face with its second, minute, and hour hands, and of a train of wheels which communicate motion from the action of the second hand to that of the hour hand, in the same man­ner as in an ordinary clock train ; a small electro-magnet is caused to act upon a peculiarly-constructed wheel (scarce­ly capable of being described without a figure) placed on the second's arbor, in such a manner that whenever the temporary magnetism is either produced or destroyed, the wheel, and consequently the second's hand, advances a six­tieth part of its revolution. It is obvious, then, that if an electric current can be alternately established and arrested, each resumption and cessation lasting for a second, the in­strument now described, although unprovided with any in­ternal maintaining or regulating power, would perform all the usual functions of a perfect clock. The manner in which this apparatus is applied to the clocks, so that the movements of the hands of both may be perfectly simultane­ous, is the following :—On the axis which carries the scape-wheel of the primary clock a small disc of brass is fixed, which is first divided on its circumference into sixty equal parts ; each alternate division is then cut out and filled with a piece of wood, so that the circumference consists of thirty regular alternations of wood and metal. An extreme­ly light brass spring, which is screwed to a block of ivory or hard wood, and which has no connection with the me­tallic parts of the clock, rests by its free end on the cir­cumference of the disc. A copper wire is fastened to the fixed end of the spring, and proceeds to one end of the wire of the electro-magnet ; while another wire attached to the clock-frame, is continued until it joins the other end of that of the same electro-magnet: A constant voltaic battery, con­sisting of a few elements of very small dimensions, is inter­posed in any part of the circuit. By this arrangement the circuit is periodically made and broken, in consequence of the spring resting for one second on a metal division, and the next second on a wooden division. The circuit may be extended to any length ; and any number of electro­magnetic instruments may be thus brought into sympa­thetic action with the standard clock. It is only necessary to observe, that the force of the battery and the proportion between the resistances of the electro-magnetic coils, and those of the other parts of the circuit, must, in order to produce the maximum effect with the least expenditure of power, be varied to suit each particular case.”

In Professor Wheatstone’s paper, of which the above is an abstract, he has pointed out several methods of effecting the same purpose. In one of them he substitutes Dr Fa­raday's magneto-electric currents, in place of the voltaic battery, and he likewise describes a modification of his clock which will enable it to exercise its controlling power with a weaker electric current than when constructed on the plan above described. Professor Wheatstone has like­wise pointed out other most important purposes to which his invention is applicable.

PART III—MAGNETO-ELECTRICITY.

In the preceding chapter, we have detailed the leading phenomena produced by electric currents, or electricity in motion, for no magnetic effects are produced by accumu­lated electricity. We come now to give an account of the new science of magneto-electricity, which we owe to Dr Faraday. Although certain effects of the *induction@@*1 of elec­trical currents had been discovered. It had always appeared to Dr Faraday unlikely that these could be the only effects which induction by currents could produce ; and whatever theory of the phenomena might be adopted. It still seemed to him “ very extraordinary, that as every electric current was accompanied by a corresponding intensity of magnetic action, at right angles to the current, good conductors of electricity, when placed within the sphere of this action, should not have any current induced through them, or some sensible effect produced equivalent in force to such a current. With these views, and under the expectation of obtaining electricity from ordinary magnetism, he investi­gated experimentally the inductive effect of electrical cur­rents.”

If the uniting wire of a voltaic battery is placed parallel to the wire connecting the two ends of a delicate galvano­meter, the most powerful current along the uniting wire will produce no deviation in the needle. But if the cur­rent along the uniting wire is stopped, by *breaking the cir­cuit,* a momentary deviation of the needle takes place, as if a wire passed in the same direction as that of the voltaic current. When the needle has become stationary, a simi­lar impulse is given to it in the opposite direction, by *re­storing the circuit.* Dr Faraday found that similar effects took place, when the *current along the uniting wire being uninterrupted,* the uniting wire was made to approach or to recede *suddenly* from the wire of the galvanometer, the *approximation* inducing a current in the direction *contrary* to the inducing current in the uniting wire, and the *divi­sion* inducing a current in the *same* direction as the in­ducing current.@@3 To this inductive action of the voltaic current Dr Faraday has given the name of *volta-electric induction.*

As the preceding effects were clearly produced by a transverse action of the current, in the first case at the in­stant where the current was annihilated or generated, and in the second by the mechanical motion of the uniting wire, Dr Faraday expected to obtain similar results, by the sud­den induction and cessation of the same magnetic force, either by means of a voltaic current, or by that of a com­mon magnet. By various experimental arrangements, Dr Faraday verified these anticipations ; but in order to con­nect his experiments on volta-electric induction with the present ones, he constructed a combination of helices upon a hollow cylinder of pasteboard. The wire was 1-20th of an inch in diameter, and the different spires were prevented from bending by a thin interposed twine. Each helix was covered with calico. Eight lengths of copper wire were used, or nearly 220 feet of wire. “ Four of these helices were connected end to end, and then with the galvano­meter ; the other intervening four were also connected end to end, and the battery of 100 pairs discharged through them. In this form, the effect on the galvanometer was hardly sensible, though magnets could be made by the in­duced current. But when a soft iron cylinder, 7/8ths of an inch thick, and 12 inches long, was introduced into the pasteboard tube, surrounded by the helices, then the in­duced current affected the galvanometer powerfully. It possessed also the power of making magnets with more energy apparently than when an iron cylinder was used. When the iron cylinder was replaced by an equal cylinder of copper, no effect beyond that of the helices alone was produced.” “ Similar effects,” continues Dr Faraday, “ were produced with ordinary magnets. Thus, the hollow helix just described had all its elementary helices connected with the galvanometer, by two copper wires each five feet long ; the soft iron cylinder was introduced into its axis ; a couple of bar magnets, each 24 inches long, were ar­ranged, with their opposite poles at one end in contact, so as to resemble a horse-shoe magnet, and then contact made between the other poles and the ends of the iron cylinder, so as to convert it for the time into a magnet ; by breaking the magnetic contacts, or reversing them, the magnetism of

@@@1 By ***induction*** Dr Faraday intends to express the power of electrical currents “ to induce any particular state upon matter in their immediate neighbourhood otherwise indifferent." ***Experimental Researches,*** p. 1.

@@@, Experimental Researches, p. 5.