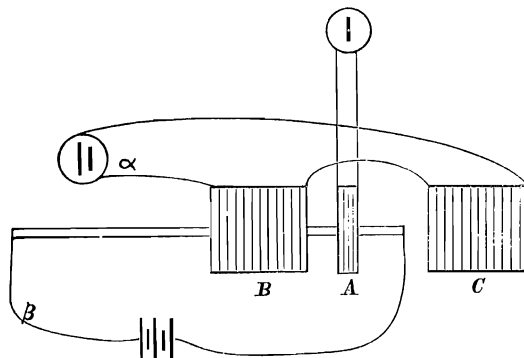


ART. III.—*Brief Contributions from the Physical Laboratory of Harvard College.* No. IX.—*On a Molecular Change produced by the passage of Electrical Currents through Iron and Steel bars;* by JOHN TROWBRIDGE.

IN the following experiments the magnetism induced in soft iron and in steel bars is employed to show the molecular change produced by the instantaneous passage of electrical currents in an axial direction. The apparatus employed was the following: Two coils, B and C, of thick copper wire 12 cm. long, 9 cm. in diameter, were connected with the poles of a Daniell's cell. The soft iron or steel bars, 2 meters in length, 12 mm. in diameter, were introduced as cores into one of the coils, B. A coil, A, of fine copper wire was slipped upon the core to a distance of 25 cm. from the face of the magnetizing helix B. This coil of fine wire was connected with a Thomson's reflecting galvanometer. The second magnetizing helix of coarse wire, C, was so arranged that its action neutralized the inducing effect of the

electric current circulating through the helix B. When the circuit, therefore, was made through B and C, an induced current passed through the helix A and the galvanometer, which was due to the magnetism of the core at the distance of 25 cm. from the face of the helix B. The iron core was then made a



portion of an independent electrical current. Thus it was possible to magnetize the iron core by the helix B, and to send a current through it in the axial direction by the independent circuit. We shall call the magnetizing circuit circuit α , and the axial circuit circuit β .

The circuit α was first made and the deflection of the galvanometer noted; it was then broken. The following table shows the results obtained: δ , represents the deflection produced by the magnetism of the bar, δ' , after the circuit β was made, δ'' , after the breaking of the circuit β . Two Grove cells were used upon the circuit β .

TABLE I.

δ	δ'	δ''
110	150	155
110	145	150
110	150	155
110	150	155

This table shows that the instantaneous passage of the axial current through the iron bar gave rise to an increase in its magnetism. This phenomenon was apparent both at making and breaking the axial circuit. The increase of magnetism was greater on the breaking of the circuit β than on the making. This increase of magnetism disappeared on the second making of the magnetizing circuit α .

The magnetism of the core was then reversed, and the same effects were noted. An instantaneous passage of the axial current β was sufficient to produce the increase of magnetism. The following table shows the effects produced by allowing

the axial current β to be made permanently. D and D' represent the deflections produced by repeatedly breaking the magnetizing circuit α .

TABLE II.

δ	δ'	D.	D'.
90	120	90	90
90	120	90	90
90	120	90	90
90	120	90	90

It will be seen that the same effects were produced as on instantaneously making and breaking; there was no increase or diminution noticeable. Table III shows the effect of rapidly reversing the current β through the iron bar.

TABLE III.

δ	Current in one direction.	Current in two directions.
120	190	240
120	180	230
120	190	240
120	190	240

In all cases the rapid reversal of the current through the iron bar produced a momentary increase of magnetism, which disappeared on the magnetization of the core by the circuit α .

Experiments were then made upon the permanence of the effect of the instantaneous passage of an electrical current through an iron bar. Observations were taken at periods of three hours after the passage of the current through the iron. The results are embodied in Table IV.

TABLE IV.

δ	δ'	D.
160	190	160
150	180	150
137	167	137

Allowance having been made for variations in the batteries used, it was found that the iron bar maintained the molecular state imparted to it by the axial current during the period of observation, viz: three hours.

Table V. shows the effect upon a steel bar of the same dimensions as the soft iron bar previously used. The conditions of the experiments were the same.

TABLE V.

δ	δ'	D.
160	180	160
160	185	160
160	180	160
160	184	160

The increased effect is less marked in steel than in iron. The following table shows the effect of rapid reversals of the current.

TABLE VI.

δ	δ'	D.
160	180	190
160	180	190
160	185	189
160	180	190

It will be seen that the effects in this case are much less than in the case of soft iron. The current was passed through different portions of the iron bar outside of the portion covered by the helix A, which was connected with the galvanometer, but no effect was produced. The effect of heating the iron bar by the passage of the axial current β was infinitesimal on account of the large size of the bar and the instantaneous duration of the current.

The conclusions from the foregoing experiments appear to be as follows :

1. The passage of an electric current through an iron or steel bar produces a molecular change in it, which is apparent both at the closing and breaking of the circuit.
2. The rapid change of direction of a current through iron or steel bars produces a molecular disturbance which is greater than that imparted by a current sent in one direction alone.
3. Magnetization of the iron or steel bar is sufficient to restore it to the normal magnetic state which is imparted by the magnetizing helix.
4. The molecular action increases with the strength of the electric current.