fundamental law, that *the magnetical effect of the electrical current* has a circular *motion round the current.*

Soon after this important discovery was made, M. Am­pere established a second fundamental law of electro-mag­netism, that the two conducting wires from the poles of the battery, when conveniently suspended, *attract each other when they transmit electrical currents moving in the same direction, and repel each other when the currents which they transmit have opposite directions.*

On the 25th September 1820, M. Arago communicated to the French Institute the important discovery, that the electrical current possesses, in a very high degree, the power of developing magnetism in iron and steel. Sir H. Davy communicated a similar fact to Dr Wollaston on the 12th November 1820, and Dr Seebeck laid before the Royal Academy of Berlin a series of experiments on the same subject. Μ. Savary of Paris has more recently found that steel needles, placed at different but small distances from a wire conveying an electrical discharge, are not all magnetised in the same direction.

The most important addition to voltaic electricity, since the discovery of Oersted, is that of Dr Seebeck, who found that electro-magnetic currents can be produced by heat alone, a subject which will be treated in a separate chapter on *Thermo-electricity.*

When we join the two poles of a galvanic battery by a metallic wire, this wire is called the *conductor,* or the *unit­ing wire,* and the galvanic circle is said to be *closed* when this wire is single and unbroken, or when it consists of two wires in contact. When these two wires are not in con­tact, the circuit is said to be *open,* in which case the wires have no action upon magnetic needles.

Let A B, fig. 50, be the conducting wire of a closed galvanic circuit, along which electri­city is carried from A to B, A being the *positive* end, and B the *negative* end: then, if a delicate magnetic needle is suspended near A B. its di­rection is changed in the following manner :

1. When the needle is *above* the wire. Its north pole will *go* from the observer as at *d,* in the upper part of the ellipse, *c d e f,* fig. 50.

2. When the needle is *below* the wire. Its north pole will approach the observer, as at *f* in the lower part of the ellipse.

3. When the needle is in the same horizontal plane as the wire, and stands between the observer and the wire. Its north pole is *elevated,* as at *c.*

4. When the needle is in the same plane, but on the other side of the conductor. Its north end is *depressed,* as at *e.*

Hence. It appears, that the direction of the magnetic current is *c d e f,* when the electrical current is in the direction A B.

If the uniting wire is bent into parallel directions, as in fig. 51. the two exterior surfaces of the branches AC, BD, will exercise similar actions on a needle NS, and so will the two interior surfaces, the actions at *e* and *f* being similar, and also those at *g* and *h.*

From these experiments, Professor Oersted concluded, *that the magnetical action of the electric current describes circles* round the conductor, and hence he gave the name of r*evolving magnetism* to this magnetical action.

This action of *revolving magnetism* was at first opposed by Professor Schweigger, on the ground that if it were true, a magnet might be made to revolve round the uniting wire. Dr Wollaston drew the same conclusion, but for the purpose of producing such a revolution. Be­fore he had effected his purpose, however, Dr Faraday went a step farther, and found experimentally not only *that a magnet could be made to revolve round the uniting wire, but that a moveable uniting wire might be made to revolve round a magnet.* An apparatus for exhibiting these remarkable properties is shewn in fig. 52. A wire *a,* from the voltaic bat­tery, passes into the glass vessel M, through a hole in its bottom, so as to com­municate with mercury contained in the vessel. The lower end of a small magnet *b,* of the form of a cylinder, is fixed by a thread to the bottom of the vessel, so that it floats al­most vertically in the mercury. A wire *Ced,* communicating with the other end of the battery, by means of the brass pillar C, dips with its lower end *d* into the mercury in M ; and as soon as the voltaic current is established in the direction of the arrows, or *a d e* C*,* the pole *b* of the magnet will revolve round the fixed conductor *deC.*

The revolution of the conductor round a magnet is ex­hibited in the same figure, where N is a glass vessel con­taining mercury, and having a small cylindrical magnet F fixed to its bottom, and projecting a little above the sur­face of the mercury. The wire *d,* being attacl>ed by a hook to the horizontal arm C, will commence its revolutions round, as soon as the voltaic current passes in the direction of the arrows, or *x* F, *d C.* If we make the current pass in the direction *a d e* C F *x*, from the zinc to the platinum end of the battery, both the above revolutions will go on simul­taneously. When the current was made to pass in the opposite direction, the direction of the rotation was like­wise changed.

The rotation of a magnet round its own axis was first effected by M. Ampere. The magnet was made to float vertically in mercury, by a platina weight at its lower end. When the electrical current descended through the upper half which stood above the mercury. It was carried off by the mercury without entering the other halt of the magnet. Had a positive current entered the other half, after passing through the first half. It would have tend­ed to make the upper pole revolve from left to right, and the under pole fιom right to left, and these contrary forces would have balanced each other; but when it is prevented from entering the lower half, the positive current pro­duces a rotation in the magnet from left to right. Mr Watkins@@1 has con­structed the apparatus in fig. 53, for shewing this experiment in a' better way. A flat bar magnet M is supported ver­tically by the bent wire WSW, fixed to the stand AB. The lower end of the magnet, which is pointed, rests in an atrate cup C, while its upper end is a pivot, turning in a hole in the screw S. At the centre and lower end of the mag­net are circular grooves containing mer-

@@@1 Popular Sketch of Electro-Magnetism.