

V. *A Description of a Barometer, wherein the Scale of Variation may be increased at Pleasure. By the Reverend Mr. John Rowning, Fellow of Magdalen-College in Cambridge; Communicated by Dr. Smith F. R. S.*

**A** B C D, in *Fig. 4*, is a Cylindrical Vessel filled with a Fluid to the Height W, in which is immerged the Barometer S V, consisting of the following Parts; the Principal of which is the Glass Tube T P (represented separately at *t p*) whose upper End T is hermetically sealed: This End does not appear to the Eye, being received by the lower End of a Tin Pipe G H, which in its other End G receives a Cylindrical Rod, or Tube S T, either hollow or solid, made of any Materials whatsoever, thereby fixing it to the Tube T P. The Rod S T may be taken off, in order to put in its stead a larger or lesser, as Occasion requires. S is a Star at the Top of the Rod S T, which serves as an Index, pointing to the graduated Scale L A, which is fixed to the Cover of the Vessel A B C D. M N is a large Cylindrical Tube made of Tin (represented separately at *m n*) which receives in its Cavity the smaller Part of the Tube T P, and is well cemented to it at both Ends, that none of the Fluid can get in.

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The Tube T P, with this *Apparatus*, being filled with *Mercury*, and plunged into the Bafon V, which hangs by two or more Wires upon the lower End of the Tube M N, must be so poized as to float in the Liquor contained in the Vessel A B C D, and then it will rise when the Atmosphere becomes lighter, and *è contrà*.

Let the specifick Gravity of Quickfilver be to that of Water, or to the Liquor the Barometer floats in, as  $s$  to  $1$ : and if it be proposed that the Variations of this Compound Barometer shall be to the contemporary Variations of the common Barometer in the given Ratio of  $n$  to  $1$ , this Effect will be obtain'd by making the Diameter of the Rod S T to the Diameter of the Cavity of the Tube H I, as  $\sqrt{\frac{n+s}{n s}}$  to  $1$ , which may be thus demonstrated.

Let us suppose that the Variation of the Height of the Quickfilver in the common Barometer, called  $v$ , is such, that a Cubic Inch of Quickfilver shall rise into the Vacuum X T; in order to which a Cubic Inch of Quickfilver must rise from the Vessel V, that is, the Surface P must subside so far, that a Cubic Inch of Water (if that be the Fluid made use of) shall enter the Vessel V, by which Means the Barometer with the Parts annexed will be heavier by a Cubic Inch of the Fluid.

Now this additional Weight of a Cubic Inch of Fluid will make the whole Barometer subside (according to the Laws of Hydrostaticks) 'till a Cubick Inch of the Rod H S, immediately extant above the Surface at W, shall come under it; but the Length  
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of such a Magnitude of HS will exceed the Length of an equal Magnitude of Quickfilver in the larger Tube X, as much as the Square of the Diameter at X exceeds the Square of the Diameter at H (the Lengths of equal Cylinders being reciprocal to their Bases). That is, the perpendicular Descent of the compound Barometer will be to  $v$ , the perpendicular Ascent of the Mercury in the common Barometer, as  $d$  to 1 (supposing this the Ratio of the Bases) and consequently will be equal to  $d v$ .

But by this Descent, the Distance PW between the Surface of the stagnant Quickfilver and the Top of the Fluid will be augmented by a Column, whose Height is  $d v$ , the Descent of the Compound Barometer; and consequently the Weight of the whole Column of the Fluid pressing on the lower Surface of the Quickfilver (to which the Height X is partly owing) will be increased by a Column of that Length, and this Increase, would produce a second Ascent of the Mercury at X equal to itself, namely  $d v$ , were the Fluid as heavy as Quickfilver; but since it is supposed to be lighter in the Ratio of  $s$  to 1, the Ascent of the Mercury on this Account will only be  $\frac{d v}{s}$ .

But now, as in the former Case, when the Ascent of the Mercury was  $v$ , the Descent of the Compound Barometer was shown to be  $d v$ , so here the Ascent of the Mercury being  $\frac{d v}{s}$ , the Descent of the Compound Barometer will be  $\frac{d d v}{s}$  and the next Descent  $\frac{d d d v}{s s}$  and the next  $\frac{d^4 v}{s^3}$  and so on to Infinity

Therefore the whole Defcent of the Compound Barometer, is to the Ascend of the Mercury in the common Barometer, that is,  $n$  is to 1, as  $d + \frac{d d}{s} + \frac{d d d}{s s} + \frac{d^4}{s^3} + \text{&c.}$  to 1, or as  $\frac{d s}{s-d}$  to 1; because the Terms of the Series being in Geometrical Progreffion, the Sum of them all is  $\frac{d s}{s-d}$ . Hence we have  $n = \frac{d s}{s-d}$  and  $n s = d s + d n$ ; that is,  $1 : d :: n + s : n s :: \frac{n + s}{n s} : 1$  and  $1 : \sqrt{d}$ , that is, the Diameter of S T to the Diameter of H I, as  $\sqrt{\frac{n + s}{n s}}$  to 1. Q. E. D.

*Example I.* Putting  $s = 14$  and  $n = 1$ , the Variations in each Barometer will be equal, by taking the Diameter of S T to the Diameter of H I as  $\sqrt{\frac{15}{14}}$ : 1, that is, as 30 to 29 nearly.

*Example II.* If  $n$  be put infinite, the Diameter of S T will be to the Diameter of H I as  $\sqrt{\frac{1}{s}}$  to 1, or 1 to  $\sqrt{14}$ ; that is, as 1 to  $3\frac{1}{4}$  nearly.

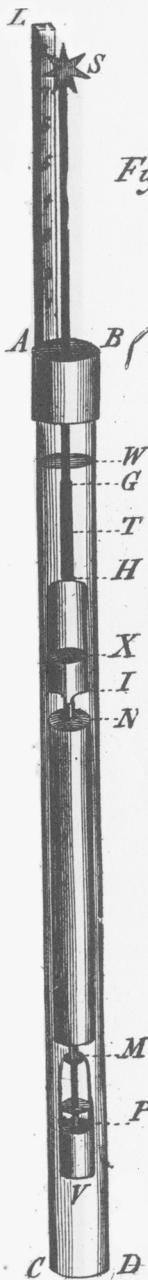
The Bottom of the Vessel V, and the Ends of the Tubes, ought to be made rather round than flat for their more easy Motion up and down in the Fluid.

It will be convenient to have a small Bafon fix'd upon the Star, to contain Shot for the more easy poising the Barometer in the Fluid.

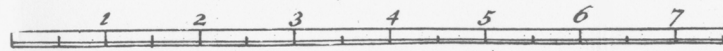
Fig. 4.

Fig. 3.

Fig. 2.



A Scale of 8 Inches



*Fig. 2.*



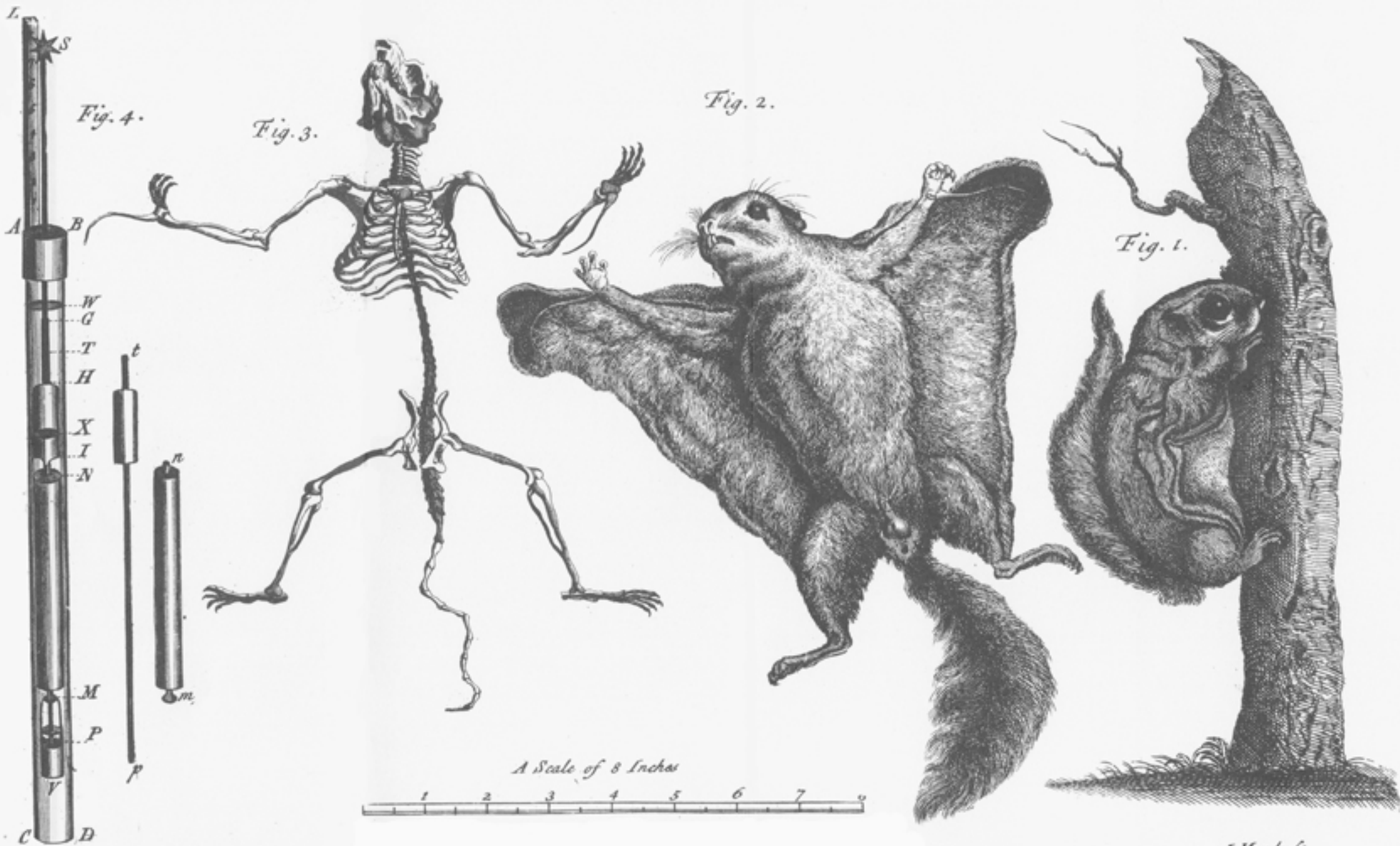
*Fig. 1.*



of 8 Inches



*I. Mynde sc.*



J. Mynde sc.