

there are as many of one kind as the other. After they have acquired a certain breadth—about one-twelfth, or the one-eighth of an inch,—the central part of the cyst appears to be drawn inwards, forming a hollow; at the bottom of which, the granular material is deposited from which the suckers, hooklets, and calcareous granules are formed, as above described.

*December 20, 1855.*

The LORD WROTTESLEY, President, in the Chair.

The President stated that Robert William Sievier, Esq., who by reason of non-payment of his annual contribution ceased to be a Fellow of the Society at the late Anniversary, had applied for re-admission; and an extract of his letter to the Council was read, explaining the circumstances under which, during his absence on the continent, the omission of payment had taken place. Notice was accordingly given, that the question of Mr. Sievier's re-admission would be put to the ballot at next meeting.

The following communication was read:—

“Further Researches on the Polarity of the Diamagnetic Force.” By JOHN TYNDALL, Ph.D., F.R.S. Received November 27, 1855.

The author commences by referring to the results recorded in the Bakerian Lecture for 1855. The fact of diamagnetic polarity was there established, by permitting fixed magnets to act upon a moveable bar of bismuth, encircled by an electric current; and, from the deflections of the bar, the character of the force acting upon it was inferred. The experiments recorded in the present paper may be regarded as complementary to the above. Here diamagnetic bars, suitably excited, are permitted to act upon an astatic system of steel magnets, and from the deflections of the system, the polarity of the bodies acting upon it is inferred. An experiment of the nature here indicated was made, three years ago.

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by Professor W. Weber ; but, notwithstanding his known skill and accuracy as an experimenter, his results did not command general conviction. The author sketches the arguments that have been urged against the inferences which M. Weber has drawn from his experiments, and the conditions laid down by those who urged these arguments, for the rigorous demonstration of diamagnetic polarity. In the present paper these conditions are accepted and fulfilled.

To arrive at an exact notion of the value of M. Weber's experiments, the author thought it best to operate with an instrument similar to that used by M. Weber himself. He has to thank the latter philosopher for the plan of an apparatus more delicate than any which has been hitherto used, which plan was carried out in an efficient manner by that able mechanician, Leyser of Leipzig. The instrument consists essentially of two spirals of covered copper wire, about eighteen inches long, firmly attached to a massive slab of mahogany. The slab is attached by brass bolts to the solid masonry of the Royal Institution, so as to have the spirals in a vertical position. Above the spirals is a wooden wheel, with a grooved periphery, and below them a similar one. The wheels are united by an endless string, which communicates motion from one of them to the other. To this string the cylinders submitted to examination are attached ; and by turning the lower wheel with a suitable key, the cylinders can be caused to move up and down within the spirals. Two steel bar magnets are arranged astatically, connected by a rigid brass junction, and so suspended that the magnets are in a horizontal plane. The two magnets have the two spirals between them, and have their poles opposite the centres of the spirals. When therefore a current is sent through the spirals, it exerts no more action upon the magnets than the central, or neutral point of a magnet would do. If the bars within the spirals be perfectly central, they also will present these neutral points to the suspended magnets, and hence exert no action upon them. But if the key be so turned that the two ends of the diamagnetic bars shall act upon the magnets, then, if these bars be polar, the intensity and character of their polarity will be indicated by the deflections of the magnets. Here, then, we have not only the action of the earth neutralized, but a turning force is brought to

bear upon the suspended system four times that which would come into play if only a single spiral and a single pole were made use of. The mode of observation is the same as that applied by Gauss to his magnetometer. The instrument is enclosed on all sides from external air-currents; the magnets have a mirror attached to them which moves as they move, and which is observed by means of a telescope and scale placed at a distance of about ten feet from the instrument.

When cylinders of bismuth are submitted to experiment, a very marked deflection is produced, indicating, on the part of the bismuth, a polarity opposed to that of iron. This is the only substance which has hitherto been examined; and against M. Weber's results, obtained with this metal, it has been urged that the deflection observed by him was due to induced currents, aroused in the bismuth by its mechanical motion up and down within the spiral. With regard to this objection, as bearing upon the author's experiments, he remarks, first, that the deflection produced is *permanent*, which could not be the case if the effect were due to induced currents, which vanish instantaneously. Secondly, if the effect were due to induction, it would be shown in the most exalted degree by the best conductors. Now antimony is less diamagnetic than bismuth, but it is a better conductor. The deflection produced by it, however, shows that it is its *diamagnetic* quality, and not its *conductive* quality, which is effective; the deflection is less than that of bismuth. Copper is fifty times a better conductor than bismuth, but its diamagnetic capacity is nearly nil; it produces no sensible action upon the magnets, which could not possibly be the case were the result due to induction.

Again, a quantity of bismuth was powdered, and the powder suffered to become so tarnished that it was unable to conduct voltaic electricity. Tubes filled with this powder produced effects almost as striking as those produced by the massive cylinders of bismuth.

But the experiments have been extended to a great number of insulators, with the same result. Heavy-glass, sulphur, calcareous spar, statuary marble, nitre, phosphorus, wax, and other insulators, have been examined, and proved polar. Both paramagnetic and diamagnetic liquids have also been embraced in the examina-

tion, and the polarity of both established. Thus every objection that has been raised against the polarity of the diamagnetic force has been removed, and an amount of evidence accumulated in its favour, which places it amongst the most firmly established truths of science.

The Society then adjourned over the Christmas recess, to the 10th of January, 1856.