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Art. V.—*Magneto-Electric and Electro-Magnetic Apparatus and Experiments;* by Charles G. Page, M. D., Washington City.

From the splendor of the sparks, and the extreme intensity of shocks obtained from magnetic electrical instruments where the galvanic battery is used as a source of the magnetic power, the hope has been entertained by many, that such instruments, would prove valuable in a high degree as sources of electrolytic power. The present infantile state of the science, shows clearly the futility of such a hope, and points directly to an arrangement which will place in the hands of the operator an instrument surpassing entirely the great galvanic battery in value and power. Such an instrument is the magneto-electric machine. The instrument described in the last April* number of this Journal demonstrates, by careful experiment with Faraday's volta-electrometer, that the electrolytic power of the current from the combined armatures is just double that of one. The avenue, then, to an indefinite power, is too obvious to escape notice. Increase the number of pairs of magnets, extend the series of armatures upon the same shaft, or in any way in which they may be brought to bear on the same terminal pole, and I hazard nothing in the assertion, that for the same prime cord, and contained in the same space, a magneto-electric instrument can be made of equal power to a galvanic battery of one thousand pairs of plates. It is evident, that there will not be that rapid diminution with the extension of the series which obtains in the galvanic arrangement, for in the magneto-electric machine the whole route of the current is through solid conductors, and in the galvanic battery, through a great extent of liquid and numerous soldered and imperfect joints. Nothing but the want of means has restrained me from erecting a magneto-electric machine, which I feel confident would rival the largest galvanic battery in existence. The arch of light would be obtained by disposing one set of armatures at right angles to the other, so that while one gave a diminishing current, the other would afford a current increasing in the same ratio; while one set was in the *neutral plane,* the other would be at the point of strongest action.

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* Vol. xxxiv, p. 163.

Having asserted thus much of the magneto-electric machine, it will be necessary to allude briefly to the objections to machines for electrolytic uses, where the galvanic battery is the *primum mobile.*

First.—The opposing currents produced by making and breaking the battery circuit cannot be separated, or rather cannot be united to form one current. In the magneto-electric machine, the alternating currents are made to flow in the same direction by the *pole changer*, or more properly in this connection, the *unitrep.* As it is desirable that every distinct and useful apparatus should have an appropriate name, I have selected the term *Unitrep*, as short, and descriptive of the use of this part of the magneto-electric machine. This important addition to the machine appears to be beyond simplification, consisting merely of two nearly half cylindrical pieces of metal, rivetted or secured in any manner to the circumference of a small disc of wood or ivory, and insulated from each other. Its use, as the name Unitrep implies, is to convert, or turn contrary currents into one common channel.

Secondly.—In the *galvanic* magneto-electrical machines, electro-chemical effects can be obtained (to any considerable degree) only by distinct impulses, occurring at each rupture of the circuit. These impulses or secondary currents closely resemble a common electrical discharge, and are of too short duration to allow the particles of the substances to be decomposed to assume definite polar arrangement. Nor can the circuit be broken rapidly to any advantage; for in the first place, the full magnetization of the iron requires appreciable time, and, secondly, the flowing of the secondary through a completed circuit, weakens itself by re-magnetizing the bar: (this will be spoken of in future.) In the *pure* magneto-electric machine, water is decomposed far more rapidly by the continuous current than by breaking the circuit, by the primitive than the secondary current. The secondary furnishes the most powerful shocks, but the primitive possesses the greatest decomposing power.

Compound Electro-Magnet and Electrotome for Shocks, Sparks, &c.

In the late numbers of Sturgeon's Annals, I notice that Mr. Bachoffner has introduced the bundle of wires as superior to the solid bar for reaction upon the *coil wires*. Mr. Bachoffner probably used this compound arrangement before myself, as I made the discovery February 14th, 1838. Mr. Bachoffner remarks, "that it is necessary to insulate the wires of the bundle, and that it is difficult to understand their action, as the magnetic power is not so great as that of a solid bar." In every experiment hitherto tried, I have invariably found the magnetic power to be greater than that of a solid bar of the same weight. I have never found it necessary to insulate the wires to insure their operation, although I would not say that a very careful insulation might not improve their operation. For I apprehend that in the development and return of magnetic forces, electrical currents are excited in the body of the magnet at right angles to its axis, as well as in the wires surrounding the magnet. In this case the exterior portion of the magnet would act as a *closed circuit* upon the interior.

By a closed circuit is meant a FLOWING secondary current, which has the effect to re-magnetize the bar after the primitive battery current has ceased to act. That the operation of these *secondary closed circuits* has never yet been considered in the construction of machines, will appear from the following facts and practical observations.

First.—Enclosing a compound* electro-magnet in a tube of metal, almost entirely prevents the formation of secondary currents in the exterior wires, although by this arrangement the magnetic power is not perceptibly affected, with the exception, that its development requires *more time.*† The short and complete right angle currents in the metallic casing have a greater magnetizing power than the secondary of an extended and oblique coil of wire. Hence, after the battery current ceases, the chief portion of the secondary will flow in this short circuit, and the magnetism of the bar be prolonged to a perceptible degree, and if it were possible to break this *closed circuit* immediately after the battery circuit, a secondary and *tertiary* current would be observed from the coil of wire. This *tertiary* circuit I have perceived in another way.

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* Or a common single magnet.

† The increase of time necessary to effect the full development of magnetism, is due to the formation of the initial secondary flowing against the battery current.

Secondly.—Insulate the metallic casing from the magnet, and divide it throughout its length, so that the secondaries cannot pass, and the coil wire will now exhibit the full power of the secondary.

Thirdly.—Surround an electro-magnet with an entire metallic casing, *exterior* to the coil wires, and the secondary of the wires will be depreciated as before. Split the casing as before, and the secondary will again have full power.

Fourthly.—Brass rings or straps surrounding the poles of magnets or armatures for magneto-electric experiments, detract from their value by the action of *closed circuits.*

Fifthly.—The brass cheeks which are frequently used upon the armatures of magneto-electric machines for supporting the coil wires, materially impair the power of such machines. These cheeks should in all cases be made of wood, ivory, or some non-conducting substance.

Sixthly.—A metallic casing which entirely envelops a U magnet or armature, cannot convey closed circuits, as each half of the casing would transmit currents in opposite directions. Consequently, (as I have proved by repeated experiments,) the secondary of the coiled wire is not in the least impaired by this arrangement.

The following experiments were tried with a view to ascertain if electrical currents were excited in the body of the magnet itself. A hollow magnet was wound and tried; the secondary current was not so great as that from a solid bar of the same diameter. Singular as it might at first sight appear, the insertion or filling up of this hollow magnet with a rod of soft iron or a bundle of iron wires, did not in the least exalt the force of the secondary. This result accords exactly with that of a similar experiment by Mr. Bachoffner. I then rolled upon a cylinder of wood a piece of sheet iron, not permitting its edges to meet. It was then surrounded with three layers of coiled wire and tried, and the augmentation of the secondary was greater than that produced by the entire hollow magnet, which was of much thicker metal. But when the cylinder of wood was withdrawn, and its place supplied with a bundle of fine iron wires, the secondary was increased to a very great degree, and the whole appeared to be equally powerful with a compound magnet of the same size. It should be observed particularly, that when the hollow magnet was *entire*, the insertion of an iron rod or bundle of wires produced no effect. From these experiments I think the existence of secondary currents flowing in the body of the magnet may be very plausibly inferred. If actually determined, the fact would prove important, and is well worth pursuing. I soldered two wires to the edges of the enclosed sheet of iron, and connected them with a galvanoscope, but could not perceive any effect upon the needle. But as the instrument was by no means delicate, the experiment may be regarded as valueless. Having no opportunities at present of pursuing the investigation, I hope that the subject may receive due attention from those who may be interested.

The following striking experiments afford still further illustration of the action of closed secondary circuits.

Experiment 1st.—Place a straight electro-magnet upon a large flat spiral of copper, in the direction of a radius of the spiral. When the spiral is connected with the battery, the magnet becomes charged, and a secondary current in its wires is the consequence. Break the battery connexion with the spiral, and examine by the common tests the power of the secondary from the magnet. Again, break the circuit from mercury covered with oil, and the secondary from the magnet will now be found stronger than in the first case. When the circuit is broken over clean mercury, the secondary flowing through the heated vapor and air, acts as a closed circuit to prolong the magnetism of the spiral, and thus prevent a sudden and entire influence upon the magnet. When the mercury is covered with oil the secondary is arrested, and the magnetism suddenly ceasing, exerts its whole influence upon the magnet, or rather the magnetism of the bar ceases with that of the spiral. The same phenomenon is well illustrated by the electro-magnet alone, where the fine wire is independent of the large.

Experiment 2d.—The reciprocal action of the closed circuit of the magnet itself upon the secondary of the spiral is more remarkable. Break the battery connexion with the spiral over clean mercury, when the ends of the wire on the magnet are disjoined, and observe the spark; join now the ends of the magnet wire, and on breaking the battery circuit the spark from the spiral will be diminished. The manner in which the closed circuit operates here, will be more easily understood from, *Experiment 3d.*—Bring one extremity of the magnet used in the foregoing experiment in contact with one pole of the magnet of a common magneto-electric machine. As this disguises a portion of the magnetism, the amount of electricity developed by the revolution of the armature will of course be diminished. While working the machine the magnetic state of the electro-magnet will vary with the approximation and recession of the armature, and a current of electricity in its wires will be the consequence. When the current from the armature is broken or not suffered to flow at all, the current from the electro-magnet will be much stronger than when the circuit from the armature is constantly complete. When the armature is leaving the magnet, the flowing current or *closed circuit* magnetizes the armature and consequently disguises more of the power of the inducing magnet, than when the armature leaves without the closing of the circuit. The consequence is a detraction of magnetic power from the electro-magnet. Also, breaking the circuit from the armature under oil, increases the current from the electro-magnet.

Experiment 4th.—Join the ends of the wire coiled on one leg of the curved armature of a common magneto-electric machine, and allow the coil from the other leg to be connected with the break piece, as usual. As long as the circuit of the first coil is closed, the second coil will furnish scarcely any electricity; but when the circuit of the first coil is opened, the second furnishes nearly as much electricity as the combined current from both coils. This singular fact first called my attention to the great advantage of short, straight armatures, for the magneto-electric machine. Obviously, the best arrangement for straight armatures, would be that wherein they revolved between the ends of the magnetic poles, the axis or shaft being parallel to the legs of the magnets. The points gained by this plan would be, a more uniform and powerful current, and an exact division by the Unitrep of the semicircular routes through which the alternating currents are developed. In the machine described in Vol. xxxiv, p. 164, of this Journal, and in all others where the axis of motion is perpendicular to the plane of the magnet, if the two routes in which the opposite currents are developed be represented by two arcs of a circle drawn through the two neutral points, that arc towards the bend of the magnet will be much the longer, and represents a feebler current than the shorter arc. The only objection to this arrangement is the extra room it requires.

Figure 1.

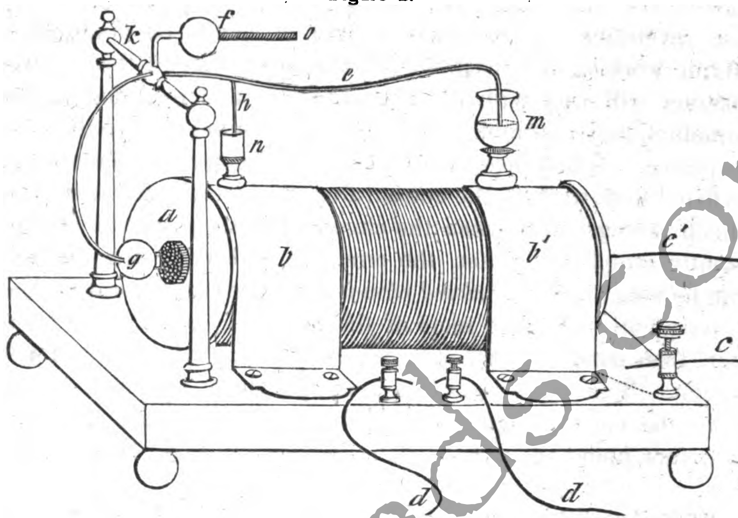


Figure 1, represents a new form of apparatus, consisting of a compound electro-magnet and electrotome ; completed April, 1838. *a*, is an ivory cheek or head, through the center of which appear the extremities of the wires composing the magnet. *b, b′*, two brass straps confining the magnet to the base board. *c, c′*, the battery connexion for the large wires, which are terminally soldered to the cups with the binding screws, the soldered connexion being underneath the base board. *d, d*, are the fine wire terminations, the solderings being out of sight, underneath the base board. The movable part of the apparatus, *e, f, g, h, k*, is the electrotome. *e*, is a stout copper wire, passing through the shaft *k*. One extremity of this wire dips into the mercury cup, (*m*,) the top of which is of glass for exhibiting the spark ; the base of brass is soldered to the brass strap *b′*. At the other extremity of *e*, is a small ball of iron, (*g*,) which, being attracted by the magnet, gives motion to the electrotome. It is proper to remark here, that the sphere of iron, *g*, is not attracted by the magnet with the same force as would be a piece of iron of ovoid form, or what would prove still better, a cylindrical piece, the length of whose axis was considerably greater than its diameter.

h, is a short piece of copper wire soldered to *e*, and descending into the mercury cup *n*, which is soldered to the brass strap *b*. The brass ball *f*, is movable on the projecting screw *o*, and serves as a regulator to the vibrations of the electrotome. The circuit traversed by the galvanic current is as follows. From the cup *c*, by the dotted line to the brass strap *b'*, thence through *m*, *e*, *h*, *n*, *b*, to one of the large wire terminations. The other termination of the large wires surrounding the magnet, is soldered to a cup connected with *c'*. When the galvanic circuit is completed, the magnet attracts the ball *g*, and raises *e* from *m*, producing a bright spark at *m*, and a powerful shock from *d*, *d*; *e*, then falls by its own weight, re-establishes the connexion, and thus the vibration continues. On the side of the ball *g*, towards the pole of the magnet, is fastened a piece of brass, or other non-magnetic substance, to prevent the adhesion of the ball to the magnet. The tips of the wires *h*, *m*, should be tinned before use. In all cases, tinning, or covering with soft solder the extremities of wires for connexions, and dipping them into mercury, will be found a much more preferable mode of amalgamating, than the usual practice of dipping them into nitrate of mercury, as they preserve their brightness a greater length of time.

Circular Galvanometers.

Figures 2 and 3, represent two new forms of galvanometers, which are found to possess some advantages over other forms in common use. The whole appearance of this instrument, (though a trivial consideration,) is somewhat in its favor for purposes of general exhibition to a class. *a*, fig. 2, is the magnetic needle suspended by its centre on a fine point. The needle is made of watch spring, and bent into a form concentric with the coil *c*. The distance between the poles of the needle is about one sixteenth of an inch more than the width of the coil. The coil *c*, of insulated copper wire, is fastened by strong cement to the pillar *d*. *p*, *n*, are the terminations of the coil passing into the mercury cups on the stand. The coil is made of a number of strands of wire in lieu of a continuous wire. Galvanometer coils are usually made of too fine wire, and of a single wire of too great a length. M. Pouillet, in his late investigation of the general law of the intensity of currents, has shown that *derivation* made upon a primitive current from an elementary battery, strengthens

Figures 2 and 3.

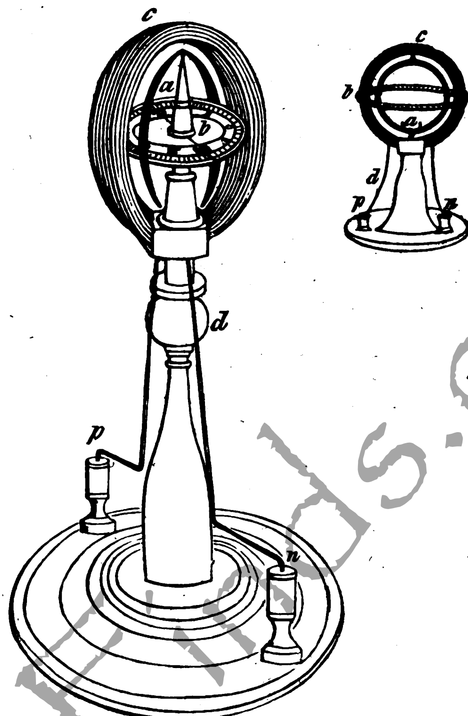
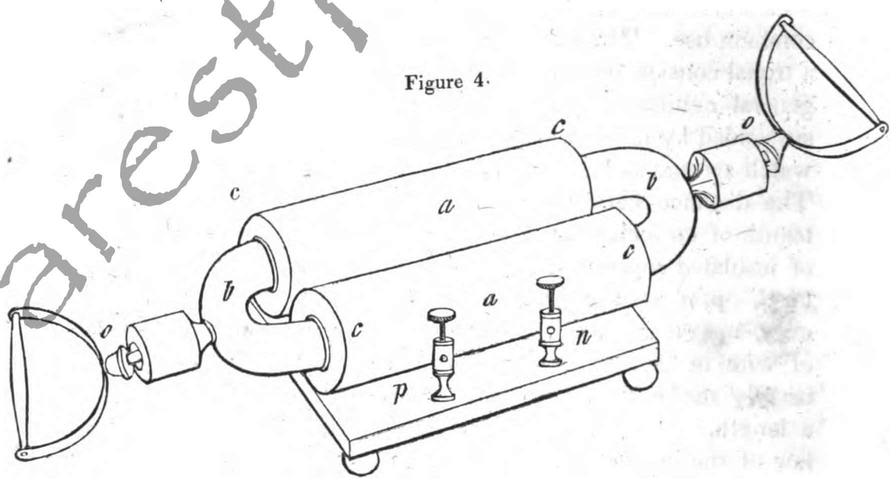


Figure 4.



that primitive current. By derivation is meant, the addition of another wire to any portion of the primitive circuit. The simple solution of the fact is, that derivation, or the addition of another wire, increases the conducting power of the circuit. Professor J. Henry's discovery of the method of increasing the power of the electro-magnet by winding upon it several short coils of wire, is a most striking practical illustration of this law. M. Pouillet has also arrived at the conclusion, that the intensity of the current produced by a single element, is in an inverse proportion to the real length of the circuit. The adoption of the several strands in the galvanometer seems therefore to be plainly indicated, and experiment fully warrants it. *b*, fig. 2, is a graduated circle of ivory for marking the deviations of the needle. Since the construction of the instrument, fig. 2, I have adopted the plan represented in fig. 3, which is much to be preferred on account of its simplicity of construction, and the perfect steadiness of the needle. *c*, is the coil cemented upon the stand *d*; *b*, a graduated zone surrounding the coil. *p* and *n*, the wire terminations. *a*, the circular needle of watch spring, with a very delicate upper bearing at *c*, and a slender pivot at *a*, resting upon an agate centre cemented to the coil. As this needle is not liable to any mechanical displacement, it may come very near the coil *c*. The portion of the circle between the two lines at *a*, which bears the pivot, is of brass.

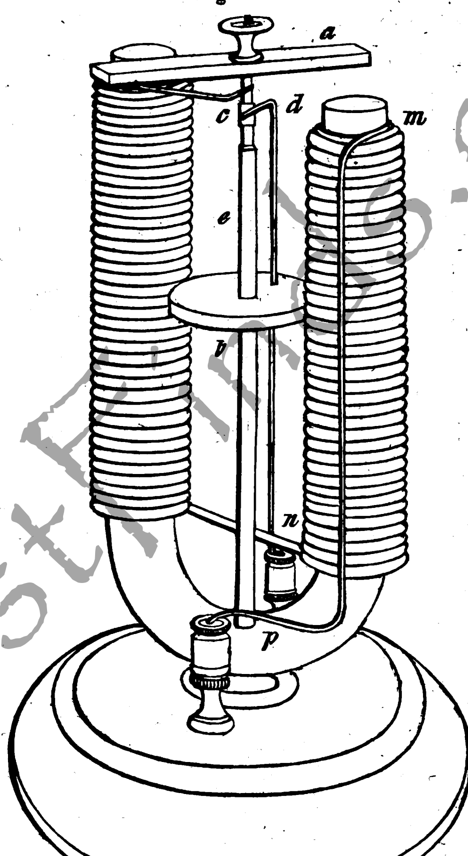
Double Helix for Inducing Magnetism.

Figure 4, represents an apparatus contrived January 11th, 1838, for exhibiting the magnetic forces of the centre of the helix. *a*, *a*, are the two helices of five layers of wire, protected by brass casings, (split on the under side,) and by ivory heads, *c*, *c*, *c*, *c*. *b*, *b*, are two curved bars of soft iron which slide readily into the helices. *o*, *o*, the handles for pulling, furnished with ball and socket joints at *o*, *o*, to prevent the magnets being twisted or wrenched. The wire terminations of the helices pass through the openings in the brass casings, underneath the base board, and are soldered to the screw cups *p*, *n*, for battery connexions. The attractive force manifested by this arrangement in the centre of the helices, is much greater than when an armature is applied at the extremities. A small apparatus of this kind will resist the strength of two stout men pulling by the handles. This makes a very pretty arrangement for a reciprocating electro-magnetic engine, there being no change of poles, as the motion is effected by an arrangement shown in the two next figures. This form of engine will be described in a future article.

Revolving Armature.

Figure 5, represents an instrument invented in February, 1838, for exhibiting motion by magnetism without change of poles.

Figure 5.

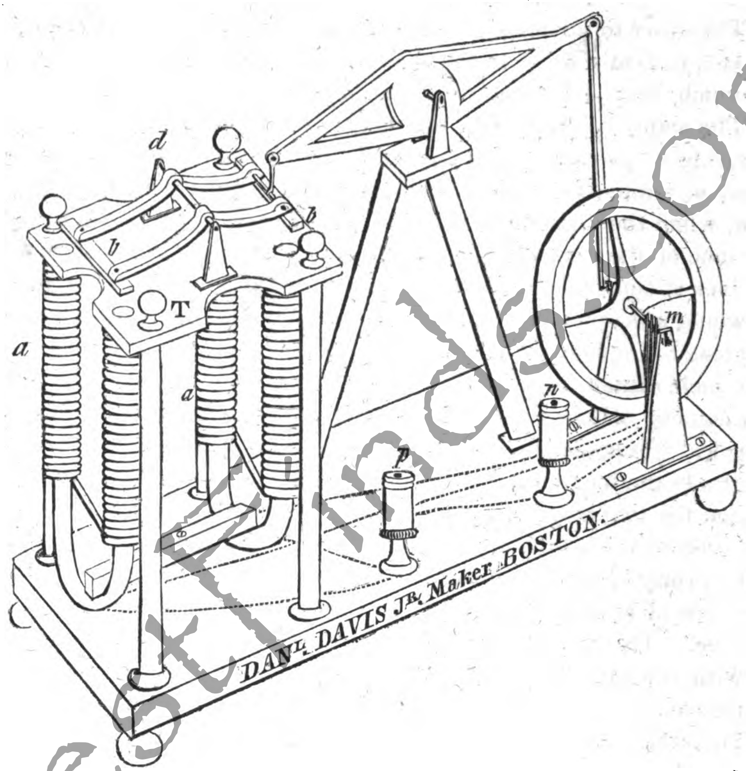


This instrument was the foundation of a series of experiments, made with reference to the mechanical application of magnetism, which will be published with drawings in a future communication. *m*, is the electro-magnet. *a*, the armature of soft iron. *e*, is an upright stem of brass, to receive and make the bearings of the shaft of the armature. *b*, is a disc of wood or ivory to brace the upright stem *e*. *c*, is one termination of the magnet coil, serving as a conducting spring. *d*, is the other conducting spring passing through the disc *b*, into the cup *n*, for battery connexion. The other termination of the magnet wires passes into the cup *p*. At *c*, *d*, firmly fixed to the shaft, is a cylindrical piece of silver, which may be technically called the *cut-off*, or electrotome. The spring *c*, plays upon the whole portion of the *cut-off*. The spring *d*, plays upon the dissected part, whose metallic divisions are so arranged that they shall come into contact with the spring *d*, when the armature is a little inclined from right angles to the plane of the magnet, and leave spring *d*, before the armature arrives at equilibrium. This armature revolves much faster than would a magnet changing its poles. Besides the advantage of greater simplicity, the *revolving armature* possesses advantages which cannot be gained by change of poles, or by revolving magnets, where the power is only cut off without a change of poles. Suppose another electro-magnet to be placed at right angles to the magnet *m*, in the figure, and the cut-off so arranged that the two magnets shall be charged in succession by the revolution of the armature. The velocity of the armature will thus be nearly doubled without the addition of more battery, for the points of action are doubled, and only one magnet charged at a time. This same plan admits of enlargement on any scale, only with the alteration of the mode of revolution. If electro-magnetism should ever be introduced for small powers, such as turning lathes, &c. it probably will be effected by either the revolving or vibrating armature machines.

Reciprocating Armature Engine.

Figure 6, represents an electro-magnetic engine with vibrating or reciprocating armatures. *a*, *a*, are the electro-magnets, firmly secured to the base board and the wooden table *t*. *b*, *b*, are the armatures of soft iron connected with the shaft (*d*) by stout brass arms. The balance beam, connecting rods, and balance wheel, represented in the figure, require no particular description. The *cut-off* by which the magnets are alternately charged, is on the shaft of the balance wheel at *m*. It is simple in construction, made of silver, and similar to the one described for the revolving armature. There are three conducting springs tipped with silver, one playing upon the whole portion, and two upon the dissected portion of the *cut-off.* The connexions of the magnet

Figure 6.



wires with the springs and cups *p*, *n*, for battery connexion, are made under the base boards, and are marked by the dotted lines. Several of these engines have been made by Mr. Daniel Davis, Jr., philosophical instrument maker, of Boston; and are beautiful working models. As a proof that electro-magnetism is susceptible of useful application where only a small power is wanted, a small engine was made by Mr. Davis in the month of July last, by the aid of which, an individual gains fifteen dollars per day by the simple operation of drilling the steel plates for gas burners. I think this may be considered the first instance in which the mechanical application of electro-magnetism has been turned to profitable account. This engine is to undergo considerable alteration and improvement, when a description and drawing of it will be published.

That much remains yet to be determined concerning the most advantageous form and size of magnets and armatures, will appear from the following observations made during last October, while on a visit in Boston.

First: it is possible to present a piece of *soft iron* to the most powerful magnet in such a manner that it will not be attracted in the least by the magnet.

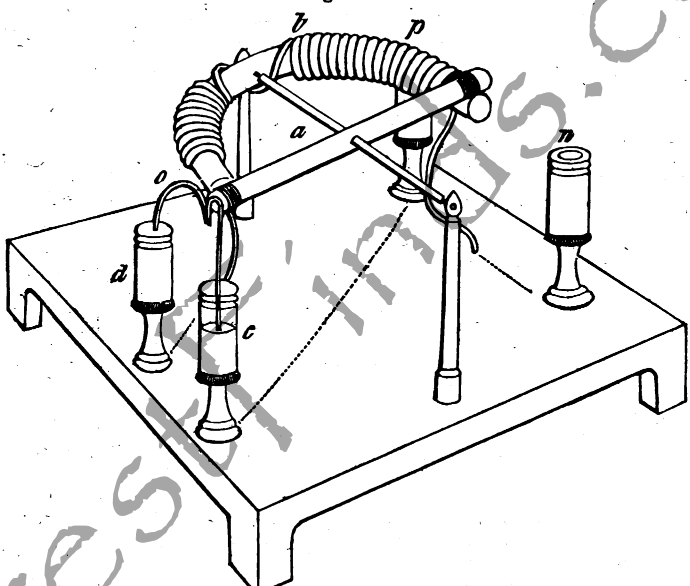
Experiment.—Drill a hole in the center of the pole of an electro or permanent magnet, to admit a small sliding rod of brass. To one end of this sliding rod, fasten a small disc of soft iron. The diameter of the disc must be less than that of the pole of the magnet, and the thickness or axis of the disc, must be considerably less than its own diameter. Put the sliding rod in its place, and if the disc of soft iron be exactly parallel to the face of the magnetic pole, it will not be attracted by it, be the magnet never so strong. If the disc is in the least inclined from parallelism, it will be attracted by the magnet. The experiment will appear more satisfactory if varied in the following manner. Place the disc of soft iron, with its sliding rod, in a frame, and place the magnet on a rest, so that its position can be varied; the same results will follow as before. Again: put the disc, without its silding rod, on the center of a large magnetic pole, and it will slip down to the edge of the pole, and there adhere. Again: sprinkle iron filings on a piece of paper laid over the end of a bar magnet; the filings will cluster over the pole around a vacant space at its center. Again: drill out the disc of iron so as to make a ring, whose width is greater than its thickness, and present it to the magnet in the same manner as the disc, and the ring will be attracted by the magnet. It appears from this, that the dise, though magnetized by induction is polarized in a radial direction, and the forces counteract, or disguise each other's influence upon the magnetic pole. When the diameter of the disc is greater than that of the magnetic pole, there cannot be this counterpoise of forces. When the disc is inclined to the face of the magnetic pole, it becomes polarized in the direction of an oblique line, joining that part of the disc in contact with the magnet, and that point most remote from the point of contact. These experiments throw some light upon a fact which, though long since known, does not seem to have been understood; viz. an armature which entirely subtends the poles of a U magnet, will not sustain so great a weight as one which covers only about one third of each pole. If the surface of the armature be flat, it will not be held so firmly as if spherical, presenting much fewer points. If the armature be flat and broad, that portion over the pole may be considered in the light of the soft iron disc. Numerous holes in an armature do not sensibly interfere with its adhesion. A piece of soft iron was first suspended from a single pole, with just as much weight as it would hold. It then had several large holes drilled through it, taking away a large portion of its substance, and was again tried; the induced magnetic power appeared to be as great as through the entire piece. This doubtless would not be true to any extent, although the properties of the armature are not perceptibly affected by a hole through its center, yet if a steel, or soft iron rod, be passed through this hole, its inductibility will be greatly impaired. This fact should be particularly observed in the construction of magneto-electric, and electro-magnetic machines, where a steel, or iron shaft, is often allowed to pass through an armature or magnet. If, while the armature is suspended by one end to a single pole, a piece of soft steel is drawn through the hole in its center, the steel becomes properly and permanently polarized; but if, while the armature is thus in contact with the magnet, the steel rod be passed half its length through the hole, and examined in that situation, both its extremities will be found to be similar poles.

In the management of electro-magnetic engines, it is worth observing here, that a greater power is always obtained by using a compound, instead of a single battery, provided the series does not exceed two. As the elementary battery has always been considered as possessing the greatest dynamic, or magnetic power, this species of battery has been preferred for application to electro-magnetic machines. I have invariably found that two pairs of plates, arranged as a compound series, connected with an electro-magnetic engine, or any apparatus for electro-magnetic rotations, produce a velocity nearly double that given by the same surface used as an elementary battery. If the series extend beyond two, the magnetizing power diminishes, although the sparks at the break pieces are brighter. In all cases where motion is produced by the galvanic current, it must meet with considerable resistance, either from secondary currents or from the breaks in the circuit. The compound current probably has a greater velocity than an elementary current, and meets with less resistance from opposing secondaries and passing breaks.

Vibrating Armature.

Figure 7, represents a vibrating armature, to be used as an electrotome, in connexion with an apparatus affording sparks or shocks. *b*, is a small electro-magnet, (of the actual size given in

Figure 7.



the figure,) and covered with only a single coil of wire, so as not to detract much from the power of the instrument with which it is used. *a*, a slender iron wire for an armature, suspended on a delicate shaft. *o*, is a connecting wire of copper fixed to one end of the armature, joining the mercury in the two cups *d* and *c*. *p* and *n*, are the terminal cups for connexions. The connexions between the cups and the ends of the magnet wire, are made under the base board, and marked by the dotted lines. The cup *c*, is of glass, or very thin ivory, to exhibit the illumination from the spark. When the battery circuit is complete through the instrument, the end *o*, of the armature is raised by the magnet, the connexion is broken at *c*, and the end *o*, falls by its weight, again rises, thus giving a rapid succession of sparks at *c*. The extremities of the armature are wound with a little sewing silk, or thread, to prevent their retention by the magnet.

Washington, November 13th, 1838.

Art. VI.—*Description of some new Shells;* by Benjamin Tappan, Steubenville, Ohio.

Prof. Silliman,—I send for publication in the Journal of Science the following descriptions of some shells found in Ohio, which are believed to be new.

"Unio Sayii, *Ward.* Plate III. Fig. 1.

Shell sub-rhomboidal, inequilateral, transverse, compressed; valves thin, beaks slightly prominent and *divergingly* wrinkled; cardinal teeth oblique, *single* in the right and *double* in the left valve; lateral teeth *slightly* curved; nacre white.

Hab. Walnut creek and Ohio canal, near Circleville. W. H. Price. My cabinet; cabinets of Dr. Kirtland, R. Buchannan, Esq., B. Tappan, A. Binney, Esq., Dr. Gould, Dr. Jay, Col. Totten, &c., &c.

Diam. 1. Length 1.60. Breadth 2.80.

Shell inequilateral, transverse, sub-rhomboidal, compressed; posterior and superior margins rectilinear, basal margin curved, anterior margin regularly rounded. Valves thin, translucent. Beaks slightly prominent, incurved and divergingly wrinkled, placed near the anterior margin. Umbonal slope sub-carinate, carina somewhat elevated. Ligament long, narrow, nearly straight and partially concealed. Epidermis pale yellow, inclining to cupreous on the umbos; glabrous, with indistinct capillary rays of a lighter color extending over the whole disk; lines of growth black, and very distinct; two faintly impressed lines diverging from under the points of the beaks and extending to the posterior basal margin. Cardinal teeth very oblique, not prominent, single in the right and double in the left valve, slightly crenate; lateral teeth lamellar, slightly curved. Anterior cicatrices distinct, poste-