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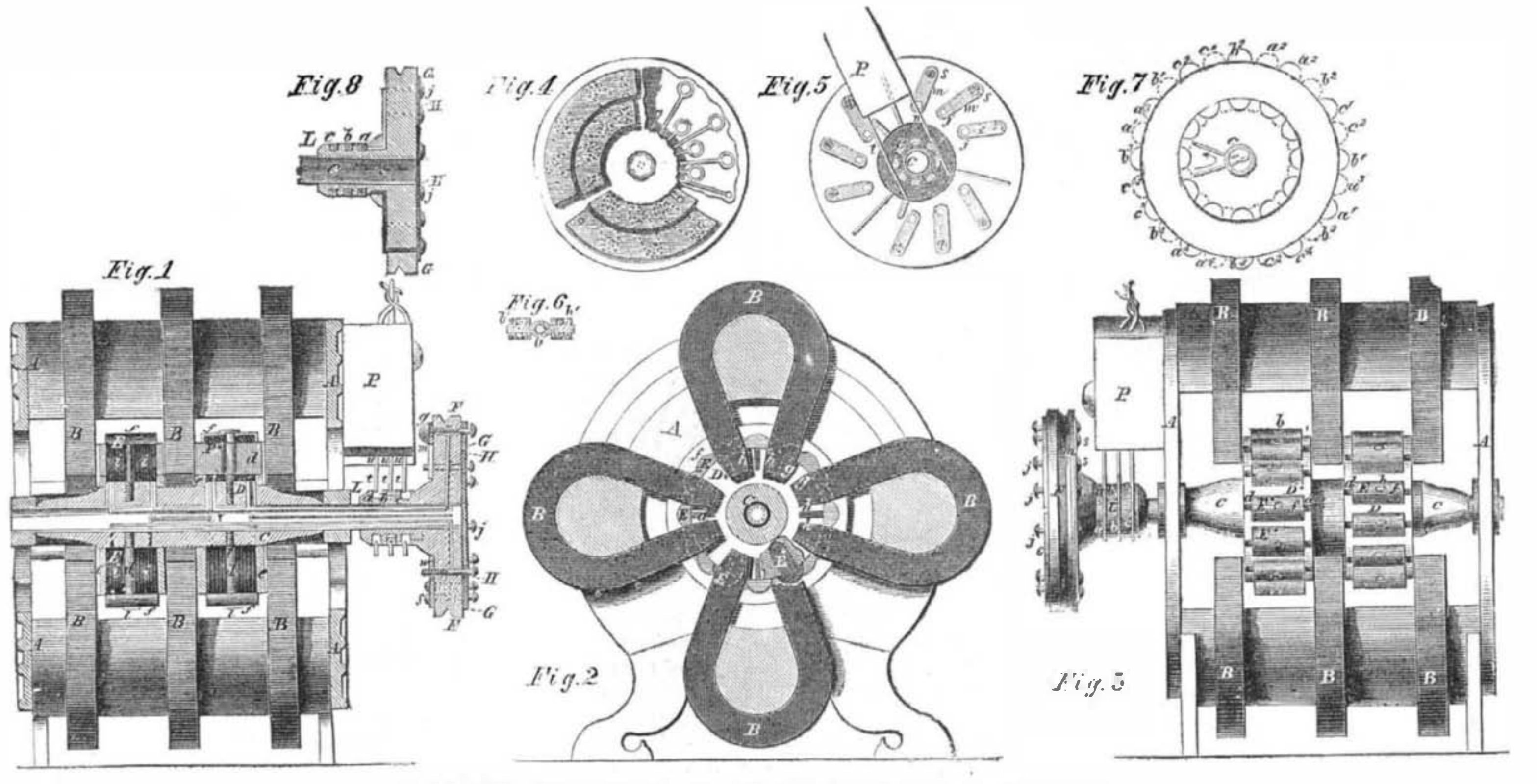
MAGNETO-ELECTRIC APPARATUS.

If a metallic wire, insulated by being covered with silk or other non-conductor of electricity, is wound spirally around a soft iron bar, and the bar is made magnetic by placing the pole of a steel magnet against its end, a wave of electricity flows through the surrounding wire for an instant, but immediately ceases. If, now, the steel magnet is drawn away from the end of the soft iron core, another wave of electricity flashes through the helical wire in the opposite direction to the former. Electricity thus induced by magnetism is called magneto-electricity, and as its production requires no acids or other liquids, it is a convenient way of obtaining a current, and has been extensively used in the cure of diseases. In Way's electrical light, which has attracted so much attention in England, magneto-electricity is employed; the machine being driven by a 2-horse power steam engine. Two forms of magneto-electrical machines are employed; in one, permanent magnets being placed on a wheel and carried by its revolutions past the ends of stationary cores of helical wires; and in the other, helical wires being placed on the revolving wheel and carried past the poles of stationary magnets. The improvements which we here illustrate are applicable to either form of magneto-electrical machine, but the drawings represent them as applied to a machine in which the helices revolve and the magnets are stationary.



BAKER'S IMPROVED MAGNETO-ELECTRIC APPARATUS.

A A, Figs. 1, 2 and 3, are two standards of iron or other material which constitute the framing of the machine, having secured between them the stationary permanent magnets, B B, of which there are twelve arranged in three circles, four in each circle, at equal distances from each other, those of either circle being directly opposite those of the other two circles.

C is the main shaft, working in bearings in the standards, A A, in the center of the circular series of magnets, and having secured in it two wheels, D D*, in each of which there are twelve helices, E E or E* E*, arranged at equal distances apart, making the proportion of helices in each wheel (twelve) to the number of poles (eight) in each circular series of magnets as three to one. The spiral arrangement of these helices in the two wheels with reference to each other is illustrated in Figs. 2 and 3, in both of which figures it is shown that the helices, E E, of the one wheel are opposite to the middle of the spaces between the helices, E* E*, of the other wheel, and *vice versa*. The core, *d*, of each of these helices is composed, as shown in Figs. 2, 3 and 6, but most clearly in the last-mentioned figure, of two pieces of thin, flat, soft iron, swaged in the center to form a cavity for the reception of a screw bolt, *l*, by which the helix is attached to the wheel. The core, thus formed, has the covered copper wire, *i*, wound round it in such a manner as to leave the central cavity clear for the insertion of the screw bolt, *l*, and to leave a portion of the core at each end naked, to be inserted in radial grooves formed in two circular face plates, *e e*, which are secured to the sides of each wheel.

The manner in which the ends of the poles of the magnets are tapered to make their edges parallel with the edges of the cores of the helices as the latter pass them in their revolution, is shown at *g h*, in Fig. 2. In the construction of the magnets care should also be taken that the width of the spaces between the tapered ends or poles of each magnet, and the width of the spaces between the several magnets in the same circular series, should be equal to half the width of the tapered ends or poles, as shown in Fig. 2.

By proportioning the number of helices in each wheel to the number of poles of the magnets in each series, and constructing the magnets and helices as described, only one-third of the helices in each wheel or circular series are acted upon in the same degree at the time; but the strongest electric impulses from one-third of the helices fill the conducting wire at the same instant that the impulses are weakest from another third, and at rest in the remaining third of that wheel or series; and, as by the spiral arrangement of the helices of the two wheels, the helices of the one and those of the other are brought alternately within the magnetic influences, the electric impulses therefrom alternate in a corresponding manner. Thus this arrangement produces a very constant current.

The intensity regulator consists of a wheel, F, of non-conducting material, which is secured to and rotates with the shaft, and which may be made to constitute the driving pulley. Upon the outer face of this wheel there are secured three pairs of arc-formed plates, G H, of good conducting metal. Only two pairs of these plates are represented in the face view in Fig. 4, as part of said wheel is supposed to be broken away to expose the internal arrangement of wires, but the plates constituting the pair which has been omitted are arranged, one within the other, in the same manner as the pairs represented. The three outer arcs, G, have connected with them one set of the terminal wires (that is to say, all those constituting the positive poles or all those constituting the negative poles) of the helices and the three inner arcs, H, have connected with them the other set of the terminal wires, the said wires all passing through the shaft, C. To avoid an inconvenient multiplicity of connections, the terminal wires of each two corresponding helices in the two wheels are connected in pairs before they are lead through the hollow shaft of the regulator, as shown in Fig. 1, thus requiring in the machine represented only 24 connections with the plates, G H, instead of 48, as would be necessary if each plate were connected independently. By the two corresponding helices of the two wheels is meant the two which, by reason of their arrangement and the arrangement of the magnets, have their currents elicited simultaneously in the same direction. The helices of each wheel are divided into as many series of threes as there are magnets in each circle, making four series in each wheel in the machine represented. This division is illustrated by the diagram, Fig. 7, which represents the helices of the two wheels, one in full the other in dotted lines, those of one series being marked $a'\ b'\ c'$, those of the second, $a2\ b2\ c2$, those of the third, $a3\ b3\ c3$, and those of the fourth, $a4\ b4\ c4$. The helix, a', of one wheel corresponds with a' of the other wheel, and the corresponding helices are, in all instances, marked with the same letter on the two wheels. This diagram shows the connection between the two, $a'\ a'$. The terminal wires of all the helices marked with the letter, a, lead to one pair of plates, G H, and the wires of all those marked with the letter, b, to another pair of plates, G H, and the wires of all those marked with the letters, c, to the third pair of plates. The terminal wire constituting the positive pole of one pair of helices, and that constituting the negative pole of another pair of helices, are connected directly with the two plates, G H, by soldering, as shown at $a'\ a4$ and $b'\ b4$, in Fig. 4, but the wires of the other helices are connected to the said plates by metal screws, $j\ j$, which pass through the wheel, F, and fit metal nuts or rings, K K, which are soldered to the ends of the wires and enclosed within the wheel, the said screws all having heads at their outer ends. The plates, G H, have holes large enough to allow these screws to pass through them without contact. On the inside face of the wheel there are secured metal coupling straps, $m\ m$, to connect the opposite screws in the positive and negative arcs, and thereby to connect, when desired, the helices to which these screws are joined. These coupling straps are so situated as to be each within the reach of two screws of opposite polarity. The screws which pass through the inner plates, H H, screw through the coupling straps, and are always in contact with them, but those which screw through the plates, G G, have the holes provided for them in the coupling straps large enough for them to pass through without touching the straps; but the latter screws have metal nuts or collars, S S, at their rear ends, as shown at the top of the wheel, F, in Fig. 1, which may be brought into contact with the straps by screwing them out to bring their heads clear of the plates, G G. The plates, G and H, are connected with the pole changer each by a single wire, r, running through and down the back of the wheel, F, as shown in Fig. 5, and also in the separate section of the pole changer shown in Fig. 8.

The operation of the intensity regulator is as follows: When it is desired to produce a current of low intensity, the screws, $j\ j$, are all screwed into the wheel, F, to bring their heads into contact with the plates, G H, and thus all terminal wires from the helices are brought into direct communication with the pole changer, producing the same effect as connecting all the negative poles of a series of galvanic cups together, and all the positive poles together. When it is desired to produce a current of high intensity, the screws are all screwed out from the wheel to bring their heads clear of the plates, G H, and bring the collars, S S, into contact with the coupling straps, $m\ m$, and thus make a connection between the screws of the negative plates, G G or H H, with those of the positive ones, and a consequent connection between the negative terminal wires of the helices and the positive terminal wires of their fellow helices; thus producing the same effect as connecting the positive wire of each cup with the negative wire of the next cup of a galvanic series. In order to produce the very lowest intensity of which the machine is capable, it is obvious that the helices should be separately connected with the plates, G G and H H, and not connected in pairs, as hereinbefore described with reference to Figs. 1 and 7.

The pole changer, L, is made of three broken rings, $x1\ x2\ x3$, or rings divided into alternating sections of conducting and non-conducting material, two sections of conducting material in each ring to each of the four series of helices hereinbefore described, making eight sections of conducting material in each ring. The two plates, G and H, with which all the helices marked with the letter, a, in Fig. 1, are connected, are connected with one ring marked a, in Fig. 8, which thus receives all the currents from those helices; and in like manner all the helices marked with the letter, b, are connected by another pair of plates, G H, with the second ring marked in Fig. 8 with the corresponding letter; and all marked with the letter, c, are connected by the third pair of plates, G H, with the third ring marked c. From each of the rings, $a\ b\ c$, of the pole changer, L, there leads off to a fixed block, P, of wood two brake-like conductors, $t\ u$, one positive and the other negative, bearing upon the rings at nearly opposite points. The three positive conducters, $t\ t\ t$, are all connected together, and the three negative conductors are all connected together. Thus are connected all the currents and electric impulses with the least possible break or interruption; for, before the connection of the conducting wire with the ring, a, of the pole changer is broken, by the intervention of the section of non-conducting material, a connection is made with the t ring, and before that is broken a connection is made with the c ring, and thus a constant current is insured.

By this arrangement a magneto-electrical machine is obtained which is operated with only the uniform resistance of the friction, and by which the intensity of the current is adjusted at will with the greatest nicety.

The patent for this invention was procured, through the Scientific American Patent Agency, Sept. 4, 1860, and further information in relation to it may be obtained by addressing the inventor, H. N. Baker, or John A. Collier, Esq. (who has an interest in the patent), at Binghampton, N. Y.

SCIENCE MADE POPULAR.

PROFESSOR FARADAY'S LECTURES ON THE PHYSICAL FORCES.

LECTURE III.—COHESION—CHEMICAL AFFINITY.

We will first return, for a few minutes, to one of the experiments made yesterday. You remember what we put together on that occasion—powdered alum and warm water. Here is one of the basins then used. Nothing has been done to it since; but you will find, on examining it, that it no longer contains any powder, but a number of beautiful crystals. Here, also, are the pieces of coke which I put into the other basin; they have a fine mass of crystals about them. That other basin I will leave as it is. I will not pour the water from it, because it will show you that the particles of alum have done something more than merely crystallize together. They have pushed the dirty matter from them, laying it around the outside or outer edge of the lower crystals—squeezed out, as it were, by the strong attraction which the particles of alum have for each other.

And now for another experiment. We have already gained a knowledge of the manner in which the particles of bodies—of solid bodies—attract each other, and we have learned that it makes calcareous spar, alum, and so forth, crystallize in these regular forms. Now let me gradually lead your minds to a knowledge of the means we possess of making this attraction alter a little in its force—either of increasing or diminishing, or, apparently, of destroying it altogether. I will take this piece of iron [a rod of iron about two feet long and a quarter of an inch in diameter]. It has at present a great deal of strength, due to its attraction of cohesion; but if Mr. Anderson will make part of this red hot in the fire, we shall then find that it will become soft, just as sealing wax will when heated, and we shall also find that the more it is heated the softer it becomes. Ah! but what does *soft* mean? Why, that the attraction between the particles is so weakened that it is no longer sufficient to resist the power we bring to bear upon it. [Mr. Anderson handed to the lecturer the iron rod, with one end red hot, which he showed could be easily twisted about with a pair of pliers.] You see, I now find no difficulty in bending this end about as I like, whereas I cannot bend the cold part at all. And you know how the smith takes a piece of iron and heats it, in order to render it soft for his purpose; he acts upon our principle of lessening the adhesion of the particles, although he is not exactly acquainted with the terms by which we express it.

And now we have another point to examine, and this water is again a very good substance to take as an illustration (as philosophers, we call it all water, even though it be in the form of ice or steam). Why is this water hard [pointing to a block of ice]? because the attraction of the particles to each other is sufficient to make them retain their places in opposition to force applied to it. But what happens when we make the ice warm? Why, in that case we diminish to such large extent the power of attraction that the solid substance is destroyed altogether. Let me illustrate this: I will take a red hot ball of iron [Mr. Anderson, by means of a pair of tongs, handed to the lecturer a red hot ball of iron, about two inches in diameter], because it will serve as a convenient source of heat [placing the red hot iron in the center of the block of ice]. You see I am now melting the ice where the iron touches it. You see the iron sinking into it; and while part of the solid water is becoming liquid, the heat of the ball is rapidly going off. A certain part of the water is actually rising in steam; the attraction of some of the particles is so much diminished that they cannot even hold together in the liquid form, but escape as vapor. At the same time, you see I cannot melt all this ice by the heat contained in this ball. In the course of a very short time I shall find it will have become quite cold.

Here is the water which we have produced by destroying some of the attraction which existed between the particles of the ice, for, below a certain temperature, the particles of water increase in their mutual attraction and become ice; and above a certain temperature the attraction decreases, and the water becomes steam. And exactly the same thing happens with platinum and nearly every substance in nature; if the temperature is increased to a certain point, it becomes liquid—and a farther increase converts it into gas. Is it not a glorious thing for us to look at the sea, the rivers, and so forth, and to know that this same body in the northern regions is all solid ice and icebergs; while here, in a warmer climate, it has its attraction of cohesion so much diminished as to be liquid water? Well, in diminishing this force of attraction between the particles of ice, we made use of another force, namely, that of *heat;* and I want you now to understand that this force of heat is always concerned when water passes from the solid to the liquid state. If I melt ice in *other* ways, I cannot do without heat (for we have the means of making ice liquid without heat—that is to say, without using heat as a *direct* cause). Suppose, for illustration, I make a vessel out of this piece of tinfoil [bending the foil up into the shape of a dish]. I am making it metallic, because I want the heat which I am about to deal with to pass readily through it; and I am going to pour a little water on this board, and then place the tin vessel on it. Now, if I put some of this ice into the metal dish, and then proceed to make it liquid by any of the various means we have at our command, it still must take the necessary quantity of heat from something, and in this case it will take the heat from the tray, and from the water underneath, and from the other things roundabout. Well, a little salt added to the ice has the power of causing it to melt, and we shall very shortly see the mixture become quite fluid, and you will then find that the water beneath will be frozen—frozen because it has been forced to give up that heat which is necessary to keep it in the liquid state to the ice on becoming liquid. I remember once, when I was a boy, hearing of a trick in a country ale-house; the point was how to melt ice in a quart pot by the fire, and freeze it to the stool. Well, the way they did it was this: they put some pounded ice into a pewter pot, and added some salt to it, and the consequence was, that when the salt was mixed with it, the ice in the pot melted (they did not tell me anything about the salt, and they set the pot by the fire, just to make the result more mysterious), and in a short time the pot and the stool were frozen together, as we shall very shortly find it to be the case here; and all because salt has the power of lessening the attraction between the particles of ice. Here, you see, is the tin dish frozen to the board; I can even lift this little stool up by it.

This experiment cannot, I think, fail to impress upon your minds the fact that when a solid body loses some of that force of attraction by means of which it remains solid, heat is absorbed; and if on the other hand, we convert a liquid into a solid, *e. g.*, water into ice, a corresponding amount of heat is given out. I have an experiment showing this to be the case. Here (Fig. 21) is a bulb, A, filled with air, the tube from which dips into some colored liquid in the vessel, B. And I dare say you know that if I put my hand on the bulb, A, and warm it, the colored liquid which is now standing in the tube at C will travel forward. Now, we have discovered a means, by great care and research into the properties of various bodies, of preparing a solution of a salt which, if shaken or disturbed, will at once be-