XLVIII. Notes on repulsion by heat

Rev. Baden Powell M.A. F.R.S. F.G.S.

To cite this article: Rev. Baden Powell M.A. F.R.S. F.G.S. (1838) XLVIII. Notes on repulsion by heat, Philosophical Magazine Series 3, 12:75, 317-321, DOI: [10.1080/14786443808649453](https://doi.org/10.1080/14786443808649453)

To link to this article: <http://dx.doi.org/10.1080/14786443808649453>

Published online: 01 Jun 2009.

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tion) eliminated at it. But no perceptible trace of this metal is deposited there, however long the voltaic pair may act upon the copper solution. Now we ask, by what means is the electrolyzing power of the current, which proceeds from the deoxidation of the peroxide, counterbalanced? No doubt by a second current, which as to direction is opposite, and as to strength equal to, the first current. But whence such a second stream? I do not know any source to which it can be assigned but to the union of the sulphuric or nitric acid with the protoxide of lead, though I am well aware of Mr. Faraday's high authority being against such a supposition, which does not allow this sort of chemical action to be a cause of current electricity. Nobody knows better than I do that the remarkable voltaic action of the peroxides is very far from having been sufficiently cleared up by my researches; I hope, however, that the interesting subject will be taken up by abler hands than mine; and I particularly wish that the British philosophers, who generally take so lively an interest in everything relating to electrical science, would engage themselves in investigating the matter still further.

Your most humble and obedient servant,

Bâle, Feb. 18, 1838.

C. F. SCHÖNBEIN.

XLVIII. *Notes on Repulsion by Heat, &c. By the Rev. BADEN POWELL, M.A., F.R.S., F.G.S., Savilian Professor of Geometry, Oxford.*

To the Editors of the Philosophical Magazine and Journal.

GENTLEMEN,

IN the *Philosophical Transactions** for 1834, part ii. there is inserted a paper in which I described an experiment for establishing without difficulty or ambiguity the existence of a repulsive power exerted between heated surfaces at small though sensible distances, viz. at those intervals at which the colours of thin plates are formed; the repulsive effect being indicated by the instantaneous descent of the tints in the

* See also Reports of British Association, vol. iii. (or Fourth Report) p. 549; and *Journal of Franklin Institute*, U.S., Feb. 1836. [and *L. & E. Phil. Mag.*, vol. vi. p. 58.]

I regret to observe in a synopsis of the analogies of light, heat, &c. in the *British Annual* of this year, this property of repulsion is mentioned as doubtful, without any reference to my experiments; which is the more remarkable, as an account of them was given in one of the early Numbers of the *Records of General Science*, by the same Editor.

order of the scale, and rapid contraction and final disappearance of the rings, between lenses or plates of glass. This method I showed was at once decisive and simple; the "warping" or change of figure (if any) in the glasses by heat being readily seen to be such as ought to cause the rings *to enlarge* at the first instant. It seemed to me a method easily applicable to a number of other points of inquiry connected with the subject; and to many such topics I began at that time to turn my attention.

The subject is evidently one which may have extensive bearings on a variety of points connected with the study of *molecular forces*. On these it was once my intention to have entered: but various circumstances have led me to discontinue such researches, more especially the superior attractions presented by the study of physical optics, and the observations and calculations connected with the verification of the theory of dispersion, in which I have been, and am likely to be, engaged. This subject at present engrosses all the time and attention I can devote to physical research, more especially in the present stage of its advance: it seems to call for a comprehensive review and systematic methodizing of the principles of the undulatory theory; and in attempting something towards the great work of a *systematic treatise on the MECHANISM OF LIGHT*, I am now likely to find ample employment, probably for some years to come.

Under these circumstances, in looking over and destroying a number of old papers, I thought that perhaps a few rough memoranda of trials of experiments, and hints for others, connected with the subject of *repulsion by heat*, which had been thrown aside formerly in the hope of some day resuming the subject, might possibly be not altogether unworthy of preservation, if they should only have the effect of drawing the attention of any experimenter to the subject, and inducing him to pursue it. With this object I thought the best course would be to request your insertion of the few following notes of this kind in your Journal; trusting that your readers will look upon them in no other light than as suggestions of experiments rather than as definite experimental investigations.

(1.) Most of these experiments were performed by forming the rings simply between two plates of glass and not with lenses. It is very easy in this way to obtain rings of tolerably regular form. The *warping* of the glasses by the heat has been alleged as likely to interfere with the results; but I have observed above (as indeed a very little consideration will sufficiently evince) that this cannot produce any effect. But further, according to the experiments of Sir David Brewster

on the polarized tints developed by heated glass, it appears that the heat is transmitted instantaneously through the glass, the system of colours appearing complete at once. This would show that in point of fact *no warping* at all takes place: the two opposite surfaces are simultaneously heated.

(2.) I made some trials for ascertaining the *time* required for the communication of heat through two glasses, when at different small intervals of separation, as marked by the appearance of different tints of the thin plates. A delicate mercurial thermometer was placed with its bulb resting on the upper plate exactly at the point where the central tint was formed. Heat was applied below by the flame of a spirit-lamp playing against the under side of an iron plate on which the glasses rested. The time was noted on which the thermometer rose 1° Centigrade under the different circumstances; the results were as follows:

	Tint at the commencement.	Time of rising 1° Centigr.	
		1st Set.	2nd Set.
Exp. 1.	Black.	40 sec ^s .	30 sec ^s .
2.	1st. Yellow.	45	35
3.	No colour.	60	45

(3.) To compare the transmission of heat when the glasses were kept in close contact by forcible compression by means of a wedge, &c., and when loose, the following results were observed with a thermometer touching the upper glass :

	Time of rising 1° Centig.
Glasses compressed	30 sec ^s .
Glasses loose.....	40 sec ^s .

(4.) In these cases part of the heat is employed in separating the glasses by repulsion, part communicated through them. It would form an interesting subject of inquiry to examine the law by which this is regulated. Many questions naturally arise as to the connection of such results with the communication of heat and expansion in general,—and thus with the specific heat of bodies, and their expansion in different directions, especially in crystals. Perhaps some results might be obtained by comparing the transmission of heat through crystals in the direction of cleavage and in that at right angles to it, especially those which split into laminæ, as sulphate of lime, &c.

(5.) When a large central black spot is formed, the attraction is so great that it seems impossible to overcome it by the repulsion of the heat. In one experiment a large black spot was formed, and heat being continued for 3^m 30^s, no change had taken place, when the upper glass cracked, but not so

as to disturb the colours : they continued unaltered for 30 seconds more, when the heat was withdrawn.

A thermometer placed with its bulb on the central black, rose 1° Centigr. in the first 30 seconds of this experiment.

Another experiment was continued to see how long the central black would remain. After about 4 minutes the lower glass cracked, but not so as to disturb the black ; at $5^m\ 30^s$ it disappeared, and the other colours rapidly vanished : in this case the flame was applied closer to the iron plate than in the former.

(6.) The repulsion between two plates at the small intervals here employed, may be compared with the repulsion between the molecules of the solid body which produces expansion.

In experiments of this kind we have an interval (τ) between the glasses, which is increased to ($\tau + i$) ; by a given increase of temperature we can easily compare the ratio of this increase with that of the glass itself by expansion for the same increase of temperature.

A thermometer having its bulb kept in contact with the lower glass, (the colours being formed close to the edge of a smaller glass laid upon it, and the bulb of the thermometer being close to the same point,) the increase of temperature was noted which reduced the tints from the bright of the first to that of the fourth order.

In several trials, an increase of only 2° Fahr. was sufficient to produce this effect.

$$\text{Here} \quad \tau = \frac{1}{178000} \text{ inch,}$$

and $i = 6\tau$ or τ becomes $\tau(1+6)$.

From the experiments of Lavoisier and Laplace the dilatation of plate-glass for a difference of 180° Fahr. is 1.00089 , or in this case τ_1 becomes $(1 + .00089)\tau$, consequently for a difference of 2° τ becomes $(1 + .000098)\tau$.

$$\text{The ratio in the two cases } \frac{i}{i'} = \frac{6.000000}{.000098} = \frac{61223}{1} \text{ nearly.}$$

(7.) I made some rough attempts towards ascertaining the *law* by which the repulsive effect of heat between the plates of glass may be regulated, in relation to the interval between the plates. Though these results are hardly of sufficient precision to justify any decisive inferences, yet they may be mentioned, as perhaps the experiments may be thought not unworthy of being repeated. The process consisted in observing the times of the central tint changing to another given tint, commencing from different points in the scale, with a constant heat.

The results of two sets of experiments were as follows :

Change.	Interval. Multiple of 178000 inch.	Time. Mean of two Experiments.
From maximum of 1st order to max. of 4th	6	11.5
----- 2nd		
to 4th	4	7.5
----- 3rd		
to 4th	2	3.5
From minimum of 1st order to min. of 4th	6	8.5
----- 2nd		
to 4th	4	4.75
----- 3rd		
to 4th	2	3.

In all such experiments the most troublesome part consists in having to wait in each instance until the apparatus has cooled down to the same temperature, before commencing. This and numerous other precautions are not here dwelt upon, as they will soon suggest themselves to those who may be induced to enter upon such experiments.

XLIX. *On the Nature and Properties of Teriodide of Chromium.* By Mr. HERBERT GIRAUD, F.B.S.E., Mem. Med. Soc., Edin.

To the Editors of the Philosophical Magazine and Journal.

GENTLEMEN,

ALTHOUGH the remarkable and beautiful combinations of chromium with chlorine and fluorine are well known to every chemist, yet I am not aware that any iodide of chromium has hitherto been formed; therefore a short account of one which I have recently produced may not be uninteresting.

When we consider the relative electro-chemical condition of iodine compared with that of chlorine or fluorine, we are led to conclude that if any combination can be effected between chromium and iodine, such a combination would be held together by weaker affinities than those which are exerted in the analogous compounds of chromium with chlorine or fluorine; accordingly we find that the compound we are about to describe is subject to decomposition from slight causes. The

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