The young man's book of amusement

Halifax, 1848

Electricity

urn:nbn:de:bsz:31-100120

Optical Illusion.

Suspend a ring freely to a string, on a level with the eye, but in such a manner that you cannot see the hole of the ring. Take a stick about a yard long, and fasten another smaller stick crosswise to one end of it. Then shut one eye and try to thread the ring with the small stick, and you will scarcely ever succeed; but use both eyes, and you will do it at the first attempt.

ELECTRICITY.

ELECTRICITY is found to be of two kinds, which are generally distinguished by the appellations of *positive* and *negative*, or their equivalents *plus* and *minus*.

Positive and negative electricity may be readily distinguished by the taste, on making the electric current pass, by means of a point, on to the tongue. The taste of the positive electricity is acid, that of the negative electricity is more caustic, and, as it were, alkaline.

The two electricities may also be distinguished in the following manner: if a pointed conductor, such as a needle, be presented to an excited glass tube in the dark, a globular speck of light will be observed

upon its point, which is a proof that the tube is electrified positively: but if this pointed conductor be presented to an excited stick of sealing-wax, a stream or pencil of light will be observed, which is an equally distinctive mark of the negative electricity in the electric.

All bodies which admit electricity to pass through them, are called *conductors of electricity;* the same bodies are often called *non-electrics.*

All bodies which are impermeable to electricity, are called *non-conductors of electricity;* they are also called *electrics,* with almost equal frequency.

The following lists of these bodies will be useful to the reader: they are classed according to their excellence:

Conductors or Non-Electrics.

Gold,
Silver,
Copper,
Platina,
Brass,
Iron,
Tin,
Quicksilver,
Lead,
Semi-metals, and metallic ores,
Black lead, or carburet of iron,
Charcoal from all substances,
The fluids of an animal body,
Salt-water, fresh-water, and all non-elastic fluids, except fixed oils.
Ice and snow, till cooled down—13 of Fahren-

heit's thermometer; below this temperature, Achard of Berlin, found that they became electrics.

Most saline substances, of which the metallic salts are best.

Earthy substances,

Smoke,

The vapour of hot water

Electrics or Non-conductors.

Glass, and vetrifications, whether of earths, or metals.

All precious stones, of which the most transparent are the best,

Amber,

Jet,

Sulphur,

All resinous substances,

Baked wood,

Wax,

Silk,

Cotton,

Hair, wool, feathers, and most animal substances, when dry,

Paper,

Air, and other elastic fluids,

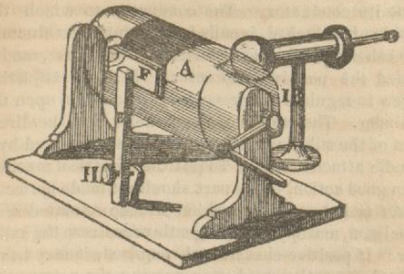
Fixed oils,

Metallic oxides,

The ashes of animal and vegetable substances,

Dry vegetable substances,

Most hard stones, of which the hardest are the best.



Electrical Machine.

The best electrical machine for experimental purposes is represented in the above Fig. It consists of a glass cylinder, A, about ten or twelve inches in diameter, and fifteen or twenty inches in length, turning between two upright pieces of wood, fixed to a stout mahogany base. Two smooth metal conductors equal in length to the cylinder, and about one-third of its diameter, are placed parallel to it upon two glass pillars B, B, which are cemented into sliding pieces of wood, by which their distance from the cylinder may be adjusted. One of the conductors has a cushion, F, attached to it by a bent metallic spring, nearly as long as the cylinder, and about one inch, or an inch and a half wide, to the upper part of which is sewed a flap of oil-silk, which should reach from the cushion over the upper surface of the glass cylinder, to within about

an inch of a row of points attached to the side of the opposite conductor. The conductor to which the cushion is attached, is called the negative conductor; the other collects the electricity of the glass, and is called the positive conductor. H is an adjusting screw to regulate the pressure of the cushion upon the cylinder. The motion of the cylinder is in the direction of the silk flap, and may be communicated by a handle attached at I. To put this electrical machine into good action, every part should be made perfectly clean and dry. The cushion is then anointed with amalgam, and applied by a gentle pressure to the cylinder. If positive electricity is required, it may be received from the conductor bearing the points, that supporting the cushion being uninsulated by a wire passing from it to the stand; if, on the contrary, negative electricity is required, it may be obtained from the insulated cushion cylinder, the other being uninsulated.

Plate Electrical Machine.

The plate electrical machine consists of a circular plate of glass revolving on an axis which passes through its centre, the excitation is effected by two pairs of cushions placed at opposite parts of the circumference of the plate. The cushions are loosely attached to thin pieces of mahogany, and the pressure upon the plate is adjusted by screws which pass through the opposite pieces. A brass conductor, supported by a glass arm, is fixed to one pillar, or in

large ones to the bottom of the frame of the machine, carrying two branches expanding beyond the periphery of the plate. The extremities of the conductors are furnished with points in order to collect the electricity from the excited surface.

The Leyden Phial.

The Leyden phial (see Fig. 8.) consists of a thin glass jar, coated internally and externally with tinfoil, to within a short distance of its mouth. When the inner surface is rendered positive by union with the conductor of the electrical machine, the exterior, being connected with the ground, becomes negative by induction. When the inner and outer surfaces are united by a conductor, all electrical accumulation is annihilated by a powerful spark, and the two opposite states are found to have been precisely equivalent. If the communication between the opposite surfaces of the Leyden phial be made by the hands, a painful jarring sensation is felt at the joints of the fingers, the elbows, shoulders, and chest, commonly called the electrical shock. Metallic wires, with balls at their ends, bent or jointed and fixed to a glass handle, are generally used to transfer the electric charge, and these instruments are called dischargers.

Electrical Automata.

If a metal plate be attached to the prime conductor of the electrical machine, and a similar plate be supported by a foot beneath, small figures, made of pith or paper, will readily leap from the one to the other continuously; and to effect this amusing dance, it will only be necessary to turn the cylinder of the electrical machine rapidly. A representation of this simple apparatus is seen at Fig. 9.

Electric Spider.

Insulate two bodies, and charge one of them plus, the other minus. Then suspend between them, by a silken string, an artificial spider, of which the body may be cork and the legs and fibres of feathers; the spider will move from one of the insulated bodies to the other, till their charge is equalized.

To Exhibit Electrical Attraction on a Number of Objects at once.

Place a cap or covering of metal upon the two extremities of a glass tube four or five inches long, and enclose in the tube some saw-dust or pith-balls; then charge one of the plates plus and the other minus,

when, as glass is a non-conductor, the equilibrium can only be restored by the saw-dust or balls, which will accordingly jump up and down till the charge of each plate is the same.

To shew Electric Attraction and Repulsion.

Two distinct bodies in the same electrical state repel each other, whether they have both more or less than their natural share of electricity; but if the one has more or less than the other, attraction takes place; this is a summary of the doctrine of electrical attraction and repulsion, and explains the various experiments which bring these properties into action.

If a bundle of hairs or feathers be hung upon the prime conductor, the moment they are electrified by working the machine, they begin to fly from one another, and they will not again collapse until the electricity is taken off. A fanciful mode of shewing

this experiment consists in making the form of a human head, (See the Fig.) with hair on, and placing this image upon the electrified conductor, the hair immediately stands up like "quills upon the fretful porcupine."

Curious Peal of Bells.

From a small pedestal A, (Fig. 10.) rises a stem, F, which supports a small bell, B. From this bell rises a glass tube, to the top of which is cemented a brass ball, C, with four wires of the same metal fastened in it at equal distances. From each extremity of these wires, which terminate in small knobs, hangs, by a brass chain, a small bell, like a bell B. From the middle of each wire, hangs, by a silken thread, a small brass ball. The bells are all suspended in the same plane, and the balls *a*, *b*, *c*, *d*, are at such a height that they will, if caused to vibrate, equally strike near the base, the bell in the centre, and their respective bells hanging from the wires. From this construction it will be understood, that the brass balls *a*, *b*, *c*, *d*, are insulated, because they are suspended by silk; but the bell B has a communication with the earth, because its support is a conductor, while it is separated from the brass knob C and the wires, by the non-conductor or glass pillar. Connect the knob C with the machine, by means of a chain or wire, and electrify it; the wires and bells suspended from them will be electrified at the same instant. As soon as this is done,

the bells attract the insulated clappers, and having communicated to them a little electricity, immediately repels them. The clappers now fly to deposit the electricity, they have received upon the centre bell. They are then again in a condition to be attracted by the suspended bells, and again return to the centre bell on being repelled, and this alternate motion continues, accompanied of course by the ringing of the bells till the electrification of the ball C, is discontinued, or the communication of the bell B with the earth cut off.

The Electric Aurora Borealis.

Make a Torricellian vacuum* in a glass tube, about three feet long, and hermetically sealed."† Let one end of this tube be held in the hand, and the other applied to the conductor; and immediately the whole tube will be illuminated from one end; and when taken from the conductor will continue luminous, without interruption, for a considerable time, very often about a quarter of an hour. If after this, it be drawn through the hand either way, the light will be uncommonly brilliant, and without the least interrup-

* A Torricellian vacuum is made by filling a tube with pure mercury, and then inverting it, in the same manner as in making a barometer; for as all the mercury runs out, the space above will be a true vacuum.

† A glass is hermetically sealed by holding the end of it in the flame of a candle, till it begins to melt, and then twisting it together with a pair of pincers.

tion, from one hand to the other, even to its whole length. After this operation, which discharges it in a great measure, it will still flash at intervals, though it be held only at the extremity, and quite still; but if it be grasped by the other hand at the same time, in a different place, strong flashes of light will dart from one end to the other. This will continue for twenty-four hours, and often longer, without any fresh excitation. Small and long glass tubes, exhausted of air, and bent in many irregular crooks and angles, will, when properly electrified, exhibit a very beautiful representation of vivid flashes of lightning.

The Animated Feather.

Electrify a smooth glass tube with a rubber, and hold a small feather at a short distance from it. The feather will instantly fly to the tube, and adhere to it for a short time; it will then fly off, and the tube can never be brought close to the feather till it has touched the side of the room, or some other body that communicates with the ground. If, therefore, you take care to keep the tube between the feather and the side of the room, you may drive it round to all parts of the room without touching it; and what is very remarkable, the same side of the feather will be constantly opposite the tube.

While the feather is flying before the smooth tube, it will be immediately attracted by an excited rough tube or a stick of wax, and fly continually from one

tube to the other, till the electricity of both is discharged.

The Candle Lighted by Electricity.

Charge a small coated phial, whose knob is bent outwards so as to hang a little over the body of the phial; then wrap some loose cotton over the extremity of a long brass pin or wire, so as to stick moderately fast to its substance. Next roll this extremity of the pin, which is wrapped up in cotton, in some fine powdered resin; then apply the extremity of the pin or wire, to the external coating of the charged phial, and bring, as quickly as possible, the other extremity that is wrapped round with cotton, to the knob; the powdered resin takes fire, and communicates its flame to the cotton, and both together burn long enough to light a candle. Dipping the cotton in oil of turpentine will do as well, if you use a larger sized jar.

Electrical Air Cannon.

Hydrogen is inflammable, and extinguishes flame. When pure, it burns quietly with a lambent blue flame at the surface, in contact with air; but, if mixed with thrice its volume of air, it burns rapidly, and with detonation. In making this experiment, a strong phial, capable of holding about six ounces of water, may be employed; or the inflammable air cannon,

which admits of the mixture being fired by the electric spark. This instrument consists of a cylinder of brass about three-fourths of an inch diameter, and six inches long, in the form of a small cannon or pistol-barrel, properly mounted, and having a wire, passing through a tube of ivory, and not quite touching the interior of the cylinder, at the part usually occupied by the touch-hole, an electric spark communicated to this wire inflames the mixture of hydrogen and atmospheric air in its interior. It may be charged by previously filling it with dry sand, and emptying it out into a phial of hydrogen, which rises into the gun sufficiently mixed with air; the muzzle may be secured by a cork, which is expelled with much violence and a loud report, upon the inflammation of the gas.

Artificial Earthquake.

In the middle of a large basin of water, lay a round wet board. On the board place any kind of building made of pasteboard, of separate pieces, and not fastened together. Then fixing a wire that communicates with the two chains of the electrifying battery, so that it may pass over the board and the surface of the water, upon making the explosion, the water will become agitated as in an earthquake, and the board moving up and down, will overturn the structure, while the cause of the commotion is totally concealed.

Magical Explosion.

Make up some gunpowder, in the form of a small cartridge, in each end of which put a blunt wire, so that the ends inside of the cartridge be about half an inch of each other; then joining the chain that proceeds from one side of the electrifying battery, to the wire at the other end, the shock will instantly pass through the powder, and set it on fire.

Method of receiving the Electrical Shock from a Cat.

Place the left hand under the throat, with the middle finger and thumb slightly pressing the bones of the animal's shoulder, then gently passing the right hand along the back, sensible electrical shocks will be felt in the left hand, and very distinct discharges may be obtained by touching the tips of the ears, after applying friction to the back: the same may be obtained from the foot.

Another Electrical Experiment.

Place a thin piece of tin-foil vertically, between two horizontal and insulated rods of brass, each terminated by a knob, and distant from each other be-

tween one and two inches, then pass from one to the other a strong charge of a large electrical battery: the plate of tin will be found pierced by two holes, with their burs in opposite directions. That the experiment may succeed, the tin-foil should be thin, and the charge strong, otherwise only two impressions will be seen on the plate.

The Electrical Fountain.

Suspend a vessel of water from the middle of the brass arch, and place in the vessel a small tube. The water will be one continued stream; and if the electrification be strong, a number of streams will issue, in form of a cone, the top of which will be at the extremity of the tube. This experiment may be stopped and renewed almost instantly, as if at the word of command.

To pierce a Card, &c. by Electricity.

Take a card, a quire of paper, or any similar material, and place it against the outside coating of a charged jar: keep the card in its situation by pressing against it one knob of the discharged rod, and with the other knob of the rod touch that of the jar. The discharge which will immediately follow, to restore the equilibrium of the two sides of the jar, will be found to have made one or more holes entirely

through the card; and each hole will have a bur or raised edge on both sides, unless pressed rather hard against the sides of the jar. This double bur shews that the card is not perforated in the direction of the passage of the fluid, but by the expansion of its substance in every direction.

If, instead of paper, a very thin plate of glass, sealing-wax, rosin, or the like, be interposed between the knob of the discharging rod and the outside coating of the jar, the discharge will break these substances to pieces.

A small insect interposed, in the manner of the card, though not pressed, will be instantly killed by the discharge: and a discharge of six square feet will deprive a man of sensation for a time, if the head be made part of the circuit.

Electric Chase.

The experiment called *The Electric Flies*, shews the effect of points in an amusing manner. Fig. 11, shews a combination of two of these flies, which consist of brass wires fastened, in the same plane, in a small brass centre-piece or cap; these wires are finely pointed, and bent at right angles near their extremities; and those of each fly are bent in the same direction, though the two flies with respect to each other have their points in a contrary direction. Each fly *a*, *b*, is exactly balanced, and will turn on its centre by the slightest impulse. The supporting

wire *c* is fixed in the prime conductor, and so soon as it is electrified, the flies begin to turn with great rapidity, each in a contrary direction to that of its point, and in the dark the course of each fly will be marked by a line of fire. With a sufficiently powerful machine, the number of flies may be considerable, and by varying their sizes, distances, and position, an interesting spectacle will be produced

The flies, in this experiment, turn the same way, whether positively or negatively electrified. This must be evident, when the cause of their motion is considered. When they are positively electrified, the electric fluid issuing from the points strikes the air, and causes their motion in a contrary direction to the points: and when they are electrified negatively, the stream of electricity which they solicit, impels them in the same direction. Under an exhausted receiver no motion is produced, because the medium which still remains is not dense enough for the electric fluid to act upon with so much force, as to overcome the friction of the flies upon their centres. Also, under an insulated receiver, containing only common air, the motion soon ceases, because the air and the glass soon become so much electrified, that the electric fluid ceases to escape from the points.

Another.

On the top of a finely-pointed wire, rising perpendicularly from the conductor, let another wire, sharp-

ened at each end, be made to move freely, as on a centre. If it be well balanced, and the points bent horizontally, in opposite directions, it will, when electrified, turn very swiftly round, by the re-action of the air against the current which flows from off the points. These points may be nearly concealed, and the figures of men and horses, with hounds, and a hare, stag, or fox, may he placed upon the wires, so as to turn round with them, when they will appear as if in pursuit. The chase may be diversified, and a greater variety of figures put upon them, by increasing the number of wires proceeding from the same centre.

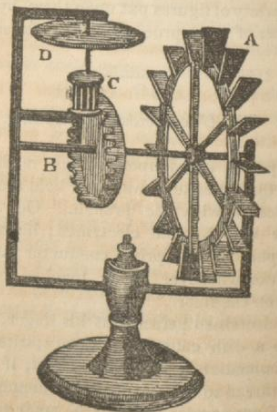
The Unconscious Incendiary.

Let a person stand upon a stool made of baked wood, or upon a cake of wax, and hold a chain which communicates with the branch. On turning the wheel he will become electrified; his whole body forming part of the prime conductor; and he will emit sparks whenever he is touched by a person standing on the floor.

If the electrified person put his finger, or a rod of iron, into a dish containing warm spirits of wine, it will be immediately in a blaze: and, if there be a wick or thread in the spirit, that communicates with a train of gunpowder, he may be made to blow up a magazine, or set a city on fire, with a piece of cold iron, and at the same time be ignorant of the mischief he is doing.

The Electrical Mill.

See the following Fig. A is the water-wheel, B the cog-wheel on its axis, C the trundle turned by that wheel, and D the running mill-stone on the top of the axis of the trundle. It may easily be turned by electricity, if instead of the round plate D for the mill-stone, there be a horizontal wheel on the axis of the trundle C, with spur-cogs, which will turn two



trundles placed on its opposite sides; and on the top of each axis of the trundles, may be a round plate, representing a mill-stone: so that this model has all

the working parts of a double water-mill, turning two mill-stones.

Set the mill near the prime conductor, and place the crooked wire, so that its point may be directed towards the uppermost side of the great wheel A; then work the electrical machine, and the stream of fire that issues from the point of the wire will turn the wheel; and consequently all the other working parts of the mill.

The Inconceivable Shock.

Put in a person's hand a wire that is fixed on to the hook that comes from the chain which communicates with one side of the battery, and in his other hand put a small wire with a hook at the end of it, which you direct him to fix on a hook which comes from the other chain. On attempting to do this, he will instantly receive a shock from his body, without being able to guess the cause.

Care should be taken that the shock be not too strong; and regard should be had to the constitution and disposition of the party, as a shock that would hardly affect one person, might be productive of very serious consequences to another.

Much entertainment may be derived from concealing the chain that communicates with that which proceeds from the outside of the battery, under a carpet, and placing the wire that communicates with the chain from the inside, in such a manner, that a

person may put his hand on it without suspicion, at the same time that his feet are upon the other wire.

The whole company may be made to partake of the shock, by joining hands, and forming a circle. The experiment may also be varied if they tread upon each other's toes, or lay their hands upon each other's heads. It might happen, by the latter method, that the whole company would be struck to the ground; but it will be productive of no danger, and very little inconvenience; on the contrary, it has happened that they have neither heard nor felt the shock.

Electrical Orrery.

A great diversity of other experiments have been contrived to shew the power of points, one of them is the *Electrical Orrery*, represented at Fig. 12. The sun and earth go round their common centre of gravity in a solar year, and the earth and moon go round their common centre of gravity in a lunar month. These motions are represented by an electrical experiment as follows; the ball S represents the sun, E the earth, and M the moon, connected by wires *a*, *c*, and *b*, *d*; *a* is the centre of gravity between the sun and earth, and *b* is the centre of gravity between the earth and the moon. These three balls and their connecting wires are hung and supported on the sharp point of a wire A, which is set upright in the prime conductor B of the electrical machine; the earth and moon hanging upon the sharp point of the

wire *e*, in which wire is a pointed short pin, sticking out horizontally at *c*; and there is just such another pin at *d*, sticking out in the same manner, in the wire that connects the earth and moon.

When the working of the electrical machine is commenced, and consequently these electrical balls and wires are electrified, the fluid that flies off horizontally from the point *c* and *d*, causes S and E to move round their common centre of gravity *a*; and E and M to move round their common centre of gravity *b*: and as E and M are light when compared with S and E, there is much less friction on the point *b* than upon the point *a*; so that E and M will make a much greater number of revolutions about the point *b*, than S and E made about the point *a*. The weights of the balls may be adjusted so that E and M may go twelve times round *b*, in the same time that S and E go once round *a*.

Brilliant Electrical Star.

If a plate of tin be cut into the form of a star, and be supported on its centre by a wire projecting from the prime conductor, as soon as the wheel of the machine is turned, and this apparatus electrified, a flame will appear at the extremity of every angle of the star, which will be very beautiful; and if the star be made to turn swiftly on its centre, an entire circle of fire will be seen in the dark. This experiment will appear very surprising to persons unacquainted with

electricity, if the operator now and then privately touch the prime conductor, which may easily be managed as the experiment is performed in the dark; for by this means he may command the appearance or disappearance of the star or circle of fire, at pleasure.

Electrical Illumination.

To illuminate eggs by electricity, it is merely necessary to get a mahogany stand so constructed as to hold three eggs at a greater or smaller distance, according to the position of two sliding pieces of wire. A chain is then placed at the bottom in such a manner as to touch the lowest egg with one end, and with its other the outside coating of a charged jar. The sliding wire at the top is made to touch the upper egg, and the distance of the eggs asunder should not exceed the quarter or eighth part of an inch. The electricity being, by means of the discharging rod, sent down the ball and wire, will, in a darkened room, render the eggs luminous and transparent.

To Illuminate a Piece of Sugar by an Electrical Explosion.

Place a piece of sugar on the top of a Leyden Jar, and bring the discharging rod in contact with it, so

that an explosion will take place; if the room be darkened, the light will be seen upon its surface; continuing some time after the explosion. If chalk be used, it will also retain the light after the explosion, which will be of a different colour.

The Electrical Kiss.

A lady may challenge any gentleman, not acquainted with the experiment, that he will not be able to kiss her, although she may incline to meet him. If he accepts the challenge, and the machine turn while they are inclining their heads to kiss each other, provided their clothes do not touch before their lips meet, a spark of fire will fly from the lady to the gentleman, which will be sure to make him draw back, without accomplishing his design.

The Miraculous Luminaries.

You must previously prepare the following phosphorus: Calcine common oyster-shells, by burning them in the fire for half an hour: then reduce them to powder; of the clearest of which take three parts, and of flowers of sulphur one part; put the mixture into a crucible, about an inch and a half deep. Let it burn in a strong fire for rather better than an hour; and when it is cool, turn it out and break it in pieces;

and taking those pieces into a dark place, scrape off the parts that shine brightest, which, if good, will be a white powder.

Then construct a circular board, of three or four feet diameter, on the centre of which draw in gum-water, or any adhesive liquid, a half-moon, of three or four inches in diameter, and a number of stars round it, at different distances, and of various magnitudes. Strew the phosphorus over the figures, to the thickness of about a quarter of an inch, laying one coat over the other. Place this board behind a curtain; and when you draw the curtain up or back, discharge one electrifying jar or phial over each figure, at the distance of about an inch, and they will become illuminated, exhibiting a very striking resemblance of the moon and stars; and will continue to shine for about half an hour, their splendour being gradually more faint.

The Fiery Shower.

On the plate put a number of any kind of seeds, grains of sand, or brass dust. The conductor being strongly electrified, those light particles will be attracted and repelled by the plate suspended from the conductor, with amazing rapidity, so as to exhibit a perfect fiery shower.

Another way is by a sponge that has been soaked in water. When this sponge is first hung to the conductor, the water will drop from it very slowly; but

when it is electrified, the drops will fall very fast, and appear like small globes of fire, illuminating the basin into which they fall.

The Illuminated Vacuum.

Take a tall receiver that is very dry, and fix through the top of it, with cement, a blunt wire: then exhaust the receiver, and present the knob of the wire to the conductor, and every spark will pass through the vacuum in a broad stream of light, visible through the whole length of the receiver, let it be as tall as it will. This generally divides into a variety of beautiful rivulets, which are continually changing their course, uniting and dividing again in the most pleasing manner.

If a jar be discharged through this vacuum, it presents the appearance of a very dense body of fire, darting directly through the centre of the vacuum, without touching the sides; whereas, when a single spark passes through, it generally goes more or less to the side, and a finger placed on the outside of the glass, will draw it wherever a person pleases. If the vessel be grasped by both hands, every spark is felt like the pulsation of a large artery; and all the fire makes towards the hands. This pulsation is even felt at some distance from the receiver, and a light is seen between the hand and the glass.

All this while the pointed wire is supposed to be electrified positively; if it be electrified negatively,

the appearance is astonishingly different; instead of streams of fire, nothing is seen but one uniform luminous appearance, like a white cloud, or the *milky way* in a clear star-light night. It seldom reaches the whole length of the vessel, but generally appears only at the end of the wire, like a lucid ball.

If a small phial be inserted in the neck of a small receiver, so that the external surface of the glass be exposed to the vacuum, it will produce a very beautiful appearance. The phial must be coated on the inside, and while it is charging, at every spark taken from the conductor into the inside, a flash of light is seen to dart at the same time from every part of the external surface of the phial, so as quite to fill the receiver. Upon making the discharge, the light is seen to run in a much closer body, the whole coming out at once.

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*The Illuminated Cylinder.**

Provide a glass cylinder, three feet long, and three inches in diameter; near the bottom of it fix a brass plate, and have another brass plate, so contrived that you may let it down the cylinder, and bring it as near the first plate as you desire. Let this cylin-

* To shew this and the other electrical experiments of a like nature, the room in which they are exhibited ought to be completely darkened; the illuminated water, eggs, &c. will then appear to great advantage;—the discharge even of the Leyden Phial will appear with greater brilliancy under such circumstances.

der be exhausted and insulated, and when the upper part is electrified, the electric matter will pass from one plate to the other, when they are at the greatest distance from each other that the cylinder will admit. The brass plate at the bottom of the cylinder will also be as strongly electrified, as if it were connected by a wire to the prime conductor.

The electric matter, as it passes through this vacuum, presents a most brilliant spectacle, exhibiting sparkling flashes of fire the whole length of the tube, and of a bright silver hue, representing the most lively exhalations of the aurora borealis.

To Illuminate Water.

Connect one end of a chain with the outside of a charged jar, and let the other end lie upon the table. Place the end of another piece of chain at the distance of about one quarter of an inch from the former; then set a decanter of water upon these separated ends, and on making the discharge, the water will be illuminated.

The Electrified Cotton.

Take a small lock of cotton, extended in every direction as much as can conveniently be done, and by a linen thread about five or six inches long, or by a

thread drawn out of the same cotton, tie it to the end of the prime conductor: then set the machine in motion, and the lock of cotton on being electrified, will immediately swell, by repelling its filaments from one another, and will stretch itself towards the nearest conductor. In this situation let the cylinder be kept in motion, and present the end of your finger or the knob of a wire towards the lock of cotton, which will then immediately move towards the finger, and endeavour to touch it: but take with the other hand a pointed needle, and present its point towards the cotton, a little above the end of the finger, and the cotton will be observed immediately to shrink upwards, and move towards the prime conductor. Remove the needle, and the cotton will come again towards the finger. Present the needle, and the cotton will shrink again.

The Electric Sparks.

When the prime conductor is situated in its proper place, and electrified by whirling the cylinder, if a metallic wire, with a ball at its extremity, or the knuckle of a finger, be presented to the prime conductor, a spark will be seen to issue between them, which will be more vivid, and will be attended with a greater or less explosion, according as the ball is larger. The strongest and most vivid sparks are drawn from that end or side of the prime conductor which is farthest from the cylinder. The sparks have the same appear-

ance whether they be taken from the positive or the negative conductor; they sometimes appear like a long line of fire reaching from the prime conductor to the opposite body, and often (particularly when the spark is long, and different conducting substances in the line of its direction) it will have the appearance of being bent to sharp angles in different places, exactly resembling a flash of lightning.

The figure of a spark varies with the superficial dimensions of the part from which it is taken. If it be drawn from a ball of two or three inches in diameter, it will have the appearance of a straight line; but if the ball from which it is drawn be much smaller, as half an inch in diameter, it will assume the zig-zag appearance above mentioned.

Dancing Balls.

Take a common tumbler or glass jar, and having placed a brass ball in one of the holes of the prime conductor, set the machine in motion, and let the balls touch the inside of the tumbler; while the ball touches only one point, no more of the surface of the glass will be electrified, but by moving the tumblers about so as to make the ball touch many points successively, all the points will be electrified, as will appear by turning down the tumbler over a number of pith or cork balls placed on a table. These balls will immediately begin to fly about.

Resin Ignited by Electricity.

Wrap some cotton wool, containing as much powdered resin as it will hold, about one of the knobs of a discharged rod. Then having charged a Leyden jar, apply the naked knob of the rod to the external coating, and the knob enveloped by the cotton to the ball of the wire. The act of discharging the jar will set fire to the resin.

A piece of phosphorus or camphor wrapped in cotton wool, and used in the same way, will be much more easily inflamed.

Spirits Ignited by Electricity.

Hang a small ball with a stem to the prime conductor, so that the ball may project below the conductor. Then warm a little ardent spirit, by holding it a short time over a candle in a metallic spoon; hold the spoon about an inch below the ball, and set the machine in motion. A spark will soon issue from the ball, and set fire to the spirits.

This experiment may be varied different ways, and may be rendered very agreeable to a company of spectators. A person, for instance, standing upon an electric stool, and communicating with the prime conductor, may hold the spoon with the spirits in his hand, and another person, standing upon the floor, may set the spirits on fire, by bringing his finger

within a small distance of it. Instead of his finger he may fire the spirits with a piece of ice, when the experiment will seem much more surprising. If the spoon be held by the person standing upon the floor, and the insulated person bring some conducting substance over the surface of the spirit, the experiment succeeds as well.

Electrified Ball.

Place an ivory ball on the prime conductor of the machine, and take a strong spark, or send the charge of a Leyden phial through its centre, and the ball will appear perfectly luminous; but if the charge be not sent through the centre, it will pass over the surface of the ball and singe it. A spark made to pass through a ball of box-wood, not only illuminates the whole, but makes it appear of a beautiful crimson, or rather fine scarlet colour.

Illuminated Phosphorus.

Put some of Canton's phosphorus into a clear glass phial, and stop it with a glass stopper, or a cork and sealing-wax. If this wire be kept in a darkened room (which for this experiment must be very dark) it will give no light; but let two or three strong sparks be drawn from the prime conductor, when the phial is kept about two inches distant from the sparks, so

that it may be exposed to that light, and this phial will receive the light, and afterwards will appear illuminated for a considerable time.

This powder may be stuck upon a board by means of the white of an egg, so as to represent figures of planets, letters, or any thing else, at the pleasure of the operator, and these figures may be illuminated in the dark, in the same manner as the above described phial.

A beautiful method of expressing geometrical figures with the above powder, is to bend small glass tubes, of about the tenth part of an inch diameter, in the shape of the figure desired, and then to fill them with the phosphoric powder. These may be illuminated in the manner described; and they are not so subject to be spoiled, as the figures represented upon the board frequently are.

The Luminous Writing.

Small pieces of tin-foil may be stuck on a flat piece of glass, so as to represent various fanciful figures. Upon the same principle is the word LIGHT produced, in luminous characters.

It is formed by the small separations of the tin-foil pasted on a piece of glass fixed in a frame of baked wood. To use this, the frame must be held in the hand, and the ball presented to the conductor. The spark will then be exhibited in the intervals composing the word, from whence it passes to the hook,

and then to the ground by a chain. The brilliancy of this is equal to that of the spiral tubes.

Electrified Air.

Fix two or three pointed needles into the prime conductor of an electrical machine, and set the glass in motion so as to keep the prime conductor electrified for several minutes. If now, an electrometer be brought within the air that is contiguous to the prime conductor, it will exhibit signs of electricity, and this air will continue electrified for some time, even after the machine has been removed into another room The air, in this case, is electrified positively; it may be negatively electrified by fixing the needles in the negative conductor while insulated, and making a communication between the prime conductor, and the table, by means of a chain or other conducting substance. The air of a room may be electrified in another way. Charge a large jar, and insulate it; then connect two or more sharp pointed wires or needles, with the knob of the jar, and connect the outside coating of the jar with the table. If the jar be charged positively, the air of the room will soon become positively electrified likewise; but if the jar be charged negatively, the electricity communicated by it to the air, will also become negative. A charged jar being held in one hand, and the flame of an insulated candle held in the other being brought near the knob of the jar, will also produce the same effect.

Another Electric Orrery, (See p. 118.)

From the prime conductor of an electric machine, suspend six concentric hoops of metal at different distances from each other, in such a manner as to represent in some measure the proportional distances of the planets. Under these, and at a distance of about half an inch, place a metallic plate, and upon this plate, within each of the hoops, a glass bubble blown very thin and light. On electrify ing the hoops, the bubbles will be immediately attracted by them, and will continue to move round the hoops as long as the electrification continues. If the electricity be very strong, the bubbles will frequently be driven off, run hither and thither on the plate, making a variety of pleasing and surprising motions round their axis; after which they will return to the hoop, and circulate as before; and if the room be darkened, they will all appear beautifully illuminated with electric light.

Beautiful Electrical Experiment.

Take some oxalate of lime, obtained by precipitation, well washed, and dried in a Wedgewood's basin at a temperature of 300 degrees, until so dry as not to render a cold glass plate, placed over it, dim Stir it with a platina spatula; in a few moments, by friction against the metal, it will become so strongly

electrical, that it cannot be collected together, but will fly about the dish whenever it is moved, and over its sides into the sand-bath. It requires some little stirring before the particles of the powder are all of them sufficiently electrical to produce the effect.

Safest Situation during a Thunder-Storm.

[*Though not exactly an experiment, the following advice will be important to the reader.*]

The safest situation during a thunder-storm is the cellar; for when a person is below the surface of the earth, the lightning must strike it before it can reach him, and will of course, in all probability, be expended on it. Dr. Franklin advises persons apprehensive of lightning to sit in the middle of a room, not under a metal lustre, or any other conductor, and to lay their feet upon another chair. It will be safer still, he adds, to lay two or three beds or mattresses in the middle of the room, and folding them double, to place the chairs upon them. A hammock suspended by silk cords would be an improvement upon this apparatus. Persons in fields should prefer the open parts to the vicinity of trees, &c. The distance of a thunder-storm, and consequently the danger, is not difficult to be estimated. As light travels at the rate of 72,420 leagues in a second of time, its effects may be considered as instantaneous within any moderate distance. Sound on the contrary, is transmitted

only at the rate 1,142 feet, or about 380 yards, in a second. By accurately observing therefore the time which intervenes between the flash and the noise of the thunder which follows it, a very near calculation may be made of its distance, and there is no better means of removing apprehensions.

The Electric Kite.

Make a small cross of two light strips of cedar, the arms so long as to reach to the four corners of a large thin silk handkerchief when extended; tie the corners of the handkerchief to the extremities of the cross, and you have the body of the kite; which being properly accommodated with a tail, loop, and string, will rise in the air like those made of paper; but this being silk, is more adapted to bear the wet and wind of a thunder gust, without tearing. To the top of the upright stick of the cross is to be fixed a very sharp pointed wire, rising a foot or more above the wood. To the end of the twine is to be tied a silk ribbon, and where the silk and twine join, a key may be fastened. This kite is to be raised when a thunder-storm appears to be coming on; and the person who holds the string must stand within a door or window, or under some cover, so that the silk ribbon may not be wet; and care must be taken that the twine do not touch the frame of the door or window. As soon as any of the thunder clouds come over the kite, the pointed wire will draw the electric fire from them, and the

kite, with all the twine, will be electrified, while the loose filaments of the twine will stand out every way, and be attracted by an approaching finger. When the rain has wetted the kite and twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key, on the approach of your knuckle. At this key an electric phial may be charged; and from electric fire thus obtained, spirits may be kindled, and all the other electric experiments performed, which are usually done by the help of a rubbed glass or tube, and thereby the identity of the electric matter with that of lightning completely demonstrated.

The Electric Ball.

Provide a ball of cork about three quarters of an inch in diameter, hollowed out in the internal part by cutting it in two hemispheres, scooping out the inside, and then joining them together with paste. Having attached this to a silk thread between three and four feet in length, suspend it in such a manner that it may just touch the knob of an electric jar, the outside of which communicates with the ground. On the first contact it will be repelled to a considerable distance, and after making several vibrations, will remain stationary; but if a cradle be placed at some distance behind it, so that the ball may be between it and the bottle, the ball will instantly begin to move, and will turn round the knob of the jar. moving in a

kind of ellipsis as long as there is any electricity in the bottle. This experiment is very striking, though the motions are far from being regular; but it is remarkable that they always affect the elliptical rather than the circular form.

To Spin Sealing-Wax into Threads by Electricity.

Stick a small piece of sealing-wax on the end of a wire, and set fire to it. Then put an electrical machine in motion, and present the wax just blown out at the distance of some inches from the prime conductor. A number of extremely fine filaments will immediately dart from the sealing-wax to the conductor, on which they will be condensed into a kind of net-work resembling wool.

If the wire with the sealing-wax be stuck into one of the holes of the conductor, and a piece of paper be presented at a moderate distance from the wax, just after it has been ignited, on setting the machine in motion, a net work of wax will be formed on the paper. The same effect, but in a slighter degree, will be produced, if the paper be briskly rubbed with a piece of elastic gum, and the melting sealing-wax be held pretty near the paper immediately after rubbing.

If the paper thus painted, as it were, with sealing-wax, be gently warmed by holding the back of it to the fire, the wax will adhere to it, and the result of the experiment will thus be rendered permanent.

The Electrified Camphor.

A beautiful experiment of the same nature is made with camphor. A spoon holding a piece of lighted camphor is made to communicate with an electrified body, as the prime conductor of a machine; while the conductor continues electrified by keeping the machine in motion, the camphor will throw out ramifications, and appear to shoot like a vegetable.

GALVANISM.

A LONG time prior to the establishment of galvanism as a science, it had been observed, that if two different metals were placed in contact under water, they were subject to a rapid oxidation, though the water had no perceptible action upon them, when they were alone.

When metals have been soldered by means of other metals, they were found to tarnish about the places where they were joined; and the copper sheathing of ships when fastened by means of iron nails, soon corrodes about the place where the different metals touch each other.

It had been generally affirmed, that porter drunk