X. *An Account of Rings conſiſting of all the Priſmatic Colours, made by Electrical Exploſions on the Surface of Pieces of Metal, by* Joſeph Prieſtley, *LL. D. F. R. S.*

Read March 10, 1768.

IT was a diſcovery of Sir Iſaac Newton, that the colours of bodies depend upon the thickneſs of the fine plates which compoſe their ſurfaces. He has ſhown that a change of the thickneſs occaſions a change in the colour; differently coloured rays being thereby diſpoſed to be tranſmitted through the plate, and conſequently rays of different colours being diſpoſed to be reflected at the ſame place, ſo as to preſent the appearance of different colours to the eye.

A variation in the denſity of the plate, he ſhows, will occaſion a variation in the colour; but ſtill a medium of any denſity would exhibit all the colours according to the thickneſs of the different parts of it. Theſe obſervations he confirmed by experiments on plates of air, water, and glaſs. He alſo mentions the colours which ariſe on poliſhed ſteel, by heating it; as likewiſe on bell-metal, and ſome other metalline ſubſtances, when melted and poured on the ground, where they may cool in the open air: and he aſcribes theſe colours to the *ſcoriæ*, or vitrified parts of the metal, which, he ſays, moſt metals, when heated, or melted, do continually protrude, and ſend out to their ſurface, covering them in the form of a thin glaſſy ſkin. *Optics*, pag. 194.

This capital diſcovery, concerning the colours of bodies depending upon the thickneſs of the fine plates

plates which compoſe their ſurfaces, of whatever denſity thoſe plates be (and which may be of ſuch admirable uſe to explain the colours, and perhaps, in due time, the conſtituent parts and internal ſtructure of natural bodies) I have been ſo happy as to hit upon a method of illuſtrating and confirming, by means of electrical exploſions. Theſe, being received upon the ſurfaces of all the metals, change the colour of them, to a conſiderable diſtance round the ſpot on which they are diſcharged, ſo that the whole ſpace is divided into a number of concentric circular ſpaces, each exhibiting all the priſmatic colours; and perhaps as vivid as they can be made in any method whatever.

It was not by any reaſoning *a priori*, but by a mere accident, that I firſt diſcovered theſe colours. Having occaſion to take a great number of exploſions, in order to aſcertain the lateral force of them; I obſerved that a plate of braſs, on which they were received, was not only melted, and marked with a circle, by a fuſion round the central ſpot, but likewiſe tinged, beyond this circular ſpot, with a green colour, which I could not eaſily wipe out with my finger. Struck with this new appearance, I replaced the apparatus, and continued the exploſions; till, by degrees, I perceived a circle of red beyond the fainter colours; and, examining the whole with a microſcope, I plainly diſtinguiſhed all the priſmatic colours, in the order of the rainbow. The diameter of the red, in this inſtance, happened to be one third of an inch, and the diameter of the purple about one fourth.

Pleaſed with this experiment, I afterwards purſued and diverſified it in a great variety of ways, the reſult of which I ſhall compriſe in the following obſervations.

1. When

1. When a pointed piece of metal is fixed oppoſite to a plain ſurface, the nearer it is placed to the ſurface, the ſooner do the colours appear, the cloſer do the rings ſucceed one another, and the leſs ſpace they occupy; as, on the other hand, the farther it is placed from the ſurface, the later do the colours appear; but the rings then occupy a proportionably greater ſpace, and have more room to expand themſelves. N° 1. on the ſteel *, was made by the exploſions paſſing from the point of a needle, fixed at the diſtance of $\frac{2}{25}$ of an inch from the ſteel; and N° 2. was made at the ſame time, when the needle was placed at the diſtance of $\frac{1}{25}$ of an inch. It ſeems, however, that when the point is placed at ſuch a diſtance, as that the electric matter has room to dilate, and form as large a circular ſpot as the battery will admit, the rings are as large as they are capable of being made; but that ſtill the colours appear later, in proportion to the diſtance beyond that. When the point is fixed exceeding near, or is made to touch the ſurface, the colours appear at the very firſt exploſion, but they ſpread irregularly, and make not diſtinct rings, as N° 1. upon the tin.

2. The more acutely pointed is the wire, or needle, from which the electric matter iſſues, or at which it enters, the greater number of rings appear. A blunt point makes the rings larger, but fewer; and in that circumſtance it is likewiſe much later before the colours make their appearance at a given diſtance. N° 3.

* All the coloured rings mentioned in this paper were ſhewn to the Royal Society, but could not be well repreſented by a print.

upon

upon the ſteel, was made by a blunt wire, and N° 2. upon the tin by a braſs knob fixed oppoſite to it.

3. In making theſe rings, the firſt appearance is a duſky red, about the edges of the circular ſpot; preſently after which (generally after four or five ſtrokes) there appears a *circular ſpace*, viſible only in a poſition oblique to the light, and looking like a ſhade on the metal. This ſpace expands very little during the whole courſe of the exploſions, and it ſeems to be, as it were, an attempt at the firſt and fainteſt red; for by degrees, as the other colours fill the bulk of that ſpace, the edges of this ſhade deepen into a kind of brown; as may be ſeen particularly in N° 4. upon the ſteel, where it is ſomething more than half an inch in diameter, and in N° 1. where it is near $\frac{3}{4}$ of an inch.

4. After a few more exploſions, a ſecond circular ſpace is marked out by another ſhade, beyond the firſt, generally about $\frac{1}{8}$ or $\frac{1}{10}$ of an inch in diameter, which I have never obſerved to change its appearance, after ever ſo many exploſions. This ſecond ſhade, by ſucceeding the firſt; which as I obſerved, becomes gradually of a brown, or a light red, ſeems to be an attempt at the fainter colours, which intervene between the reds.

5. All the ſtronger colours make their firſt appearance at the edges of the circular ſpot; and more exploſions make them continually expand towards the extremity of the ſpace firſt marked out, while others ſucceed in their place; till, after about thirty or forty exploſions, three diſtinct rings generally appear, as in N° 4. upon the ſteel. If the exploſions be continued farther, the circle becomes leſs beautiful, and leſs diſtinct;

tinct; the red commonly prevailing, and ſuffuſing all the other colours, as in N° 1. upon the ſteel; though I attribute the confuſion of the colours in that circle, in part, to the needle having been ſeveral times accidentally broken from the cement which ſupported it, and to its not having been replaced exactly as before.

6. The laſt formed colours are always the moſt vivid, as appears very diſtinctly in the reds of N° 1 upon the ſteel. Alſo the laſt formed rings lie cloſer to one another than the firſt.

7. Theſe rings may be bruſhed with a feather, and even wetted, or a finger may be drawn over them, without their receiving any injury; but they eaſily peel off, when ſcratched with one's nail, or any thing that is ſharp, the innermoſt rings being the moſt difficult to eraſe.

8. The firſt circles are ſometimes covered with a quantity of black duſt; part of which however may be wiped off with a feather, ſo as to ſhow the colours under it. An attempt to wipe off more, on the rough ſide of the ſteel, took off the colours along with it; but more than half yet remains, with the duſt upon it, as it was firſt formed.

9. It makes no difference whether the electric matter iſſue from the pointed body upon the plate, or from the plate upon the pointed body; the plate oppoſed to the point being marked exactly alike in both caſes. Alſo the points themſelves, from which the fire iſſues, or at which it enters, are coloured to a conſiderable diſtance, often about half an inch, but not very diſtinctly. The colours likewiſe return here, in concentric rings, as upon the plate.

10. I think

10. I think that the more circles are made at the ſame time, the more delicate will the colours be; whereas the ſurface is, as it were, torn, or corroded by more violent exploſions; which makes the colours appear rough and courſe. N° 4. is I think on this account, as well as ſome others, marked in a more delicate and beautiful manner than N° 1. or N° 5. But this roughneſs is only perceived on the ſteel. On ſilver, tin, and poliſhed braſs, the colours were always free from that roughneſs.

11. A poliſhed ſurface is not neceſſary, the colours being very manifeſt on the rough ſide of the ſteel, where it is not covered with the black duſt mentioned above.

12. Theſe coloured rings appear almoſt equally well on all the metals on which I have made them; namely, gold, ſilver, copper, braſs, iron, lead, and tin.

I have not tried any of the ſemi-metals; but I have no doubt of their anſwering as well as the proper metals.

13. When the pointed wire was made to incline to the plane on which the colours were exhibited, the circular ſpot was quite round, the center of it being in the perpendicular let fall from the point; but the colours were projected oppoſite to the point, in an oblong figure.

Upon ſhewing theſe coloured rings to Mr. Canton, I was agreeably ſurpriſed to find, that he had, likewiſe, produced all the priſmatic colours from all the metals, but by a different electrical proceſs. His method had been to extend fine wires over the ſurface of pieces of glaſs; and when the wire was exploded, he obſerved that the glaſs remained tinged

with all the colours from all the metals. They are not indeed diſpoſed in ſo regular and beautiful a manner as in the rings I produced; but they equally demonſtrate, that none of the metals diſcovers the leaſt preference to any one colour more than another. A variety of other very extraordinary appearances occurred in the courſe of Mr. Canton's experiments in melting wires.

In what manner theſe colours are formed, it may not be eaſy to conjecture. In Mr. Canton's method of producing them, the metal ſeems to be diſperſed in all directions from the place of exploſion, in the form of ſpheres, of a very great variety of ſizes, tinged with all the variety of colours, ſome of them too ſmall to be diſtinctly viſible by any magnifier. In my method, it ſhould rather ſeem that they are produced in a manner ſimilar to the production of colours on ſteel &c. by heat *i. e.* the ſurface is affected, without the parts of it being removed from their places, certain plates only, or *laminæ*, being formed, of a thickneſs proper to exhibit the reſpective colours at certain diſtances; and that the thickneſs of theſe plates is continually changing by the repetition of the exploſions.

N. B. The *battery* made uſe of in the abovementioned experiments was of *twenty one ſquare feet* of coated glaſs.

Received