XI. On the properties of the Dædaleum, a new instrument of optical illusion

W.G. Horner Esq.

To cite this article: W.G. Horner Esq. (1834) XI. On the properties of the Dædaleum, a new instrument of optical illusion , Philosophical Magazine Series 3, 4:19, 36-41, DOI: [10.1080/14786443408648249](https://doi.org/10.1080/14786443408648249)

To link to this article: <http://dx.doi.org/10.1080/14786443408648249>

Published online: 01 Jun 2009.

Submit your article to this journal [↗](#)

Article views: 2

View related articles [↗](#)

Citing articles: 1 View citing articles [↗](#)

This angle, which can only be known by experiment, let us call α . As AE, EF is the shortest course from A to F, if the angle AKO be α , the angle ELW is $\pi - \alpha$. The same may be said of EF, FG, the shortest course from E to G, and of FG, GB, the shortest course from F to B. If AE, BG be produced to meet in C, FC is plainly a parallelogram, and the brachystochronous course from A to B is also AC, CB.

From all that precedes we may derive the following simple construction for the brachystochronous course, when the angle α is known. Let it be required to sail from A to B, (fig. 2.) in the shortest time possible, the wind blowing from B towards N. Upon AB describe a segment of a circle AZB, containing an angle equal to $\pi - 2\alpha$. Complete the circle and bisect the arc AVB in V. Draw VZ perpendicular to BN and join AZ, ZB. Then AZB is the course required; for as $AZB = \pi - 2\alpha$, each of the angles ZRB, ZBR is equal to α .

Papworth St. Everard, Dec. 13, 1833.

XI. *On the Properties of the Dædaleum, a new Instrument of Optical Illusion.* By W. G. HORNER, Esq.*

THE ingenious and amusing invention of M. Plateau, by superadding the resources of art to those of science, has rendered an instructive experiment exceedingly popular. But neither the Professor nor any of his imitators have added anything to the mathematical principles, which remain hitherto in exactly the position in which Mr. Faraday left them nearly three years ago, in the Journal of the Royal Institution. The repose of one portion of the spectrum, the residual motion apparent in the advance or retrogression of others, and the blending of variation of action with identity of subject, have been traced to their causes, both by Mr. Faraday and Dr. Roget, most satisfactorily; nor does it appear that any phænomenon observable in the relative motions of a wheel and a system of detached bars, or of a pair of perforated disks, has escaped the notice of one or other of those gentlemen. One set of phænomena, derived from a still more simple apparatus, has, however, been left unnoticed, as far as I can discover, by all; and my design in submitting the present paper to the readers of the Philosophical Magazine and Journal of Science is to familiarize both the principle and the exhibition of an experiment involving all the interesting illusions of the phantasmoscope, but capable of being performed without a

* Communicated by the Author.

mirror or any second instrument, and of being displayed to unlimited numbers at once.

The apparatus is merely a hollow cylinder, or a moderately high margin, with apertures at equal distances, and placed cylindrically round the edge of a revolving disk. Any drawings which are made on the interior surface in the intervals of the apertures will be visible through the opposite apertures, and if executed on the same principle of graduated action, will produce the same surprising play of relative motions as the common magic disk does when spun before a mirror. But as no necessity exists in this case for bringing the eye near the apparatus, but rather the contrary, and the machine when revolving has all the effect of transparency, the phenomenon may be displayed with full effect to a numerous audience. I have given this instrument the name of *Dædaleum*, as imitating the practice which the celebrated artist of antiquity was fabled to have invented, of creating figures of men and animals endued with motion. The peculiarities incident to this form of construction, some of which demand the careful attention of artists, will appear from the following investigation.

Let ABD in the annexed diagram (fig. 1.*) represent a cir-

Fig. 1.

cular section of the cylinder, C its centre, E the place of the observer's eye, A an aperture brought on the line AC. For the sake of a more general investigation, let any circle, Oo, Pp,

* It is necessary to remark here, that by a mistake of the engraver the circles in the above diagram are all of nearly equal strength, instead of the middle one ATD, representing the section of the cylinder, being the strongest, and the outer and inner ones both faint, as in Mr. Horner's drawing. —EDIT.

be described from the same centre C, and either interior or exterior to the circle ABD.

From A draw AP to any point in this second circle, and from centre C describe a circle touching AP. From E draw Eap, touching the same circle, and meeting the second circle in p. Then it is manifest that ap = AP, and that the object P, which to a spectator at A would be apparent in the situation P, can only be seen from E when it has arrived in the situation p, the aperture A having then arrived at a.

Let an indefinite line be drawn through B and C, and join pC. Put $\S = \text{PCD}$ the angular distance of P from the point D diametrically opposite A; $\phi = \text{pCD}$, the like distance of the projected point p; $\psi = \text{PAC}$, the angular distance of P from D as apparent at A. Also let $a = \text{AC}$, $d = \text{EC}$, $x = \text{CD}$, $y = \text{pq}$, coordinates; and $u = \text{PC} = \text{pC}$. Then

it will be seen that $u = \frac{a \sin \psi}{\sin (\S - \psi)}$, $x = u \cos \phi$, $y = u \sin \phi$;

likewise that $\phi = \S - \psi + \sin^{-1} \frac{a \sin \psi}{d}$. From these general premises we may deduce all the particulars we have occasion for.

(1.) Wherever the observer is placed, whether near the cylinder or remote from it, *all the objects* depicted on the inner surface of the cylinder are visible to him at one and the same time. This is a highly paradoxical phenomenon; but the explanation of it is involved in the deductions already made. For, if we assume P to be coincident with A, or make

$\S = \pi$ and $\psi = \frac{1}{2} \pi$, we have $\phi = \frac{\pi}{2} + \sin^{-1} \frac{a}{d}$, which is equi-

valent to the arc TBD, contained between the tangent ET and the diameter AD. Consequently the point T is the projected place of the point A, and TBD, the portion concave toward the eye, is the projection of the whole semicircle ABD. And so of the other semicircle AtD, which is projected on tD. But the thickness of the material will obstruct the view of a small portion adjacent to T and t.

(2.) Wherever the eye is placed, the divisions of the projected picture are sensibly equal in breadth, especially toward the central parts. For since $\sin^{-1} \frac{a \sin \psi}{d} = \frac{a \psi}{d} - \frac{a(d^2 - a^2)\psi^3}{6d^3}$

&c., if we neglect the second and following terms, which are

evidently small, we have $\phi = \S - \psi + \frac{a \psi}{d}$ exceedingly near;

where, $\mathfrak{S}$ remaining constant, ϕ will vary, differentially, as ψ varies. The greatest effect of the neglected portion occurs when $d = a\sqrt{3}$, which is therefore the worst situation for observing the phenomenon.

(3.) If the eye is brought *close* to the revolving cylinder, d becomes $= a \therefore \phi = \mathfrak{S}$, or each projected division occupies exactly the same breadth as each of the originals.

(4.) If the spectator removes to an *indefinite distance*, $\frac{a}{d}$

approaches 0 as its limit $\therefore \phi = \mathfrak{S} - \psi$ or $\pi + \mathfrak{S} - \psi$; and ϕ varies differentially as $\mathfrak{S}$. Therefore the projected divisions will be exactly equal to each other. As these last conditions are those which a lecturer will require, artists should keep them especially in view. And since in this projection all the divisions round the *outer circle* are projected upon just a *semi-circle*, all figures and objects depicted should be considerably *exaggerated in breadth*, nearly in the proportion of 2 to 1 when compared with the natural breadth.

(5.) Objects connected with the effect of those in the cylindrical border may be drawn in corresponding sectors on the disk itself. But the projections of these sectors will of course appear considerably curved if extended quite to the centre. The curves produced, however similar in appearance to those observed by Dr. Roget, are, notwithstanding, of quite a distinct class. A few of their properties it may be worth while to unfold.

(α .) If $\psi = \pm \frac{\pi}{2}$, $u = \mp \frac{a}{\cos \mathfrak{S}}$ gives the two points

where the tangents ET, Et are likewise *tangents* to the curve.

(β .) If $\psi = \mathfrak{S}$ or $\pi + \mathfrak{S}$, $u = \infty$ while $\phi = \pm \sin^{-1} \frac{a \sin \mathfrak{S}}{d}$,

indicating two *asymptotes*, which are tangents from E to the circle whose radius is $\sin \mathfrak{S}$.

(γ .) If $\phi = 0$ or π , $\therefore u = -d$, $x = -d$, and $y = 0$, indicating a *nodus* at E.

The entire curve has then four branches of the hyperbolic species, two of which have double curvature, touching given lines, and then returning to become asymptotes to lines interior to those.

When E is at an infinite distance the curves are of a more simple kind, and the family to which they belong becomes apparent. The most simple of all is when $\mathfrak{S} = \pm \pi$, giving

$x = \frac{a \sin \psi^2}{\cos \psi}$, or $a \sin \psi \tan \psi$ and $y = a \sin \psi$. Eliminating

$u = \frac{tc^2 \cos \phi}{t^2 \sin \phi^2 \pm c^2 \cos \phi^2}$. But these remarks are beyond the purpose of the present occasion. I shall conclude with observing, that the equation $u_2 = a \cot \phi$ suggests a much readier process for outlining the second cissoid than that which was indicated by its optical development.

P.S. I have not thought it requisite to give a more particular description of the instrument, having communicated every needful part of the detail, some weeks ago, to a respectable optician of Bristol, Mr. King, jun. The publication seems, however, to have met with some impediment, probably in the sketching of the figures.

XII. *Remarks on Mr. Phillips's Observations on the Use of Chemical Symbols.* By Mr. JOHN PRIDEAUX, Member of the Plymouth Institution.

To the Editors of the Philosophical Magazine and Journal.

Gentlemen,

THE observations of Mr. Phillips will, it is to be hoped, have their effect; if not that so much desired by him, yet in inducing chemists to conform as nearly as possible to the symbols already extensively known and employed. Perfection is as unattainable in a system of symbols, as in any other; and although improvement may be desirable here, as in other cases, one should be well convinced, before attempting innovations, that their effects and inconveniences will be less than those of what they are proposed to supersede.

In the case in point, however, the confusion is really not so great as it appears.

There is but one known combination of phosphorus with 5 atoms of oxygen; in which many chemists (chiefly in this country) apprehend the phosphorus to enter as a single atom, whilst others regard it as double, from its requiring 2 atoms of alkali. The first class will write the P simple; the others will bisect it: and as this difference of opinion is generally known, the 5 atoms of oxygen, whether represented by dots or initials, immediately distinguish the symbol as that of phosphoric acid.

With hydrogen, the case is different: H may signify, according to our atomistic notions, either pure or oxygenated water; and considering the great number of compounds into which water enters in definite proportions, it were to be wished that Berzelius had adhered to his original decision of

Third Series, Vol. 4. No. 19. Jan. 1834.

G