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EXPERIENCES relating to the magnetization of iron and steel by the action of the voltaic current.

ÎJA. The brilliant discovery that M. OErsted has just made consists, as we have seen, in the action which the voltaic current exerts on a steel needle previously magnetized. By repeating the experiments of the Danish physicist, I recognized that this same current strongly develops the magnetic virtue in blades of iron or steel which, at first, were completely deprived of it.

I will relate the experiments which establish this result, in the order, very nearly, where they were made.

Having adapted a fairly fine cylindrical copper wire \* one of the poles of the voltaic pile, I noticed that the instant this wire was in communication with the opposite pole, it attracted the soft iron filings, as would have made him a real magnet.

The wire, immersed in the filings, also took care of it all around, and acquired, by this addition, a diameter almost equal to that of an ordinary feather pipe.

As soon as the connecting wire cease to be in communication with the two poles of the battery at a time, the l1 ' mesh falling off the thread and fell.

These effects did not depend on a previous magnetization of the filings, since soft steel wires 011 of steel attracted no plot.

They would be explained just as little, by attributing them to ordinary electric actions; because, repeating the experience with copper and brass filings, 011 with sawdust, we find that they are committed in any case, a sensible way to 61 Connective.

This attraction, which the connective wire exerts on the Ii mesh iron decreases very rapidly with qlle the action of the battery weakens. Perhaps will be found, 110 day, in the weight of the quantity of iron filings soulev by a given thread length, measure of the energy of this instrument, the different periods of m experience.

The action of the connective wire on the iron is exercised say " tance: it is easy to see, in fact, that the filings

lifts up well before the wire comes into contact with it.

I have hitherto spoken only of a connecting wire of brass; but silver, platinum, etc. give similar results. However, it remains to be studied whether, in terms of shape, mass or diameter, wires of different metals act with exactly the same intensity.

The connective wire communicates to the soft iron only a momentary magnetization; if we use small pieces of steel, we sometimes give them a permanent magnetization. I even managed to completely magnetize a sewing needle.

M. Ampère, to whom I was showing these experiences, had just made the important discovery that two rectilinear and parallel wires, through which two electric currents pass, attract each other when the currents move in the same direction, and repel each other when they are headed in opposite senses; he had moreover drawn from there, by analogy, this consequence that the attractive and repulsive properties of aimans depend on electric currents which circulate around the molecules of iron and steel, in a direction perpendicular to the line which joins the two poles . Mr. Ampère also supposed that on a horizontal needle directed to the north, the current in the upper part moved from west to east. These theoretical views immediately suggested to him the thought that we would obtain a stronger magnetization by substituting for the straight connective wire which I had used, a wire folded in a helix in the center of which the steel needle would be placed; he also hoped that this would give a constant position of the poles, which would not happen

in my method. Here is how we, Mr. Ampère and I, put these conjectures to the test of experience.

A copper wire rolled in a helix was finished p3 \* two rectilinear portions which could adapt, as desired, to the opposite poles of a strong horizontal voltaic pile; a steel needle wrapped in paper was inserted into the propeller, but only after III communication between the two poles had been established, so that the expected effect could not be attributed to the electric discharge, which manifest at the instant ulea ' where the connective thread ends at the two poles. During the experiment, the portion of this wire in which the steel needle was enclosed, remained constantly perpendicular to the magnetic meridian, so that there was nothing to fear from it.

Now, after a few minutes of stay in the propeller, the steel needle had received a fairly strong dose of magnetism; the position of the north and south poles was also perfectly consistent with the result that Mr. AJ11 " father had deduced, in advance, from the direction of the propeller elements, and from the hypothesis that the electric current flows the connective wire going from the zilo end of the pile to the copper end.

It seems proven, from these experiments, 1UE if a steel wire is magnetized by a galvanic current which runs longitudinally, the position of pole5 is not only determined by management DTJ current; and that light, almost inappro- priate circumstances, such as, for example, a weak beginning of magnetization; a. slight irregularity in the

shape or texture of the yarn can completely change the results; while if the galvanic current circulates around the steel, along the turns of a propeller, we can always predict, in advance, where the north and south poles will be placed. ;, ¡ , Ii , - ,; However, reflecting on the singular discrepancies that the; magnetization experiments by electric charges, presented to the physicists who took care of this research, it seemed to me iterated.

to submit to more decisive tests the ^ (53.

nomenes of helical currents. The reader will judge if we have reached this goal. • " ; , ',' I first imagined forming with a wire dtféi.Ífvté ;; of d: symmetrical helices (1), each of five centimeters eftviron , and separated by a rectilinear part dtY same wire; turns of one of the propellers turned in one direction;

(1) These symmetrical helices are similar to those that botanists have designated by the words dextrorsum for one, and sinistrorsum for the other. Their diameters are equal; 1RS turns which compose them have similar inclinations; but they can never be superimposed, however presented one to the other: so that any reversal does not make them change species. The dextrorsum (turned) helix is ​​that which nature offers us in a large number of plants 'g /' i! Ripiilltes-; it is also almost the only one that we enipjoiie dao ^^ èfe.aPtsv ^ ! ;

The steel cylinder enclosed in a © -mixer? Mbxtmr $ ​​um acquires an austral pole (the one that heads north on the negative side, or copper, of the conductor wire; while this same pole will form the positive side, m. zinc, the ooij uses the sinistrorsum propeller. These results are in accordance with the theory of M. Ampère .. , ", 18 ,,, ' ,, \_.

those of the other in the opposite direction, may be with similar inclinations; the diameters were equal. A steel wire enclosed in a small glass tube was deposited in the first propeller; I then placed a wire perfectly similar to the previous one, and also guaranteed from any electrical discharge by one. glassy envelope, in the neighboring propeller; a small piece of copper wire established constant communication between the latter propeller and the positive pole of the pile; from then on, to start the experiment, it was enough to attach to the negative pole the wire which started from the end of the second propeller: now, at the moment when this communication took place, the electricity accumulated at the pole positive of the instrument flowed through the right part of the connective wire, reached the first helix, gradually followed all its turns, arrived at the second propeller by the straight wire which separated it from the previous one, and after having traversed it, returned it to the negative pole. The two steel wires were therefore both subjected, during the experiment, to the action of a galvanic current of the same force; this current, in mass, moved in one direction; but if it circulated from left to right around the first wire, this same movement was executed from right to left around the second. Now, in all the experiments of this kind which we have made at M. Ampère with a fairly strong battery which he possesses, it was enough of this simple change in the direction according to which the current circulated around the steel wires, for give rise to a complete reversal of the poles:

In another test, I bent the copper wire in a helix, from right to left, over a length of 5 centimeters

then from left to right, over an equal length; then finally, a second time, from right to left: these three helices were separated by rectilinear portions of the same wire.

A single steel wire, sufficiently long, more than a millimeter in diameter, and wrapped in a glass tube, was placed in the three propellers at the same time. The galvanic current, traversing the turns of these various propellers, magnetized the corresponding portions of steel wire, as if they had been separated from each other.

I noticed, in fact, that at one end was a north pole; 5 cm apart, a pole-south; further on, a second pole south followed by a pole north; finally, a third north pole, and 5 centimeters from there or at the other end of the needle, a south pole. We could therefore, by this method, multiply at will these intermediate poles that physicists have designated by the name of consequent points.

I must point out, however, that in general, in these experiments, the influence of the helices is exerted not only on the portions of the steel wire which they contain, but also on the neighboring parts; so, for example, that if the interval between the consecutive propellers is small, the portions of the steel wire, corresponding to these intervals, will themselves be magnetized, as if the rotational movement prints on the magnetic fluid, followed M. Ampère's idea, by the influence of a propeller; continued beyond the last turns.

Having sought to discover, while we were printing the previous sheet, what were the circumstances which varied the position of the poles when steel wires were traversed longitudinally by a galvanic current, I invariably found, even with a very -active, that if the connective wire is perfectly straight, a steel wire placed on it receives no magnetism. The sewing needle which I used in my first experiments had, it is true, acquired poles; but then the effects dependent on the shape of the connective wire were not known, and to hold the needle more easily, I had wound the wire a little around its ends.

We see that I have constantly endeavored, in the preceding experiments, to avoid that any discharge should pass from the connective wire to the steel rod on which I operated.

There is therefore an essential distinction to be drawn between this mode of magnetization and that which has been the subject of research by Wilke, Franklin, Dalibard, Beccaria, Van-Swinden and Van-Marum; because, in this last mode, the magnetization was produced by the passage of a strong electric spark through the steel bar. It could be curious, however, to find out whether the spark provided by the battery would not behave like that which escapes from an ordinary machine: now, I learn from M. Boisgiraud, physics coach at the military school of Saint-Cyr, that he had this experience with success. He suspects that by doing so, the

magnetic force only becomes somewhat sensitive as long as the two portions of wire intended to make the needle communicate with the copper and zinc poles, are themselves of steel, and form it like two kinds of armor. M. Boisgiraud promises, on this subject, new experiences which we will hasten to share with the readers of the Annals.

The connective wire of copper is endowed, as we have seen, with a very intense magnetic virtue, as long as it communicates with the two poles of the pile. It happened to me more than once to find him still traces of this property, a few moments after the communication between the two poles had been completely interrupted; but this phenomenon is very fleeting, and I have not been able to reproduce it at will. M. Boisgiraud was not happier than me, although in one case the platinum wire which he used would have retained enough strength, after having been completely isolated from the pile, to support a small sewing needle.

The experiences of Mr. OErsted seem to me to be able to be repeated in a circumstance which would further add to the interest which they must inspire, by making us take one more step towards the explanation of the phenomenon, hitherto so incomprehensible, of the aurora boreal es. At the Royal Institution in London, there is a voltaic pile made up of 2000 double four-inch square plates. Using this powerful device, Sir Humphry Davy recognized that there is an electric shock between two suitable coal tips

at the ends of the positive and negative conductors, even though these points are still distant from each other by -rj or an inch. The first effect of the discharge is to blush the coals: however, as soon as the incandescence is established, the tips can be gradually moved up to four inches, without the intermediate light breaking. This light is extremely bright, and wider in its middle than at its ends: it has the shape of an arc.

The experience succeeds all the better as the air becomes more scarce. Under a quarter inch pressure, the discharge from one coal to another began at the distance of half a pumice; then, gradually moving the coals away, Sir Humphry Davy obtained a continuous purple flame, which was up to seven inches in length.

It is doubtless very natural to suppose that such an electric current will act on the magnetic needle as if it were moving along a metallic connective wire; nevertheless the experience seems to me to be recommended. to physicists who have voltaic batteries of great strength at their disposal, especially because of the views which it can give rise to in relation to the northern lights. Besides, would it not be, independently of any immediate application, a phenomenon worthy of note that the production in vacuum or in very-rarefied air, of a flame which, acting on the magnetic needle, would in turn be attracted or repelled by the poles of a magnet?