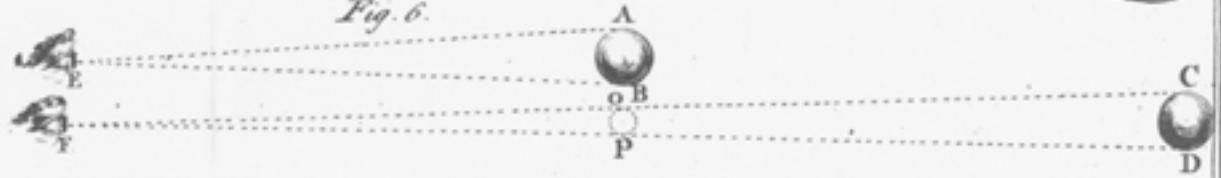


Fig. 6.