Title: Endless Amusement

Author: Unknown

Release Date: May 23, 2010 [EBook #32492]

Language: English

Credits: Produced by Chris Curnow and the Online Distributed Proofreading Team at http://www.pgdp.net (This file was produced from images generously made available by The Internet Archive)

ENDLESS AMUSEMENT:

A COLLECTION OF

NEARLY 400 ENTERTAINING EXPERIMENTS

IN VARIOUS BRANCHES OF SCIENCE;

INCLUDING

ACOUSTICS, ELECTRICITY, MAGNETISM, ARITHMETIC, HYDRAULICS, MECHANICS, CHEMISTRY, HYDROSTATICS, OPTICS;
WONDERS OF THE AIR-PUMP;

ALL THE

POPULAR TRICKS AND CHANGES OF THE CARDS,

&c., &c.

TO WHICH IS ADDED,

A COMPLETE SYSTEM OF PYROTECHNY;

OR,
THE ART OF MAKING FIRE-WORKS.

THE WHOLE SO CLEARLY EXPLAINED AS TO BE WITHIN THE REACH OF THE MOST LIMITED CAPACITY.

With Illustrations.

FROM THE SEVENTH LONDON EDITION.

PHILADELPHIA:
LEA AND BLANCHARD.
1847.

CONTENTS.

[Pg iii]

ENDLESS AMUSEMENT.

[Pg 13]

To produce Fire by the Mixture of two cold Liquids.

Take half a pound of pure dry nitrate, in powder; put it into a retort that is quite dry; add an equal quantity of highly rectified oil of vitriol, and, distilling the mixture in a moderate sand heat, it will produce a liquor like a yellowish fume; this, when caught in a dry receiver, is *Glauber's Spirits of Nitre*; probably the preparation, under that name, may be obtained of the chemists, which will of course save much time and trouble.

You then put a drachm of distilled oil of cloves, turpentine, or carraways, in a glass vessel; and if you add an equal quantity, or rather more, of the above spirit, though both are in themselves perfectly cold, yet, on mixing them together, a great flame will arise and destroy them both, leaving only a little resinous matter at the bottom.

The Exploding Bubble.

If you take up a small quantity of melted glass with a tube, (the bowl of a common tobacco-pipe will do,) and let a drop fall into a vessel of water, it will chill and condense with a fine spiral tail, which being broken, the whole substance will burst with a loud explosion, without injury either to the party that holds it, or him that breaks it; but if the *thick* end be struck, even with a hammer, it will not break.

The Magic Picture.

Take two level pieces of glass, (plate glass is the best,) about three inches long and four wide, exactly of the same size; lay one on the other, and leave a space between them by pasting a piece of card, or two or three small pieces of thick paper, at each corner. [Pg 14]

Join these glasses together at the edges by a composition of lime slaked by exposure to the air, and white of an egg. Cover all the edges of these glasses with parchment or bladder, except at one end, which is to be left open to admit the following composition.

Dissolve, by a slow fire, six ounces of hogs'-lard, with half an ounce of white wax; to which you may add an ounce of clear linseed oil.

This must be poured in a liquid state, and before a fire, between the glasses, by the space left in the sides, and which you are then to close up. Wipe the glasses clean, and hold them before the fire, to see that the composition will not run out at any part.

Then fasten with gum a picture or print, painted on very thin paper, with its face to one of the glasses, and, if you like, you may fix the whole in a frame.

While the mixture between the glasses is cold, the picture will be quite concealed, but become transparent when held to the fire; and, as the composition cools, it will gradually disappear.

Artificial Lightning.

Provide a tin tube that is larger at one end than it is at the other, and in which there are several holes. Fill this tube with powdered resin; and when it is shook over the flame of a torch, the reflection will produce the exact appearance of lightning.

Artificial Thunder.

Mix two drachms of the filings of iron, with one ounce of concentrated spirit of vitriol, in a strong bottle that holds about a quarter of a pint; stop it close, and in a few minutes shake the bottle; then taking out the cork, put a lighted candle near its mouth, which should be a little inclined, and you will soon observe an inflammation arise from the bottle, attended with a loud explosion.

To guard against the danger of the bottle bursting, the best way would be to bury it in the ground, and apply the light to the mouth by means of a taper fastened to the end of a long stick.

[Pg 15]

Another way.

Mix three ounces of saltpetre, two ounces of salt of tartar, and two ounces of sulphur; roll the mixture up into a ball, of which take a quantity, about the size of a hazel-nut, and, placing it in a ladle or shovel over the fire, the explosion will resemble a loud clap of thunder.

You will produce a much more violent commotion if you double or treble the quantity of the last experiment; suppose you put two or three ounces of the mixture into the shovel. For fear of accidents, it should not be done in the house, but by placing the shovel over a chafing-dish of very hot coals, in the open air, standing a great distance off.

Common prudence will dictate the necessity of using great care in the above experiments, as an accident will soon happen if a person does not get out of the way before the composition explodes.

Money augmented by an Optical Illusion.

In a large drinking-glass of a conical shape, (small at the bottom and wide at the top,) put a shilling, and let the glass be half full of water; then place a plate on the top of it, and turn it quickly over, that the water may not escape. You will see on the plate a piece of coin of the size of half-a-crown; and a little higher up another the size of a shilling.

It will add to the amusement this experiment affords, by giving the glass to any one in company, (but who, of course, has not witnessed your operations,) and, desiring him to throw away the water, but save the pieces, he will not be a little surprised at finding only one.

Three objects discernible only with both Eyes.

If you fix three pieces of paper against the wall of a room at equal distances, at the height of your eye, placing yourself directly before them, at a few yards' distance, and close your right eye, and look at them with your left, you will see only two of them, suppose the first and second; alter the position of your eye, and you will see the first and third: alter your position a second time, you will see the second and third, but never the whole three together; by which it appears, that a [Pg 16] person who has only one eye can never see three objects placed in this position, nor all the parts of one object of the same extent, without altering his situation.

To construct the Camera Obscura.

Make a circular hole in the shutter of a window, from whence there is a prospect of some distance; in this hole place a magnifying glass, either double or single, whose focus is at the distance of five or six feet; no light must enter the room but through this glass. At a distance from it, equal to its focus, place a very white pasteboard, (what is called a Bristol board, if you can procure one large enough, will answer extremely well;) this board must be two feet and a half long, and eighteen or twenty inches high, with a black border round it: bend the length of it inward to the form of part of a circle, whose diameter is equal to double the focal distance of the glass. Fix it on a frame of the same figure, and put it on a moveable foot, that it may be easily placed at that distance from the glass, where the objects appear to the greatest perfection. When it is thus placed, all the objects in front of the window will be painted on the paper in an inverted position, with the greatest regularity, and in the most natural colours. If you place a swing looking-glass outside the window, by turning it more or less, you will have on the paper all the objects on each side the window.

If, instead of placing the looking-glass outside the window, you place it in the room above the hole, (which must then be made near the top of the shutter,) you may have the representation on a paper placed horizontally on a table, and draw at your leisure all the objects reflected.

Observe, the best situation is directly north; and the best time of the day is noon.

The Magnifying Reflector.

Let the rays of light that pass through the magnifying glass in the shutter be thrown on a large concave mirror, properly fixed in a frame. Then take a third strip of glass, and stick any small object on it; hold it in the intervening rays at a little more than the focal distance from the mirror, [Pg 17] and you will see on the opposite wall, amidst the reflected rays, the image of that object, very large, and beautifully clear and bright.

To tell by a Watch Dial the Hour when a Person intends to rise.

The person is told to set the hand of his watch at any hour he pleases, which hour he tells you; and you add in your mind 12 to it. You then desire him to count privately the number of that addition on the dial, commencing at the next hour to that at which he intends to rise, and including the hour at which he has placed the hand, which will give the answer: for example.

A intends to rise at 6, (this he conceals to himself;) he places the hand at 8, which he tells B, who, in his own mind, adds 12 to 8, which makes twenty. B then tells A to count twenty on the dial, beginning at the next hour to that at which he proposes to rise, which will be 5, and counting backwards, reckoning each hour as one, and including in his addition the number of the hour the

hand is placed at, the addition will end at 6, which is the hour proposed; thus,

The hour the hand is placed at is	8
The next hour to that which A intends to rise at is 5, which counts for	1
Count back the hours from 5, and reckon them at 1 each, there will be 11 hours, viz., 4, 3, 2, 1, 12, 11, 10, 9, 8, 7, 6	11
Making	20

A person having an even Number of Shillings in one Hand, and an odd Number in the other, to tell in which hand the odd or even Number is.

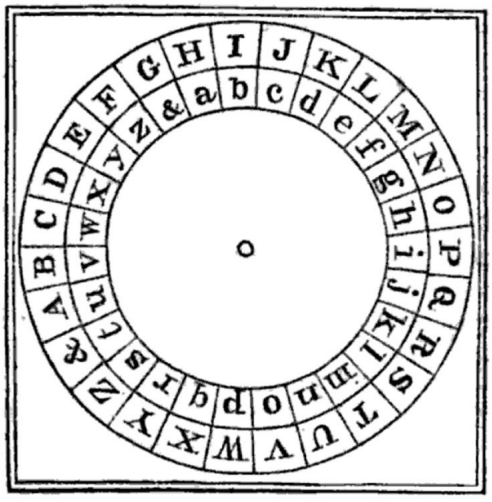
You desire the person to multiply the number in his right hand by an odd figure, and the number in his left by an even one; and tell you if the products, added together, be odd or even. If even, the even number is in the right hand; if odd, the even number is in the left. For instance, [Pg 18]

I. Number in the right hand is *even*	18	In the left hand *odd*	7
Multiply by	3	Multiply by	2
Product	54	Product	14
Add the Product of the left hand	14		
Which produces a total of	68		
II. Number in the right hand is *odd*	7	In the left hand *even*	18
Multiply by	3	Multiply by	2
Product	21	Product	36
Add the Product of the left hand	36		
Which produces a total of	57		

Secret Correspondence.

To carry on a correspondence without the possibility of the meaning of the letter being detected, in case it should be opened by any other person, has employed the ingenuity of many. No method will be found more effectual for this purpose, or more easy, than the following. [Pg 19]

Fig. 1.



Provide a piece of square card or pasteboard, and draw a circle on it, which circle is to be divided into 27 equal parts, in each of which parts must be written *one* of the capital letters of the alphabet, and the &, as in the figure. Let the centre of this circle be blank. Then draw another circle, also divided into 27 equal parts, in each of which write one of the small letters of the alphabet, and the &. This circle must be cut round, and made exactly to fit the blank space in the centre of the large circle, and must run round a pivot or pin. The person with whom you correspond must have a similar dial, and at the beginning of your letter you must put the capital letter, and at the end the small letter, which answer to each other when you have fixed your dial.

Suppose what you wish to communicate is as follows:

> *I am so watched I cannot see you as I promised; but I will meet you to-morrow in the park, with the letters, &c.*

You begin with the letter *T*, and end with the letter *m*, which shows how you have fixed the dial, and how your correspondent must fix his, that he may decipher your letter.

Then, for *I am*, you write *b uf*, and so of the rest, as follows.

T b uf lh pumrvayx b rvugghm lyy rhn ul b ikhfblyx vnm b pbee fyym rhn mh-fhkkhp bg may iukd pbma may eymmykl, tw. m.

Another Way.

Take two pieces of card, pasteboard, or stiff paper, through which you cut long squares at different distances. One of these you keep yourself, and the other you give to your correspondent. You lay the pasteboard on a paper, and, in the spaces cut out, write what you would have understood by him only; then fill the intermediate spaces with any words that will connect the whole together, and make a different sense. When he receives it, he lays his pasteboard over the [Pg 20] whole, and those words which are between crotchets [ ] form the intelligence you wish to communicate. For example: suppose you want to express these word,

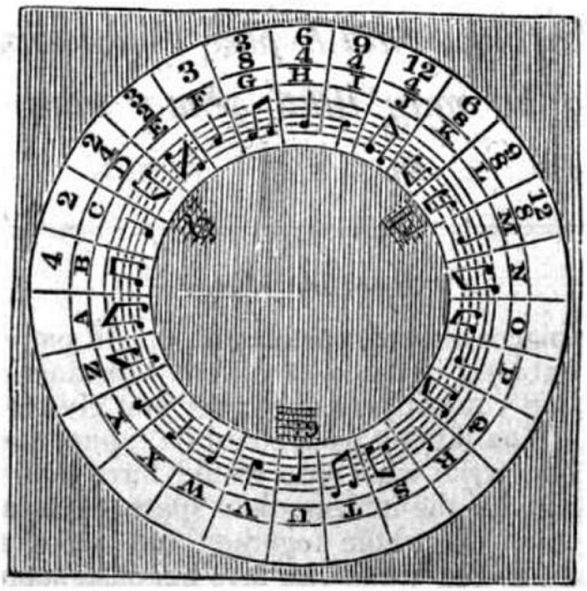
"*Don't trust Robert: I have found him a villain.*"

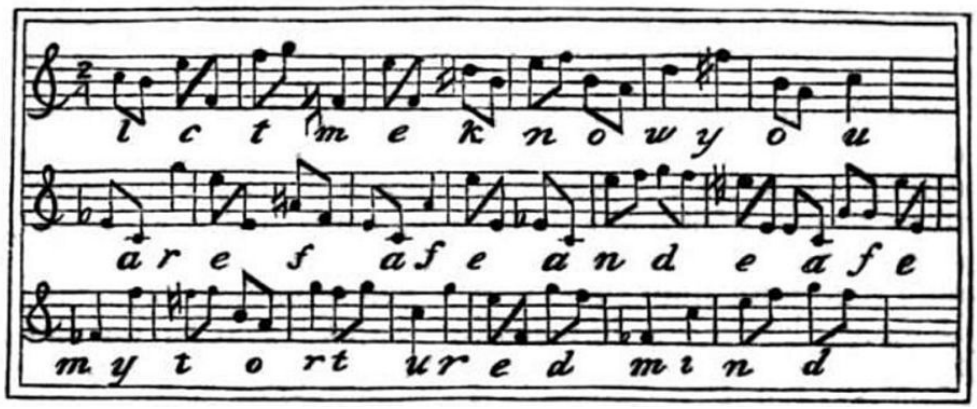
"[Don't] fail to send my books. I [trust] they will be ready when [Robert] calls on you. [I have] heard that you have [found] your dog. I call [him a villain] who stole him." You may place a pasteboard of this kind three other ways—the bottom at top—the top at bottom, or by turning it over; but in this case you must previously apprize your correspondent, or he may not be able to decipher your meaning.

Secret Correspondence by Music.

Form a circle like Fig. 2, divided into twenty-six parts, with a letter of the alphabet written in each. The interior of the circle is moveable, like that in Fig. 1, and the circumference is to be ruled like music-paper. Place in each division a note different in figure or position.

Fig. 2.



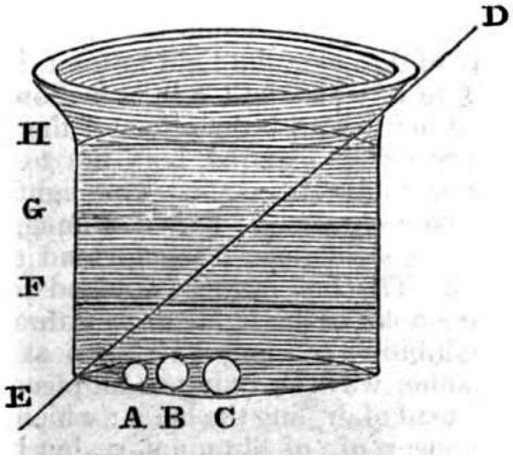


Within the musical lines place the three keys, and on the outer circle the figures to denote time. Then get a ruled paper, and place one of the keys (suppose *ge-re-sol*) against the time 2-4ths, at the beginning of the paper, which will inform your correspondent how to place his circle. You then copy the notes that answer to the letters of the words you intend to write, in the manner [Pg 21] expressed above.

The Magic Vessel.

On the bottom of a vessel, lay three pieces of money, the first at A, the second at B, and the third at C, Fig. 3. Then place a person at D, where he can see no farther into the vessel than E. You tell him, that by pouring water in the vessel you will make him see three different pieces of money; and bid him observe, that you do not convey any money in with the water. But be careful that you pour the water in very gently, or the pieces will move out of their places, and thereby destroy the experiment.

Fig. 3.



When the water rises up to F, the piece at A will be visible; when it reaches G, both A and B will be visible; and when it comes up to H, all three pieces will be visible.

[Pg 22]

Artificial Earthquake and Volcano.

Grind an equal quantity of fresh iron filings with pure sulphur, till the whole be reduced to a fine powder. Be careful not to let any wet come near it. Then bury about thirty pounds of it a foot deep in the earth, and in about six or eight hours the ground will heave and swell, and shortly after send forth smoke and flames like a burning mountain. If the earth is raised in a conical shape, it will be no bad miniature resemblance of one of the burning mountains.

Artificial Illuminations.

A very pleasing exhibition may be made with very little trouble or expense, in the following manner: Provide a box, which you fit up with architectural designs cut out on pasteboard; prick small holes in those parts of the building where you wish the illuminations to appear, observing, that in proportion to the perspective, the holes are to be made smaller; and on the near objects the holes are to be made larger. Behind these designs thus perforated, you fix a lamp or candle, but in such a manner that the reflection of the light shall only shine through the holes; then placing a light of just sufficient brilliance to show the design of the buildings before it, and making a hole for the sight at the front end of the box, you will have a very tolerable representation of illuminated buildings.

The best way of throwing the light in front, is to place an oiled paper before it, which will cast a mellow gleam over the scenery, and not diminish the effect of the illumination. This can be very easily planned, both not to obstruct the sight, nor be seen to disadvantage. The lights behind the picture should be very strong; and if a magnifying glass were placed in the sight hole, it would tend greatly to increase the effect. The box must be covered in, leaving an aperture for the smoke of the lights to pass through.

The above exhibition can only be shown at candle-light; but there is another way, by fixing small pieces of gold on the building, instead of drilling the holes; which gives something like the appearance of illumination, but by no means equal to the foregoing experiment.

N.B. It would be an improvement, if paper of various colours, rendered transparent by oil, were placed between the lights behind and the aperture in the buildings, as they would then resemble lamps of different colours.

[Pg 23]

The Cameleon Spirit.

Put into a decanter volatile spirit, in which you have dissolved copper filings, and it will produce a fine blue. If the bottle be stopped, the colour will disappear; but when unstopped, it will return. This experiment may be often repeated.

Invisible Ink.

Put litharge of lead into very strong vinegar, and let it stand twenty-four hours. Strain it off, and let it remain till quite settled; then put the liquor in a bottle.

You next dissolve orpiment in quick lime water, by setting the water in the sun for two or three

days, turning it five or six times a-day. Keep the bottle containing this liquor well corked, as the vapour is highly pernicious if received into the mouth.

Write what you wish with a pen dipped in the first liquor; and, to make it visible, expose it to the vapour of the second liquor. If you wish them to disappear again, draw a sponge or pencil, dipped in aqua fortis, or spirit of nitre, over the paper; and if you wish them to re-appear, let the paper be quite dry, and then pass the solution of orpiment over it.

Another.

Dissolve bismuth in nitrous acid. When the writing with this fluid is exposed to the vapour of liver of sulphur, it will become quite black.

Another.

Dissolve green vitriol and a little nitrous acid in common water. Write your characters with a new pen.

Next infuse small Aleppo galls, slightly bruised in water. In two or three days, pour the liquor off.

By drawing a pencil dipped in this second solution over the characters written with the first, they will appear a beautiful black. [Pg 24]

Invisible Gold Ink.

Put as much gold in as small a quantity of aqua regia as will dissolve it, and dilute it with two or three times the quantity of distilled water.

Next dissolve, in a separate vessel, fine pewter in aqua regia, and when it is well impregnated, add an equal quantity of distilled water.

Write your characters with the first solution: let it dry in the shade. To make them visible, draw a pencil or sponge, dipped in the second solution, over the paper, and the characters will appear of a purple colour.

Invisible Silver Ink.

Dissolve fine silver in aqua fortis; and after the dissolution, add some distilled water in the same manner as in the gold ink.

What is written with the above ink will remain invisible for three or four months, if kept from the air; but may be easily read in an hour, if exposed to the fire, air, or sun.

Invisible Yellow Ink.

Steep marigold flowers seven or eight days in clear distilled vinegar. Press the flowers and strain the liquor, which is to be kept in a bottle well corked. If you would have it still more clear, add, when you use it, some pure water.

To make the characters visible, which you write with this ink, pass a sponge over the paper, dipped in the following solution:

Take a quantity of flowers of pansy, or the common violet, bruise them in a mortar with water, strain the liquor in a cloth, and keep it in a bottle.

Invisible Red Ink.

To the pure spirit of vitriol or nitre, add eight times as much water.

Use the above solution of violets to make visible the characters written with this ink.

Invisible Green Ink.

Dissolve salt of tartar, clean and dry, in a sufficient quantity of river water. Use the violet solution to render it visible.

[Pg 25]

Another Invisible Green Ink.

Dissolve zaffre, in powder, in aqua regia, for twenty-four hours. Pour the liquor off, and the same quantity of common water, and keep it in a bottle well corked.

This ink will not be visible till exposed to the fire or the sun; and will again be invisible when it becomes cold.

Invisible Violet Ink.

Express the juice of lemons, and keep it in a bottle well corked. Use the violet infusion to make the writing visible.

Invisible Grey Ink.

Mix alum with lemon-juice. The letters written with this ink will be invisible till dipped in water.

We now present our readers with a variety of amusing experiments, which may be performed by the foregoing inks; and they will, probably, suggest others equally amusing and useful.

A Secret Correspondence by means of Invisible Ink.

A person wishing to carry on a correspondence with another, and who is fearful of having his letter opened, or intercepted, can adopt the following plan:

Write any unimportant matter with common ink, and let the lines be very wide apart: then between these lines write the communication you wish to make, with any of the above invisible inks you can most readily procure.

Your correspondent is to be previously apprized of the method of making the characters visible: and writing in common ink will serve to lull the suspicions of those who might intercept the letter, and who, not finding any thing important in it, will either forward or keep it. In either case there can be no danger, as the writing will not be visible without the proper application. [Pg 26]

The Mysterious Writing.

Write on a piece of paper with common ink any question; then underneath it write the answer either in invisible silver ink, or the invisible green ink, made with zaffre and aqua regia, described in pages 24 and 25.

You give this paper to your friend, and tell him to place it against the wall, or on his dressing-table, keeping the door locked, that he may be sure no person has entered his room: he will next day find the answer written on it.

The Restored Flowers.

Make a bouquet of artificial flowers; the leaves should be formed of parchment. Dip the roses in the red invisible ink, the jonquilles in the yellow, the pinks in the violet, and the leaves in the green ink. They will all appear white; and you show them to the company, observing, that you will restore them to their natural colours, and desiring any person to fix any private mark on them he pleases, that he may be sure there is no deception. You then, unperceived by the company, dip them in the revivifying liquor, used to make the yellow ink visible, described in page 24, and, drawing them gently out, that the liquor may drop, and the flowers have time to acquire their colours, you present them to the company, who will see, with surprise, that they each appear in their natural colours.

Winter changed to Spring.

Take a print that represents winter, and colour those parts which should appear green, with the second green invisible ink, described in page 25; observing, of course, the usual rules of perspective, by making the near parts deeper in colour than the others. The other objects must be painted in their natural colours. Then put the print into a frame with a glass, and cover the back with a paper that is pasted only at its extremities.

When this print is exposed to a moderate fire, or the warm sun, the foliage, which appeared covered with snow, will change to a pleasing green; and if a yellow tint be thrown on the lighter parts before the invisible ink is drawn over it, this green will be of different shades. When it is exposed to the cold, it will again resume its first appearance of winter. [Pg 27]

The Silver Tree.

Dissolve an ounce of fine silver in three ounces of strong aqua fortis, in a glass bottle. When the silver is dissolved; pour the aqua fortis into another glass vessel, (a decanter will be best,) with seven or eight ounces of mercury, to which add a quart of common water; to the whole add your dissolved silver, and let it remain untouched.

In a few days the mercury will appear covered with a number of little branches of a silver colour. This appearance will increase for a month or two, and will remain after the mercury is entirely dissolved.

The Lead Tree.

A more modern invention, and an easier method by far than the above, is the following:

To a piece of zinc fasten a wire, crooked in the form of the worm of a still; let the other end of the worm be thrust through a cork. You then pour spring water into a phial or decanter, to which you add a small quantity of sugar of lead; thrust the zinc into the bottle, and with the cork at the end of the wire fasten it up. In a few days the tree will begin to grow, and produce a most beautiful effect.

To produce beautiful Fire-works in Miniature.

Put half a drachm of solid phosphorus into a large pint Florence flask; holding it slanting, that the phosphorus may not break the glass. Pour upon it a gill and a half of water, and place the whole over a tea-kettle lamp, or any common tin lamp, filled with spirit of wine. Light the wick, which should be almost half an inch from the flask; and as soon as the water is heated, streams of fire [Pg 28] will issue from the water by starts, resembling sky-rockets; some particles will adhere to the sides of the glass representing stars; and will frequently display brilliant rays. These appearances will continue at times till the water begins to simmer, when immediately a curious aurora borealis begins, and gradually ascends, till it collects to a pointed flame; when it has continued half a minute, blow out the flame of the lamp, and the point that was formed will rush down, forming beautiful illuminated clouds of fire, rolling over each other for some time, which disappearing, a splendid hemisphere of stars presents itself: after waiting a minute or two, light the lamp again, and nearly the same phenomenon will be displayed as from the beginning. Let the repetition of lighting and blowing out the lamp be made for three or four times at least, that the stars may be increased. After the third or fourth time of blowing out the lamp, in a few minutes after the internal surface of the flask is dry, many of the stars will shoot with great splendour, from side to side, and some of them will fire off with brilliant rays; these appearances will continue several minutes. What remains in the flask will serve for the same experiment several times, and without adding any more water. Care should be taken, after the operation is over, to lay the flask and water in a cool, secure place.

Artificial Rain and Hail.

Make a hollow cylinder of wood; let it be very thin at the sides, about eight or ten inches wide, and two or three feet diameter. Divide its inside into five equal parts, by boards of five or six inches wide, and let there be between them and the wooden circle, a space of about one-sixth of an inch. You are to place these boards obliquely. In this cylinder put four or five pounds of shot that will easily pass through the opening. When turned upside down, the noise of the shot going through the various partitions will resemble rain; and if you put large shot, it will produce the sound of hail.

Illuminated Writing.

It is well known that if any words are written on a wall with solid phosphorus, the writing will appear as if on fire; but it is necessary to give this caution, lest accidents should occur. In using [Pg 29] it, let a cup of water be always near you; and do not keep it more than a minute and a half in your hand, for fear the warmth of your hand should set it on fire. When you have written a few words with it, put the phosphorus into the cup of water, and let it stay a little to cool; then take it out, and write with it again.

A Lamp that will burn Twelve Months without replenishing.

Take a stick of phosphorus, and put it into a large dry phial, not corked, and it will afford a light sufficient to discern any object in a room when held near it. The phials should be kept in a cool place, where there is no great current of air, and it will continue its luminous appearance for more than twelve months.

Curious Transcolorations.

Put half a table-spoonful of syrup of violets and three table-spoonfuls of water into a glass; stir them well together with a stick, and put half the mixture into another glass. If you add a few drops of acid of vitriol into one of the glasses and stir it, it will be changed into a crimson; put a few drops of fixed alkali dissolved into the other glass, and when you stir it, it will change to green. If you drop slowly into the green liquor, from the side of the glass, a few drops of acid of vitriol, you will perceive crimson at the bottom, purple in the middle, and green at the top; and by adding a little fixed alkali dissolved, to the other glass, the same colours will appear in different order.

Another.

If you put a tea-spoonful of a liquor composed of copper infused in acid of vitriol, into a glass, and add two or three table-spoonfuls of water to it, there will be no sensible colour produced; but if you add a little volatile alkali to it, and stir it, you will perceive a very beautiful blue colour. Add a little acid of vitriol, the colour will instantly disappear upon stirring it; and by adding a little fixed [Pg 30]

alkali dissolved, it will return again.

Another.

Put half a tea-spoonful of a liquor composed of iron infused in acid of vitriol, into half a glass of water; and add a few drops of phlogisticated alkali, and a beautiful Prussian blue will appear.

Curious Account of the Electric Effects of a Russian Climate.

Mr. Æpinus in a letter to Dr. Guthrie, relates the following phenomena, which took place in Russia, when a severe frost had continued for several weeks.

Mr. Æpinus was sent for to the palace to see an uncommon phenomenon. On going into the apartment of Prince Orloff, he found him at his toilet, and that every time his valet drew the comb through his hair, a strong crackling noise was heard; and on darkening the room, sparks were seen following the comb in great abundance, while the prince himself was so completely electrified, that strong sparks could be drawn from his hands and face; nay, he was even electrified when he was only powdered with a puff.

A few days after, he was witness to a more striking effect of the electric state of a Russian atmosphere. The Grand Duke of Russia sent for him one evening in the twilight, and told him, that having briskly drawn a flannel cover off a green damask chair in his bed-chamber, he was astonished at the appearance of a strong bright flame that followed; but considering it as an electrical appearance, he had tried to produce a similar illumination on different pieces of furniture, and could then show him a beautiful and surprising experiment. His highness threw himself on his bed, which was covered with a damask quilt, laced with gold; and, rubbing it with his hands in all directions, the young prince, who had then reached his twelfth year, appeared swimming in fire, as at every stroke flames arose all around him, darted to the gold-laced border, ran along it, and up to that of the bed, and even to the very top. [Pg 31]

While he was showing this experiment, Prince Orloff came into the room, with a sable muff in his hand, and showed us, that by only whirling it five or six times round his head in the air, he could electrify himself so strongly, as to send out sparks from all the uncovered parts of his body.

Astonishing Power of Steam.

If you put a small quantity of water into a tea-kettle, and place it on the fire, it will disappear in a short time, having escaped in the steam. But if its escape be prevented by stopping up the spout and crevices, it will force its way by bursting the vessel in which it was confined.

If the steam of boiling water be at liberty, the water never attains more than a certain degree of heat; but if confined in a close vessel, the additional fire not escaping, the power of the steam is increased, it re-acts upon the water, and raises the heat so much higher, that it would keep lead in a melting state; and so penetrating, that it would soften the marrow-bone of an ox, in a few minutes.

There is an instrument contrived for the foregoing purposes, called Papin's Digester, from the name of its inventor, and from its digestive powers on substances exposed to its action. It is a very strong vessel, made of copper, fitted with a thick close cover, and fastened down by several strong screws, so as to render it steam-tight in great degrees of heat. To render it safe, while being used, there is a valve on the cover, to let out the steam, when it is too violent; this valve is kept down by a steel-yard, with a weight moveable upon it, to regulate the degrees of the steam within.

The following account of an accident with one of these instruments, will give some idea of the great force of steam.

Mr. Papin (the inventor) having fixed all things right, and included about a pint of water, with two ounces of marrow-bone, he placed the vessel horizontally between the bars of the grate, about half-way into the fire. In three minutes he found it raised to a great heat, and perceiving the heat in a very short time become more raging, stepped to a side-table for an iron to take the digester out of the fire, when it suddenly burst with the explosion of a musket. It was heard at a [Pg 32] considerable distance, and actually shook the house. The bottom of the vessel that was in the fire gave way; the blast of the expanded water blew all the coals out of the fire into the room, the remainder of the vessel flew across the room, and, hitting the leaf of an oak table, an inch thick, broke it all in pieces, and rebounded half the length of the room back again. He could not perceive the least sign of water, though he looked carefully for it; the fire was quite extinguished, and every coal black in an instant.

The following accident was attended with more fatal consequences.

A steam-engine was repairing at Chelsea, and, as the workmen were endeavouring to discover the defect, the boiler suddenly exploded, and a cloud of steam rushing out at the fracture, struck one of the men who was near it, like a blast of lightning, and killed him in a moment; when his companions endeavoured to take off his clothes, the flesh came off with them from the bones.

Account of the Wonderful Effects of two immense Burning-Glasses.

Mr. de Tschirnhausen constructed a burning-glass, between three and four feet in diameter, and whose focus was rendered more powerful by a second one. This glass melted tiles, slates, pumice-stone, &c., in a moment; pitch, and all resins, were melted even under water; the ashes of vegetables, wood, and other matters, were converted into glass; indeed, it either melted, calcined, or dissipated into smoke, every thing applied to its focus.

Mr. Parker, of Fleet-street, made a burning-glass, three feet in diameter; it was formed of flint glass, and when on its frame, exposed a surface of 2 feet 8½ inches to the solar rays. It had a small glass fitted to it, to converge the rays, and heighten the effect. The experiments made by it were more powerful and accurate than those performed by any other glass. The following is a brief epitome of its astonishing power.

[Pg 33]

Substances melted, with their weight; and the Time in Seconds, which they took in melting.	**Weight in Grains.**	**Time in Seconds.**
Pure gold	20	4
Pure silver	20	3
Pure copper	33	20
Pure platina	10	3
Nickel	16	3
A cube of bar-iron	10	12
A cube of cast-iron	10	3
A cube of steel	10	12
Scoria of wrought-iron	12	2
Kearsh	10	3
Cauk, or terra ponderosa	10	7
A topaz, or chrysolite	3	45
An oriental emerald	2	25
Crystal pebble	7	6
White agate	10	30
Oriental flint	10	30
Rough cornelian	10	75
Jasper	10	25
Onyx	10	20
Garnet	10	17
White rhomboidal spar	10	60
Zeolites	10	23
Rotten-stone	10	80
Common slate	10	2
Asbestos	10	10
Common lime-stone	10	55
Pumice-stone	10	24
Lava	10	7
Volcanic clay	10	60
Cornish moor-stone	10	60

Fulminating Powder.

This powder is made by rubbing together, in a hot marble mortar, with a wooden pestle, three parts, by weight, of nitre, two of mild vegetable alkali, and one of flowers of sulphur, till the whole is accurately mixed. If a drachm of this powder be exposed to a gentle heat, in an iron ladle, till it melts, it will explode with a noise as loud as the report of a cannon. [Pg 34]

A more powerful fulminating Powder.

The most wonderful instance of chemical detonation is formed by the combination of volatile alkali with silver. Gunpowder, or fulminating gold, are not to be compared with this invention, and the great danger attending its manufacture prevents us from giving a methodical account of its preparation to our readers, particularly as it can be purchased, properly prepared, of the chemists.

The slightest agitation or friction is sufficient to cause its explosion. When it is once obtained, it can no longer be touched with safety. The falling of a few atoms of it, from a small height, produces an explosion; a drop of water falling on it has the same effect. No attempt, therefore, can be made to enclose it in a bottle, but it must be let alone in the capsule, wherein, by evaporation, it obtains this terrible property. To make this experiment with safety, no greater quantity than a grain of silver should be used; the last process of drying should be made in a metallic vessel, and the face of the operator defended by a mask with strong glass eyes.

To make the Phosphorus Match Bottles.

Nothing more is necessary for this purpose, than to drop small pieces of dry phosphorus into a

common phial; gently heat it till it melts; and then turn the bottle round, that it may adhere to the sides. The phial should be closely corked; and when used, a common brimstone match is to be introduced, and rubbed against the sides of the phial: this inflames the match when it is brought out of the bottle. Though there is no danger in phosphorus, till friction, or fire, is applied, yet persons cannot be too cautious in the use of it, as instances have been known of one of these bottles catching fire in the pocket, and very much endangering the person who carried it; likewise, if carelessly used, small particles are apt to get under the nails, or on the hand; and if, by accident, they are held to the fire, or rubbed together, a flame will presently kindle.

[Pg 35]

To make a Ring suspend by a Thread, after the Thread has been burned.

Soak a piece of thread in urine, or common salt and water. Tie it to a ring, not larger than a wedding-ring. When you apply the flame of a candle to it, it will burn to ashes, but yet sustain the ring.

To form Figures in relief on an Egg.

Design on the shell any figure or ornament you please, with melted tallow, or any other fat oily substance; then immerse the egg into very strong vinegar, and let it remain till the acid has corroded that part of the shell which is not covered with the greasy matter: those parts will then appear in relief, exactly as you have drawn them.

To give a ghastly Appearance to Persons in a Room.

Dissolve salt in an infusion of saffron and spirits of wine. Dip some tow in this solution, and, having set fire to it, extinguish all other lights in the room.

To change Blue to White.

Dissolve copper filings in a phial of volatile alkali; when the phial is unstopped, the liquor will be blue; when stopped, it will be white.

Magical Transmutations.

Infuse a few shavings of logwood in common water, and when the liquor is sufficiently red, pour it into a bottle. Then take three drinking-glasses, and rinse one of them with strong vinegar; throw into the second a small quantity of pounded alum, which will not be observed if the glass has been recently washed, and leave the third without any preparation. If the red liquor in the bottle be poured into the first glass, it will appear of a straw colour; if into the second, it will pass gradually from bluish-grey to black, when stirred with a key, or any piece of iron, which has been previously dipped in strong vinegar. In the third glass, the red liquor will assume a violet tint.

[Pg 36]

To make Pomatum with Water and Wax.

Water and wax are two substances that do not naturally unite together; therefore, to those who witness the following process, without knowing the cause, it will have the appearance of marvellous. Put into a new glazed earthen pot, six ounces of river water and two ounces of white wax, in which, you must previously conceal a strong dose of salt of tartar. If the whole be then exposed to a considerable degree of heat, it will assume the consistence of pomatum, and may be used as such.

Iron transformed into Copper.

Dissolve blue vitriol in water, till the water is well impregnated with it; and immerse into the solution small plates of iron, or coarse iron filings. These will be attacked and dissolved by the acid of the vitriol, while the copper naturally contained in the vitriol will be sunk and deposited in the place of the iron dissolved. If the piece of iron be too large for dissolving, it will be so completely covered with particles of copper, as to resemble that metal itself.

Iron transformed into Silver.

Dissolve mercury in marine acid, and dip a piece of iron into it, or rub the solution over the iron, and it will assume a silver appearance.

It is scarcely necessary to say, that these transmutations are only apparent, though to the credulous it would seem that they were actually transformed.

Chemical Illuminations.

Put into a middling-sized bottle, with a short wide neck, three ounces of oil or spirit of vitriol, with twelve ounces of common water, and throw into it, at different times, an ounce or two of iron filings. A violent commotion will then take place, and white vapours will arise from the

mixture. If a taper be held to the mouth of the bottle, these vapours will inflame and produce a violent explosion, which may be repeated as long as the vapours continue.

[Pg 37]

The Philosophical Candle.

Provide a bladder, into the orifice of which is inserted a metal tube, some inches in length, that can be adapted to the neck of a bottle, containing the same mixture as in the last experiment. Having suffered the atmospheric air to be expelled from the bottle, by the elastic vapour produced by the solution, apply the orifice of the bladder to the mouth of the bottle, after carefully squeezing the common air out of it, (which you must not fail to do, or the bladder will violently explode.) The bladder will thus become filled with the inflammable air, which, when forced out against the flame of a candle, by pressing the sides of the bladder, will form a beautiful green flame.

To make the appearance of a Flash of Lightning, when any one enters a Room with a lighted Candle.

Dissolve camphor in spirit of wine, and deposit the vessel containing the solution in a very close room, where the spirit of wine must be made to evaporate by strong and speedy boiling. If any one then enters the room with a lighted candle, the air will inflame, while the combustion will be so sudden, and of so short a duration, as to occasion no danger.

To melt Iron in a Moment and make it run into Drops.

Bring a bar of iron to a white heat, and then apply to it a roll of sulphur. The iron will immediately melt and run into drops.

This experiment should be performed over a basin of water, in which the drops that fall down will be quenched. These drops will be found reduced into a sort of cast-iron.

Never-yielding Cement.

Calcine oyster-shells, pound them, sift them through a silk sieve, and grind them on porphyry till they are reduced to the finest powder. Then take the whites of several eggs, according to the quantity of the powder; and having mixed them with the powder, form the whole into a kind of paste. With this paste join the pieces of china, or glass, and press them together for seven or eight minutes. This cement will stand both heat and water, and will never give way, even if the article should, by accident, fall to the ground.

[Pg 38]

To remove Stains and Blemishes from Prints.

Paste a piece of paper to a very smooth clear table, that the boiling water used in the operation may not require a colour which might lessen its success. Spread out the print you wish to clean upon the table, and sprinkle it with boiling water; taking care to moisten it throughout by very carefully applying a very fine sponge. After you have repeated this process five or six times, you will observe the stains or spots extend themselves; but this is only a proof that the dirt begins to be dissolved.

After this preparation, lay the print smoothly and carefully into a copper or wooden vessel, larger than the size of the print. Then cover it with a boiling ley of potash, taking care to keep it hot as long as possible. After the whole is cooled, strain off the liquor, take out the print with care, spread it on a stretched cord, and when half dry, press it between leaves of white paper, to prevent wrinkles.

By this process, spots and stains of any kind will be effectually removed.

To so fill a Glass with Water, that it cannot be removed without spilling the whole.

This is a mere trick, but may afford some amusement. You offer to bet any person that you will so fill a glass with water that he shall not move it off the table without spilling the whole contents. You then fill the glass, and, laying a piece of paper or thin card over the top, you dexterously turn the glass upside down on the table, and then drawing away the paper, you leave the water in the glass, with its foot upwards. It will therefore be impossible to remove the glass from the table without spilling every drop.

[Pg 39]

Two Figures, one of which blows out and the other re-lights a Candle.

Make two figures, of any shape or materials you please; insert in the mouth of one a small tube, at the end of which is a piece of phosphorus, and in the mouth of the other a tube containing at the end a few grains of gunpowder; taking care that each be retained in the tube by a piece of paper. If the second figure be applied to the flame of a taper, it will extinguish it; and the first will light it again.

A vessel that will let Water out at the Bottom, as soon as the Mouth is uncorked.

Provide a tin vessel, two or three inches in diameter, and five or six inches in height, having a mouth about three inches in width; and in the bottom several small holes, just large enough to admit a small needle. Plunge it in water with its mouth open, and when full, while it remains in the water, stop it very closely. You can play a trick with a person, by desiring him to uncork it; if he places it on his knee for that purpose, the moment it is uncorked the water will run through at the bottom, and make him completely wet.

A Powder which catches Fire when exposed to the Air.

Put three ounces of rock alum, and one ounce of honey or sugar, into a new earthen dish, glazed, and which is capable of standing a strong heat; keep the mixture over the fire, stirring it continually till it becomes very dry and hard; then remove it from the fire, and pound it to a coarse powder. Put this powder into a long-necked bottle, leaving a part of the vessel empty; and, having placed it in a crucible, fill up the crucible with fine sand, and surround it with burning coals. When the bottle has been kept at a red heat for about seven or eight minutes, and no more vapour issues from it, remove it from the fire, then stop it with a piece of cork; and, having suffered it to cool, preserve the mixture in small bottles well closed.

If you unclose one of these bottles, and let fall a few grains of this powder on a bit of paper, or any other very dry substance, it will first become blue, then brown, and will at last burn the paper or other dry substance on which it has fallen. [Pg 40]

Fulminating Gold.

Put into a small long-necked bottle, resting on a little sand, one part of fine gold filings, and three parts of aqua regia, (nitro-muriatic acid.) When the gold is dissolved, pour the solution into a glass, and add five or six times the quantity of water. Then take spirit of sal ammoniac or oil of tartar, and pour it drop by drop into the solution, until the gold is entirely precipitated to the bottom of the glass. Decant the liquor that swims at the top, by inclining the glass; and, having washed it several times in warm water, dry it at a moderate heat, placing it on paper capable of absorbing all the moisture.

If a grain of this powder, put into a spoon, (it should be an iron one,) be exposed to the flame of a candle, it will explode with a very loud report.

To melt a piece of Money in a Walnut-shell, without injuring the shell.

Bend any thin coin, and put it into half a walnut-shell; place the shell on a little sand, to keep it steady. Then fill the shell with a mixture made of three parts of very dry pounded nitre, one part of flowers of sulphur, and a little saw-dust well sifted. If you then set light to the mixture, you will find, when it is melted, that the metal will also be melted at the bottom of the shell, in form of a button, which will become hard when the burning matter round it is consumed: the shell will have sustained very little injury.

A Liquid that Shines in the Dark.

Take a bit of phosphorus, about the size of a pea; break it into small parts, which you are to put into a glass half full of very pure water, and boil it in a small earthen vessel, over a very moderate fire. Have in readiness a long narrow bottle, with a well-fitted glass stopper, and immerse it, with its mouth open, into boiling water. On taking it out, empty the water, and immediately pour in the mixture in a boiling state; then put in the stopper, and cover it with mastich, to prevent the entrance of the external air. [Pg 41]

This water will shine in the dark for several months, even without being touched; and, if it be shaken in dry warm weather, brilliant flashes will be seen to rise through the middle of the water.

Luminous Liquor.

Put a little phosphorus, with essence of cloves, into a bottle, which must be kept closely stopped. Every time the bottle is unclosed, the liquor will appear luminous. This experiment must be performed in the dark.

The changeable Rose.

Take a common full-blown rose, and, having thrown a little sulphur finely pounded into a chafing-dish with coals, expose the rose to the vapour. By this process the rose will become whitish; but if it be afterwards held some time in water, it will resume its former colour.

Golden Ink.

Take some white gum arabic, reduce it to an impalpable powder, in a brass mortar; dissolve it in

strong brandy, and add a little common water to render it more liquid. Provide some gold in a shell, which must be detached, in order to reduce it to a powder. When this is done, moisten it with the gummy solution, and stir the whole with a small hair-brush, or your finger; then leave it for a night, that the gold may be better dissolved. If the composition become dry during the night, dilute it with more gum water, in which a little saffron has been infused; but take care that the gold solution be sufficiently liquid to flow freely in a pen. When the writing is dry, polish it with a dry tooth.

Another way.

Reduce gum ammoniac into powder, and dissolve it in gum arabic water, to which a little garlic juice has been added. This water will not dissolve the ammonia so as to form a transparent liquid; [Pg 42] for the result will be a milky liquor. With the liquor form your letters or ornaments on paper or vellum, with a pen or fine camels'-hair brush; then let them dry, and afterwards breathe on them some time, till they become moist; then apply a few bits of leaf gold to the letters, which you press down gently with cotton wool. When the whole is dry, brush off the superfluous gold with a large camels'-hair brush, and, to make it more brilliant, burnish with a dog's tooth.

White Ink, for Writing on black Paper.

Having carefully washed some egg-shells, remove the internal skin, and grind them on a piece of porphyry. Then put the powder into a small vessel of pure water, and when it has settled at the bottom, draw off the water, and dry the powder in the sun. This powder must be preserved in a bottle; when you want to use it, put a small quantity of gum ammoniac into distilled vinegar, and leave it to dissolve during the night. Next morning the solution will appear exceedingly white; and if you then strain it through a piece of linen cloth, and add to it the powder of egg-shells, in sufficient quantity, you will obtain a very white ink.

To construct Paper Balloons.

Take several sheets of silk paper; cut them in the shape of a spindle; or, to speak more familiarly, like the coverings of the sections of an orange; join these pieces together, into one spherical or globular body, and border the aperture with a ribbon, leaving the ends, that you may suspend them from the following lamp.

Construct a small basket of very fine wire, if the balloon is small, and suspend it from the aperture, so that the smoke from the flame of a few leaves of paper, wrapped together, and dipped in oil, may heat the inside of it. Before you light this paper, suspend the balloon in such a manner, that it may, in a great measure, be exhausted of air, and as soon as it has been dilated, let it go, together with the wire basket, which will serve as ballast.

[Pg 43]

Water-Gilding upon Silver.

Take copper-flakes, on which pour strong vinegar; add alum and salt in equal quantities; set them on a fire, and when the vinegar is boiled, till it becomes one-fourth part of its original quantity, throw into it the metal you design to gild, and it will assume a copper colour. Continue boiling it, and it will change into a fine gold colour.

A Water which gives Silver a Gold Colour.

Take sulphur and nitre, of each an equal quantity; grind them together very fine, and put them into an unglazed vessel; cover and lute it well; then set it over a slow fire for 24 hours; put what remains into a strong crucible, and let it dissolve; put it into a phial, and whatever silver you anoint with it will have a gold colour.

To make an old Gold Chain appear like new.

Dissolve sal ammoniac in urine, boil the chain in it, and it will have a fine gold colour.

To give Silver the Colour of Gold.

Dissolve in common aqua fortis as much silver as you please. To eight ounces of silver, take four ounces of hepatic aloes, six ounces of turmeric, and two ounces of prepared tutty, that has been several times quenched in urine. Put these to the solution of the silver; they will dissolve, but rise up in the glass like a sponge; this glass must therefore be large, to prevent running over. Then draw it off, and you will have ten ounces of silver as yellow as gold.

A Water to give any Metal a Gold Colour.

Take fine sulphur and pulverize it; then boil some stale spring water; pour it hot upon the powder, and stir it well together; boil it again, and pour into it an ounce of dragon's blood. After it is well boiled, take it off, and filter it through a fine cloth; pour this water into a matrass, (a chemical vessel,) after you have put in what you design to colour; close it well, and boil it a third [Pg 44]

time, and the metal will be a fine gold colour.

Another way.

Take hepatic aloes, nitre, and Roman vitriol, of each equal quantities; and distil them with water, in an alembic, till all the spirits are extracted; it will at last yield a yellowish water, which will tinge any sort of metal of a gold colour.

To give Silver-plate a Lustre.

Dissolve alum in a strong ley, and scum it carefully; then mix it up with soap, and wash your silver utensils with it, using a linen rag.

The Fiery Fountain.

If twenty grains of phosphorus, cut very small, and mixed with forty grains of powder of zinc, be put into four drachms of water, and two drachms of concentrated sulphuric acid be added thereto, bubbles of inflamed phosphoretted hydrogen gas will quickly cover the whole surface of the fluid in succession, forming a real fountain of fire.

To take Impressions of Coins, Medals, &c.

Cut fish-glue, or isinglass, into small pieces, immerse it in clear water, and set it on a slow fire; when gradually dissolved, let it boil slowly, stirring it with a wooden spoon, and taking off the scum. The liquor being sufficiently adhesive, take it off the fire, let it cool a little, and then pour it on the medal or coin you wish to copy, having first rubbed the coin over with oil. Let the composition lay about the thickness of a crown-piece on the medal. Then set it in a moderate air, neither too hot nor too cold, and let it cool and dry. When it is dry, it will loosen itself; you will find the impression correct, and the finest strokes expressed with the greatest accuracy.

You may give a most pleasing effect to the composition, by mixing any colour with it, red, yellow, blue, green, &c., and if you add a little parchment size to it, it will make it harder and better. This size is made by gently simmering the cuttings of clear white parchment in a pipkin, with a little water, till it becomes adhesive. [Pg 45]

To tell a Person any Number he may privately fix on.

When the person has fixed on a number, bid him double it and add four to that doubling; then multiply the whole by 5; to the product let him add 12, and multiply the amount by 10. From the total of all this, let him deduct 320, and tell you the remainder; from which, if you cut off the two last figures, the number that remains will be what he fixed upon. For instance,

Suppose the number chosen is	7
Which doubled	14
Add 4 to it, and it will make	18
Multiply 18 by 5, gives	90
To which add 12, is	102
Multiply that by 10, makes	1020
From which deducting 320, the remainder is	700
And by striking off the two ciphers, it becomes the number thought on	7

To tell any Number a Person has fixed on, without asking him any Questions.

You tell the person to choose any number from 1 to 15; he is to add 1 to that number, and triple the amount. Then,

1. He is to take the half of that triple, and triple that half.
2. To take the half of the last triple, and triple that half.
3. To take the half of the last triple.
4. To take the half of that half.

Thus, it will be seen, there are four cases where the half is to be taken; the three first are denoted by one of the eight following Latin words, each word being composed of three syllables; and those that contain the letter i refer to those cases where the half cannot be taken without a fraction; therefore, in those cases, the person who makes the deduction is to add 1 to the number divided. The fourth case shows which of the two numbers annexed to every word has been chosen; for if the fourth half can be taken without adding 1, the number chosen is in the first column; but if not, it is in the second. [Pg 46]

The words.	*The numbers they denote.*	
Mi-se-ris	8	0
Ob-tin-git	1	9
Ni-mi-um	2	19

No-ta-ri	3	11
In-fer-nos	4	12
Or-di-nes	13	5
Ti-mi-di	6	14
Te-ne-ant	15	7

For example:

Suppose the number chosen is	9
To which is to be added	1
	——
	10
The triple of that number is	30
The half of which is	15
The triple of that half must be	45
And the half of that[A]	23
The triple half of that half	69
The half of that[A]	35
And the half of that half[A]	18

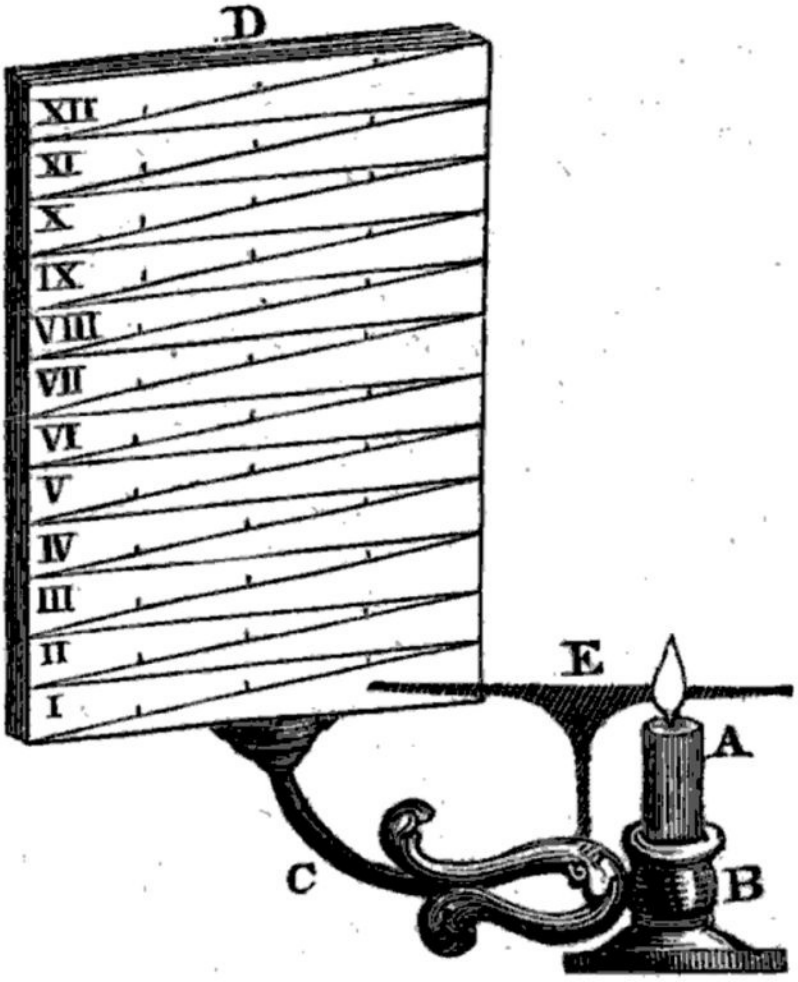
[A] At all these stages, 1 must be added, to take the half without a fraction.

While the person is performing the operation, you remark, that at the second and third stages he is obliged to add 1; and, consequently, that the word *ob-tin-git*, in the second and third syllables of which is an i, denotes that the number must be either 1 or 9; and, by observing that he cannot take the last half without adding 1, you know that it must be the number in the second column. If he makes no addition at any one of the four stages, the number he chose must be 15, as that is the only number that has not a fraction at either of the divisions.

The Lamp Chronometer.

Figure 4 represents a chamber lamp, A, consisting of a cylindrical vessel made of tin, in the shape of a candle, and is to be filled with oil. This vessel should be about three inches high and one inch diameter, placed in a stand, B. The whole apparatus, of lamp and stand, can be [Pg 47] purchased, ready-made, at any tin-shop in London. To the stand, B, is fixed the handle C, which supports the frame D, about 12 inches high, and four inches wide. This frame is to be covered with oiled paper, and divided into 12 equal parts by horizontal lines, at the end of which are written the numbers for the hours, from 1 to 12, and between the horizontal lines, and diagonals, divided into halves, quarters, &c. On the handle C, and close to the glass, is fixed the style or hand E.

Fig. 4.



Now, as the distance of the style from the flame of the lamp is only half an inch, then, if the distance of the frame from the style be six inches, while the float that contains the light descends by the decrease on the oil, one inch, the shadow of the style of the frame will ascend 12 inches, being its whole length, and show by its progression, the regular increase of the hours, with their several divisions.

You must be careful always to burn the same oil, which must be the best; and the wick must never vary in size; if these precautions are not attended to, the dial never can be accurate. [Pg 48]

The Phial of the Four Elements.

Take a phial, six or seven inches long, and about three quarters of an inch in diameter. In this phial put, first, glass coarsely powdered; secondly, oil of tartar per deliquum; thirdly, tincture of salt of tartar; and lastly, distilled rock oil.

The glass and the various liquors being of different densities, if you shake the phial, and then let it rest a few moments, the three liquors will entirely separate, and each assume its place; thus forming no indifferent resemblance of the four elements, earth, fire, water, and air: the powdered glass (which should be of some dark colour) representing the earth; the oil of tartar, water; the tincture, air; and the rock oil, fire.

The Magic Bottle.

Take a small bottle, the neck of which is not more than the sixth of an inch in diameter. With a funnel, fill the bottle quite full of red wine, and place it in a glass vessel, similar to a show-glass, whose height exceeds that of the bottle about two inches; fill this vessel with water. The wine will shortly come out of the bottle, and rise in the form of a small column to the surface of the water; while at the same time, the water, entering the bottle, will supply the place of the wine. The reason of this is, that as water is specifically heavier than wine, it must hold the lower place, while the other rises to the top.

An effect equally pleasing will be produced, if the bottle be filled with water, and the vessel with wine.

The Globular Fountain.

Make a hollow globe, of copper or lead, and of a size adapted to the quantity of water that comes from a pipe (hereafter mentioned) to which it is to be fixed, and which may be fastened to any kind of pump, provided it be so constructed, that the water shall have no other means of escape

than through the pipe. Pierce a number of small holes through the globe, that all tend towards its centre, and annex it to the pipe that communicates with the pump. The water that comes from the pump, rushing with violence into the globe, will be forced out at the holes, and form a very pleasing sphere of water. [Pg 49]

The Hydraulic Dancer.

Procure a little figure made of cork, which you may dress as your fancy dictates. In this figure place a small hollow cone made of thin leaf brass.

When the figure is placed on a jet d'eau, that plays in a perpendicular direction, it will be suspended on the top of the water, and perform a great variety of amusing motions.

If a hollow ball of very thin copper, of an inch diameter, be placed on a similar jet, it will remain suspended, turning round, and spreading the water all about it.

A Person having put a Ring an one of his Fingers, to name the Person, the Hand, the Finger, and the Joint on which it is placed.

Let a third person double the number of the order in which he stands who has the ring, and add 5 to that number; then multiply that sum by 5, and to the product add 10. Let him next add 1 to the last number, if the ring be on the right hand, and 2 if on the left, and multiply the whole by 10: to the product of this he must add the number of the finger, (counting the thumb as the first finger,) and multiply the whole again by 10. Let him then add the number of the joint, and, lastly, to the whole join 35.

He is then to tell you the amount of the whole, from which you are to subtract 3535, and the remainder will consist of four figures; the first of which will express the rank in which the person stands, the second the hand, (number 1 signifying the right, and 2 the left,) the third number the finger, and the fourth the joint.—For example:

Suppose the person who stands the third in order has put the ring upon the second joint of the thumb of his left hand; then, [Pg 50]

The double of the rank of the third person is	6
To which add	5
	11
Multiply the sum by	5
	55
To which add	10
And the number of the left hand	2
	67
Which being multiplied by	10
	670
To which add the number of the thumb	1
	671
And multiply again by	10
	6710
Then add the number of the joint	2
And lastly the number	35
	6747
From which deducting	3535
The remainder is	3212

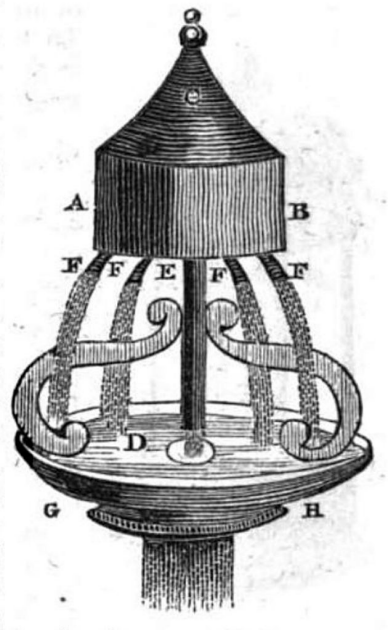
Of which, as we have said, the 3 denotes the third person, the 2 the left hand, the 1 the thumb, and the last 2 the second joint.

The Water Sun.

Provide two portions of a hollow sphere, that are very shallow; join them together in such a manner that the hollow between them be very narrow. Fix them vertically to a pipe from whence a jet proceeds. Bore a number of small holes all around that part where the two pieces are joined together. The water rushing through the holes will form a very pleasing water sun, or star.

The Magical Cascade.

Fig. 5.



Procure a tin vessel, shaped like Fig. 5, about five inches high and four in diameter, with a cover, C, closed at top. To the bottom of this vessel, let the pipe D E be soldered. This pipe is to be ten inches long, and half an inch in diameter, open at each end, and the upper end must be above the water in the vessel. To the bottom also fix five or six small tubes, F, about one-eighth of an inch in diameter. By these pipes, the water in the vessel is to run slowly out. [Pg 51]

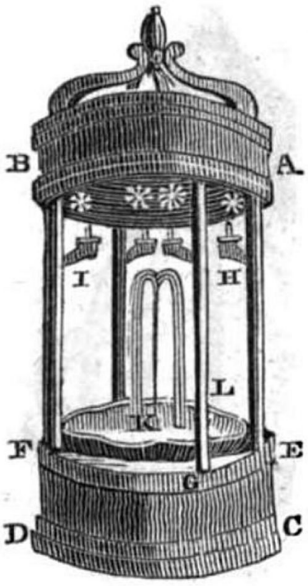
Place this machine in a tin basin, G H, with a hole in the middle, about a quarter of an inch in diameter. Fix to the tube D E, any sort of ornament that will keep the machine firm on the basin, observing, that these supports are sufficiently long to leave about a quarter of an inch between the end of the tube and the orifice in the basin; and let there be a vessel under the basin to catch the water that runs out.

As the small pipes discharge more water into the basin than can run out of the central orifice, the water will rise in the basin above the lower end of the pipe, and prevent the air from getting into the vessel, by which the water will cease to flow from the small pipes. But as the water continues to flow from the basin, the air will have liberty again to enter the vessel by the tube, and the water will again flow from the small pipes, and alternately stop and flow, while any water remains in the vessel.

As you can guess when the pipes will flow, and when they will stop, you may so manage it, that they will appear to act by word of command.

The illuminated Fountain, that plays when the Candles are lighted, and stops when they are extinguished.

Fig. 6.



Provide two cylindrical vessels, A B and C D, as in Fig. 6. Connect them by four tubes open at each end, as H I, &c., so that the air may descend out of the higher into the lower vessel. To these tubes fix candlesticks, and to the hollow cover, E F, of the lower vessel, fit a tube, K, reaching almost to the bottom of the vessel. At G let there be an aperture with a screw, whereby water may be poured into C D, which, when filled, must be closed by the screw. [Pg 52]

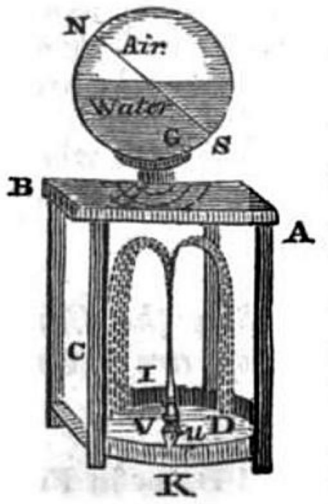
When the candles are lighted, the air in the upper cover and contiguous pipes will be thereby rarefied, and the jet from the small tube, K, will begin to play: as the air becomes more rarefied, the force of the jet will increase, and it will continue to play till the water in the lower vessel is exhausted. As the motion of the jet is caused by the heat of the candles, when they are extinguished the fountain will stop.

A Fountain which acts by the heat of the Sun.

Fig. 7.

In the annexed engraving, Fig. 7, G N S is a thin hollow globe of copper, eighteen inches diameter, supported by a small inverted basin, placed on a stand with four legs, A B C D, which have between them, at the bottom, a basin of two feet diameter. Through the leg C passes a concealed pipe, which comes from G, the bottom of the inside of the globe. This pipe goes by H V, and joins the upright pipe *u* I, to make a jet, as I. The short pipe, *u* I, which goes to the bottom, has a valve at *u*, under the horizontal pipe H V, and another valve at T, above that Horizontal pipe, under the cock at K. The use of this cock is to keep the fountain from playing in the day, if you think proper. The north pole N of the globe has a screw that opens a hole, whereby water is poured into the globe. [Pg 53]

The machine being thus prepared, and the globe half filled with water, put it in an open place, when the heat of the sun rarefying the air as it heats the copper, the air will press strongly against the



water, which, coming down the pipe, will lift up the valve at V, and shut the valve at u. The cock being opened, the water will spout out at I, and continue to play a long while, if the sun shines.

Inflammable Phosphorus.

Take the meal of flour of any vegetable, put it into an iron pan over a moderate fire, and keep it stirring with an iron spoon till it changes to a black powder; to one part of this add four parts of raw alum. Make the whole into a fine powder; put it again into the iron pan, and keep stirring it till it almost catches fire, to prevent its forming into lumps, as it is apt to do when the alum melts; in which case it must be broken again, stirred about, and accurately mixed with the flour, till it emits no more fumes, and the whole appears a fine black powder.

Put this powder in a clean dry phial with a narrow neck, filling it to about one-third of the top. Then stop the mouth of the phial with loose paper, so as to let the air pass freely through it, and leave room for the fumes to come through the neck. Place the phial in a crucible, encompassed on all sides with sand, so that it may not touch any part of the crucible, but a considerable space everywhere left between. The phial must be covered up with sand, leaving only a small part bare, by which you can discern whether the powder is ignited. In this state, the crucible is to be surrounded with coals, kindled slowly till it is well heated on all sides, and then the fire is to be raised, till the crucible and every thing in it is red-hot; keep it in this state an hour; after this, the fire still burning as fiercely, close up the orifice of the phial with wax, to exclude the air. Leave it to cool, and you will find in it a black dusty coal formed of the flour and alum.

Shake a small quantity of this out of the phial into the cool air, and it will immediately take fire, but will not burn any thing. Keep the bottle dry, as even the air will spoil it effectually.

The Magical Mirrors.

Make two holes in the wainscot of a room, each a foot high and ten inches wide, and about a foot distant from each other. Let these apertures be about the height of a man's head, and in each of them place a transparent glass in a frame, like a common mirror. [Pg 54]

Behind the partition, and directly facing each aperture, place two mirrors enclosed in the wainscot, in an angle of forty-five degrees.[B] These mirrors are each to be eighteen inches square: and all the space between them must be enclosed with pasteboard painted black, and well closed, that no light can enter; let there be also two curtains to cover them, which you may draw aside at pleasure.

When a person looks into one of these fictitious mirrors, instead of seeing his own face he will see the object that is in front of the other; thus, if two persons stand at the same time before these mirrors, instead of each seeing himself; they will reciprocally see each other.

There should be a sconce with a lighted candle, placed on each side of the two glasses in the wainscot, to enlighten the faces of the persons who look in them, or the experiment will not have so remarkable an effect.

[B] That is, half-way between a line drawn perpendicularly to the ground and its surface.

To cause a brilliant Explosion under Water.

Drop a piece of phosphorus, the size of a pea, into a tumbler of hot water; and, from a bladder furnished with a stop-cock, force a stream of oxygen directly upon it. This will afford a most brilliant combustion under water.

Fulminating Mercury.

Dissolve 100 grains of mercury by heat, in an ounce and a half of nitric acid. This solution being poured cold upon two measured ounces of alcohol previously introduced into any convenient glass vessel, a moderate heat is to be applied, till effervescence is excited. A white fume then begins to appear on the surface of the liquor, and the powder will be gradually precipitated when the action ceases. The precipitate is to be immediately collected on a filter, well washed with

distilled water, and cautiously dried in a heat not exceeding that of a water-bath. Washing the powder immediately is material, because it is liable to the re-action of the nitric acid; and, while any of the acid adheres to it, it is very subject to the action of light. From 100 grains of mercury, about 130 of the powder are obtained.

This powder, when struck on an anvil with a hammer, explodes with a sharp stunning noise, and with such force as to indent both hammer and anvil. Three or four grains are sufficient for one experiment. [Pg 55]

The Iron Tree.

Dissolve iron filings in aqua fortis, moderately concentrated, till the acid is saturated; then add to it gradually, a solution of fixed alkali, (commonly called oil of tartar per deliquum.) A strong effervescence will ensue, and the iron, instead of falling to the bottom of the vessel, will afterwards rise so as to cover the sides, forming a multitude of ramifications heaped one upon the other, which will sometimes pass over the edge of the vessel, and extend themselves on the outside, with all the appearance of a plant.

To make any Number divisible by Nine, by adding a Figure to it.

If (for example) the number named be 72,857, you tell the person who names it to place the number 7 between any two figures of that sum, and it will be divisible by 9; for if any number be multiplied by 9, the sum of the figures of the product will be either 9, or a number divisible by 9.

Arithmetical Squares.

An arithmetical magical square consists of numbers so disposed in parallel and equal lines, that the sum of each, taken any way of the square, amounts to the same.

Any five of these sums taken in a right line make 65. You will observe that five numbers in the diagonals A to D, and B to C, of the magical square, answer to the ranks E to F, and G to H, in the natural square, and that 13 is the centre number of both squares.

A Natural Square.

A		G		B
1	2	3	4	5
6	7	8	9	10
E 11	12	13	14	15 F
16	17	18	19	20
21	22	23	24	25
C		H		D

A Magical Square.

A				B
11	24	7	20	3
4	12	25	8	16
17	5	13	21	9
10	18	1	14	22
23	6	19	2	15
C				D

To form a magical square, first transpose the two ranks in the natural square to the diagonals of the magical square; then place the number 1 under the central number 13, and the number 2 in the next diagonal downward. The number 3 should be placed in the same diagonal line; but as there is no room in the square, you are to place it in that part it would occupy if another square were placed under this. For the same reason, the number 4, by following the diagonal direction, falling out of the square, it is to be put into the part it would hold in another square, placed by the side of this. You then proceed to numbers 5 and 6, still descending; but as the place 6 should hold is already filled, you then go back to the diagonal, and consequently place the 6 in the second place under the 5, so that there may remain an empty space between the two numbers. The same rule is to observed, whenever you find a space already filled. [Pg 56]

You proceed in this manner to fill all the empty cases in the angle where the 15 is placed: and as there is no space for the 16 in the same diagonal, descending, you must place it in the part it would hold in another square, and continue the same plan till all the spaces are filled. This method will serve equally for all sorts of arithmetical progressions composed of odd numbers; even numbers being too complicated to afford any amusement.

To find the Difference between two Numbers, the greatest of which is unknown.

Take as many nines as there are figures in the smallest number, and subtract that sum from the number of nines. Let another person add that difference to the largest number, and, taking away the first figure of the amount, add it to the last figure, and that sum will be the difference of the two numbers.

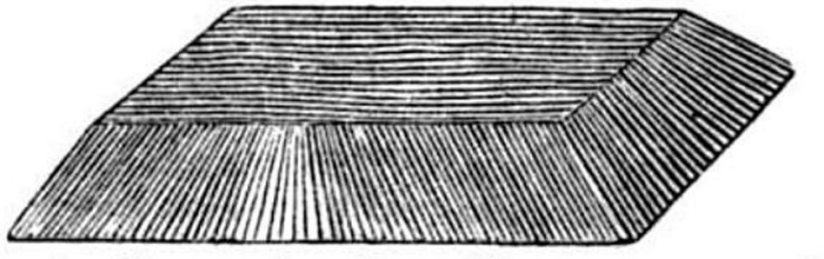
For example: Robert, who is 22, tells George, who is older, that he can discover the difference of their ages; he therefore privately deducts 22 from 99, and the difference, which is 77, he tells George to add to his age, and to take away the first figure from the amount, and add it to the last figure, and that last sum will be the difference of their ages. Thus, the difference between [Pg 57]

Robert's age and 99, is	77
To which George adding his age	35
The sum will be	112
	12
	1
Then by taking away the first figure, 1, and adding it to the last figure, 2, the sum is	13
Which added to Robert's age	22
Gives George's age, which is	35

The Boundless Prospect.

Take a square box, about six inches long and twelve high, or of any other proportionate dimensions. Cover the inside with four flat pieces of looking-glass placed perpendicular to the bottom of the box. Place at the bottom any objects you please, as a piece of fortification, a castle, tents, soldiers, &c. On the top, place a frame of glass shaped like the bottom of a pyramid, as in Fig. 8, and so formed as to fit on the box like a cover. The four sides of this cover are to be composed of ground glass, or covered inside with gauze, so that the light may enter, and yet the inside be invisible, except at the top, which must be covered with transparent glass: when you look through this glass, the inside will present a pleasing prospect of a boundless extent; and, if managed with care, will afford a deal of amusement.

Fig. 8.



To set Fire to a combustible Body by Reflection.

Place two concave mirrors at about twelve feet distance from each other, and let the axis of each be in the same line. In the focus of one of them place a live coal, and in the focus of the other some gunpowder. With a pair of strong bellows keep blowing the coal, and notwithstanding the [Pg 58] distance between them, the powder will presently take fire.

The mirror may be either made of glass, metal, or pasteboard gilt.

To find the Number of Changes that may be rung on Twelve Bells.

Multiply the numbers from 1 to 12 continually into each other, as follow: and the last product will give the number required.

1
2
——
2
3
——
6
4
——
24
5
———
120
6
———
720
7
————

5,040
8
———————
40,320
9
———————
362,880
10
———————
3,628,800
11
———————
39,916,800
12
———————
479,001,600

[Pg 59]

To find how many square Yards it would require to write all the Changes of the Twenty-four Letters of the Alphabet, written so small, that each Letter should not occupy more than the hundredth part of a square Inch.

By adopting the plan of the preceding article, the changes of the twenty-four letters will be found to be

62,044,840,173,323,943,936,000.

Now, the inches in a square yard being 1,296, that number multiplied by 100 gives 129,600, which is the number of letters each square yard will contain; therefore, if we divide the above row of figures, (the number of changes,) by 129,600, the quotient, which is 478,741,050,720,092,160, will be the number of yards required to contain the above mentioned number of changes. But as all the 24 letters are contained in every permutation, it will require a space 24 times as large, *viz.*,

11,849,785,210,282,211,840.

Now, as the surface of the whole globe only contains 617,197,435,008,000 square yards, it would require a surface 18,620 times as large as the earth to contain them.

The Enchanted Bottle.

Fill a glass bottle with water to the beginning of the neck; leave the neck empty, and cork it. Suspend this bottle opposite a concave mirror, and beyond its focus, that it may appear reversed. Place yourself still further distant from the bottle; and instead of the water appearing, as it really is, at the bottom of the bottle, the bottom will be empty, and the water seen at the top.

If the bottle be suspended with the neck downwards, it will be reflected in its natural position, and the water at the bottom, although in reality it is inverted, and fills the neck; leaving the bottom vacant. While the bottle is in this position, uncork it, and let the water run gradually out: it will appear, that while the real bottle is emptying, the reflected one is filling. Care must be taken that the bottle is not more than half or three parts full, and that no other liquid is used but water, as in either of these cases the illusion ceases.

[Pg 60]

The Solar Magic Lantern.

Make a box, a foot high, eighteen inches wide, and about three inches deep. Two of the opposite sides of this box must be quite open, and in each of the other sides let there be a groove wide enough to admit a stiff paper or pasteboard. You fasten the box against a window, on which the sun's rays fall direct. The rest of the window should be closed up, that no light may enter.

Next provide several sheets of stiff paper, blacked on one side. On these papers cut out such figures as your fancy may dictate; place them alternately in the grooves of the box, with their blacked sides towards you, and look at them through a large and clear glass prism; and if the light be strong, they will appear painted with the most lively colours. If you cut on one of these papers the form of a rainbow, about three-quarters of an inch wide, you will have a very good representation of the natural one.

For greater convenience, the prism may be placed on a stand on the table, made to turn round on an axis.

The Artificial Rainbow.

Opposite a window into which the sun shines direct suspend a glass globe, filled with clean water, by means of a string that runs over a pulley, so that the sun's rays may fall on it. Then drawing the globe gradually up, you will observe, when it comes to a certain height, and by placing yourself in a proper situation, a purple colour in the glass; and by drawing it up gradually higher, the other prismatic colours, blue, green, yellow, and red, will successively appear; after

which, the colours will disappear, till the globe is raised to about fifty degrees, when they will again appear, but in an inverted order, the red appearing first, and the blue or violet last; on raising the globe a little higher, they will totally vanish.

The Æolipiles.

The æolipile is a small hollow globe of brass, or other metal, in which a slender neck or pipe is inserted. This ball, when made red-hot, is cast into a vessel of water, which will rush into its cavity, then almost void of air. The ball being then set on the fire, the water, by the rarefaction of the internal air, will be forced out in steam by fits, with great violence, and with strange noise. [Pg 61]

If to the necks of two or more of these balls, there be fitted those calls that are used by fowlers and hunters, and the balls placed on the fire, the steam rushing from them will make such a horrible noise, that it will astonish any person who is ignorant of the contrivance.

The Talking Busts.

Procure two busts of plaster of Paris; place them on pedestals, on the opposite sides of the room. Let a thin tube, of an inch diameter, pass from the ear of one head through the pedestal, under the floor, and go up to the mouth of the other; taking care that the end of the tube that is next the ear of the one head, be considerably larger than that end which comes to the mouth of the other.

Now, when a person speaks quite low into the ear of one bust, the sound is reverberated through the length of the tube, and will be distinctly heard by any one placing his ear to the mouth of the other. It is not necessary that the tube should come to the lips of the bust. If there be two tubes, one going to the ear, and the other to the mouth of each head, two persons may converse together, by whispers, without the knowledge of any person who may stand in the middle of the room.

The Inanimate Oracle.

Place a bust on a pedestal in the corner of a room, and let there be two tubes, as in the preceding article, one to go from the mouth, and the other from the ear, through the pedestal and the floor to an under apartment; there may be also wires, that go from the under jaw and the eyes of the bust, by which they may be easily moved.

A person being placed in the room underneath, and applying his ear to one of the tubes at a signal given, will hear any question asked, and can immediately reply, by applying his mouth to the tube which communicates below, at the same time moving the eyes by the wire, to accompany his speech.

[Pg 62]

The Solar Concerto.

In a large case, similar to what is used for dials and spring clocks, the front of which, or at least the lower part, must be of glass, covered on the inside with gauze, place a barrel organ, which when wound up is prevented from playing by a catch that takes a toothed wheel at the end of the barrel. To one end of this catch join a wire, at the end of which is a flat circle of cork, of the same dimensions with the inside of a glass tube, in which it is to rise and fall. This tube must communicate with a reservoir that goes across the front part of the bottom of the case, which is to be filled with spirits, such as is used in thermometers.

This case being placed in the sun, the spirits will be rarefied by the heat, and, rising in the tube, will lift up the catch or trigger, and set the organ in play; which will continue as long as it is kept in the sun; for the spirits cannot run out of the tube, that part of the catch to which the circle is fixed being prevented from rising beyond a certain point, by a check placed over it. Care must be taken to remove the machine out of the sun before the organ runs down, that its stopping may be evidently affected by the cold.

In winter it will perform when placed before the fire.

CURIOUS EXPERIMENTS WITH THE MAGIC LANTERN.

The construction of this amusing optical machine is so well known, that to describe it would be superfluous; particularly as it can now be purchased at a very reasonable expense, at any of the opticians': but as many persons who have a taste for drawing might not be pleased with the designs to be had at the shops, or might wish to indulge their fancy in a variety of objects, which to purchase would become expensive, we here present our readers, in the first place, with the method of drawing them, which will be succeeded by a plain description of some very diverting experiments. [Pg 63]

Of Painting the Glasses.

You first draw on a paper, the size of the glass, the subject you mean to paint; fasten this at each end of the glass with paste, or any other cement, to prevent it from slipping. Then with some very black paint mixed with varnish, draw with a fine camels'-hair pencil, very lightly, the outlines sketched on the paper, which, of course, are reflected through the glass. Some persons affirm that those outlines can be more readily traced with japan writing ink, and a common pen with a fine nib; but this, even if it succeeds in making a delicate black outline, is sure to be effaced by damp or wet.

It would improve the natural resemblance, if the outlines were drawn with a strong tint of each of the natural colours of the object; but in this respect you may please your own fancy. When the outlines are dry, colour and shade your figures; but observe, to temper your colours with strong white varnish. A pleasing effect will be produced, if you leave strong lights in some parts of the drapery, &c., without any colours. The best colours for this purpose are transparent ones; opaque or mineral colours will not do. The following are in most repute.

For	Pink and crimson	Lake or carmine.
	Blue	Prussian blue.
	Green	Calcined verdigris, or distilled ditto.
	Yellow	Gamboge.

To represent a Storm at Sea.

Provide two strips of glass, whose frames are thin enough to admit both strips freely into the groove of the lantern. On one of these glasses paint the appearance of the sea from a smooth calm to a violent storm. Let these representations run gradually into each other, as in Fig. 9, and you will of course observe, that the more natural and picturesque the painting is, the more natural and pleasing will be the reflection. [Pg 64]

Fig. 9.

Fig. 10.

On the other glass, Fig. 10, paint various vessels on the ocean, observing to let that end where the storm is, appear in a state of violent commotion, and the vessels as if raised on the waves in an unsettled position, with heavy clouds about them.

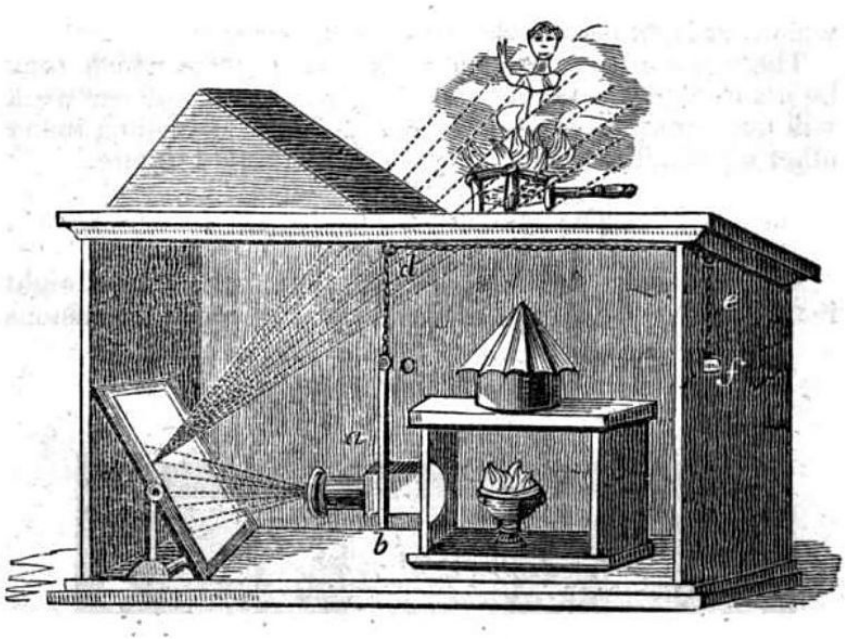
You then pass the glasses slowly through the groove, and when you come to that part where the storm is supposed to begin, move them gently up and down, which will give the appearance of the sea and vessels being agitated; increase the motion till they come to the height of the storm. You will thus have a very natural representation of the sea and ships in a calm and storm; and as you gradually draw the glasses back, the tempest will subside, the sky appear clear, and the vessels glide gently over the waves.

By the means of two or three glasses, you may also represent a battle on land, or a naval engagement, with a variety of other pleasing experiments.

To produce the appearance of a Spectre on a Pedestal in the middle of a Table.

Enclose a small magic lantern in a box, Fig. 11, large enough to contain a small swing dressing-glass, which will reflect the light thrown on it by the lantern in such a way, that it will pass out at the aperture made at the top of the box; which aperture should be oval, and of a size adapted to [Pg 65] the cone of light to pass through it. There should be a flap with hinges, to cover the opening, that the inside of the box may not be seen.

Fig. 11.



There must be holes in that part of the box which is over the lantern, to let the smoke out; and over this must be placed a chafing-dish of an oblong figure, large enough to hold several lighted coals. This chafing-dish, for the better carrying on the deception, may be enclosed in a painted tin box, about a foot high, with a hole at top, and should stand on four feet, to let the smoke from the lantern escape.

There must also be a glass planned to rise up and down in the groove *a b*, and so managed by a cord and pulley, *c d e f*, that it may be raised up and let down by the cord coming through the outside of the box. On this glass, the spectre, (or any other figure you please,) must be painted in a contracted or equal form, as the figure will reflect a greater length than it is drawn.

When you have lighted the lamp in the lantern, and placed the mirror in a proper direction, put the box on a table, and, setting the chafing-dish in it, throw some incense, in powder, on the coals. You then open the trap door and let down the glass in the groove slowly, and when you perceive the smoke diminish, draw up the glass, that the figure may disappear, and shut the trap door. [Pg 66]

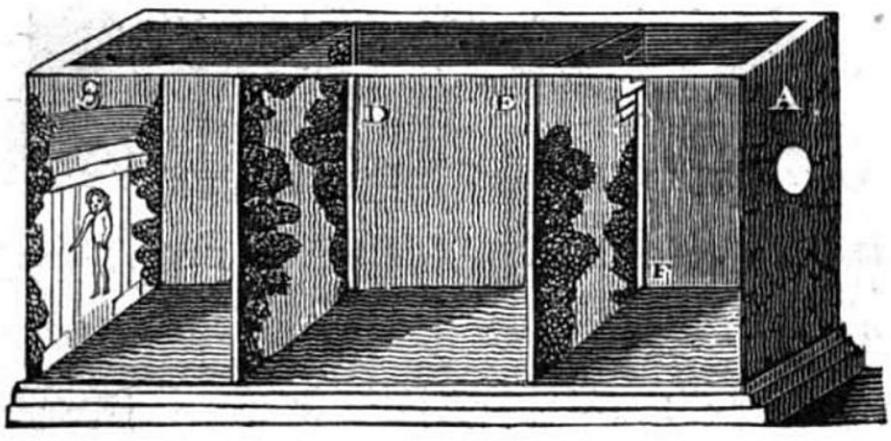
This exhibition will afford a deal of wonder; but observe, that all the lights in the room must be extinguished; and the box should be placed on a high table, that the aperture through which the light comes out may not be seen.

There are many other pleasing experiments which may be made with the magic lantern, but the limits of our work will not permit us to specify them, without excluding many other equally interesting subjects of a different nature.

The Artificial Landscape.

Procure a box, as in Fig. 12, of about a foot long, eight inches wide, and six inches high, or any other dimensions you please, so they do not greatly vary from these proportions. At each of its opposite ends, on the inside of this box, place a piece of looking-glass that shall exactly fit: but at that end where the sight hole A is, scrape the quicksilver off the glass, through which the eye can view the objects.

Fig. 12.



Cover the box with gauze, over which place a piece of transparent glass, which is to be well fastened in. Let there be two grooves at each of the places C D E F, to receive two printed

scenes, as follow: On two pieces of pasteboard, let there be skilfully painted, on both sides, any subject you think proper, as woods, bowers, gardens, houses, &c.; and on two other boards, the same subjects on one side only, and cut out all the white parts: observe also, that there ought to [Pg 67] be in one of them some object relative to the subject, placed at A, that the mirror placed at B may not reflect the hole on the opposite side.

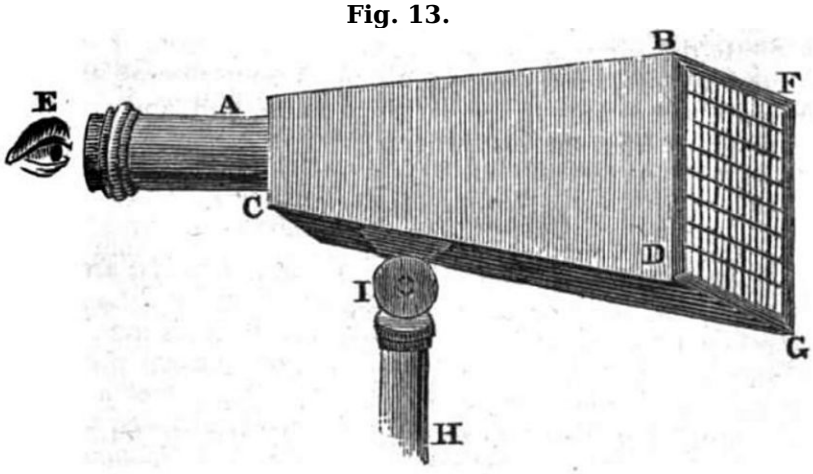
The boards painted on both sides are to slide in the grooves C D E F, and those painted on one side are to be placed against the opposite mirrors A and B; then cover the box with its transparent top. This box should be placed in a strong light, to have a good effect.

When it is viewed through the sight hole, it will present an unlimited prospect of rural scenery, gradually losing itself in obscurity; and be found well worth the pains bestowed on its construction.

To draw, easily and correctly, a Landscape, or any other Object, without being obliged to observe the Rules of Perspective, and without the Aid of the Camera Obscura.

Procure a box of pasteboard, A B C D, Fig. 13, of about a foot and a half long, and made in the shape of a truncated pyramid, whose base, B D F G, is eight inches wide, and six inches high. Fix to the other end of it a tube of four or five inches long, and which you can draw out from the box more or less. Line the inside of the box with black paper, and place it on a leg or stand of wood, H, and on which it may be elevated or depressed by the hinge I.

Fig. 13.



Take a small frame of wood, and divide it at every inch by lines of black silk drawn across it, [Pg 68] forming forty-eight equal parts; divide these into still smaller equal parts, by lines of finer silk:[C] fix this frame at the end of B D, as the base of the pyramid.

Provide a drawing-paper, divided into the same number of parts as in the frame, by lines, lightly drawn in pencil. It is not material of what size these divisions are; that will depend entirely on the size you propose to draw the objects by this instrument.

Place this instrument opposite a landscape, or any other object that you want to draw, and fix the leg firmly on, or in the ground, that it may not shake; then turning it to the side you choose, raise or incline it, and put the tube further in or out, till you have gained an advantageous view of the object you intend to draw.

Place your eye, E, by the instrument, which you have adjusted to the height of your eye, and, looking through the tube, carefully observe all that is contained in each division of the frame, and transpose it to the corresponding division in your paper; and if you have the least knowledge in painting or even drawing, you will make a very pleasing picture, and one in which all the objects will appear in the most exact proportion.

By the same method you may draw all sorts of objects, as architecture, views, &c., and even human figures, if they remain some time in the same attitude, and are at a proper distance from the instrument.

[C] The different thicknesses of the silk serve to distinguish more readily the corresponding divisions.

Illuminated Prospects.

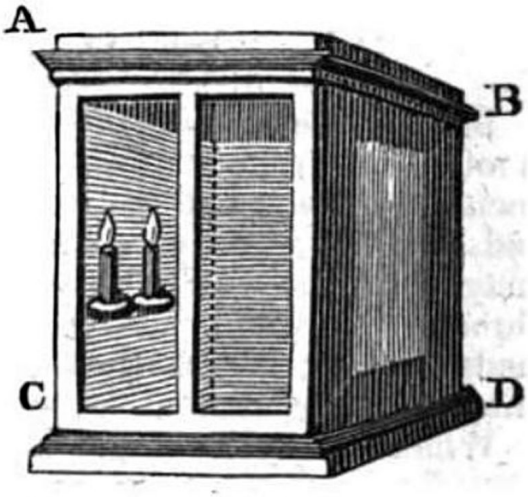
Provide yourself with some of those prints that are commonly used in optical machines, printed on very thin white paper; taking care to make choice of such as have the greatest effect from the manner in which the objects are placed in perspective. Place one of these on the borders of a frame, and paint it carefully with the most lively colours, making use of none that are terrestrial. Observe to retouch those parts several times where the engraving is strongest,[D] then cut off the upper part or sky, and fix that on another frame.

The prints being thus prepared, place them in a box, A B C D, Figs. 14 and 15, the opening to [Pg 69] which, E F G H, should be a little less than the print. Cover this opening with a glass, and paint

all the space between that and the prints, which should be about two or three inches, black. The frame that contains the sky should be about an inch behind the other. In the back part of this box, which is behind the prints, and which may be about four inches deep, place four or five small candlesticks to hold wax lights, and cover that part entirely with tin, that it may be the more luminous.

Fig. 14.

Fig. 15.



When the print is placed between the wax lights and the opening in the front of the box, and there is no other light in the room, the effect will be highly pleasing; especially if the lights are at a sufficient distance from each other, and not too strong, that they may not occasion any blots in the print. Those prints that represent the rising or setting of the sun will have a very picturesque appearance. Such as represent conflagrations have also a striking effect.

There should be two grooves for the print next the glass, that you may insert a second subject before you draw away the first; and that the lights in the back of the box may not be discovered.

You must not, thinking to make the print more transparent, cover it with varnish; for that will prevent the gradation of the colours from being visible. The frame should enter the side of the box by a groove, that a variety of subjects may be introduced.

[D] When you colour a print, place it before you, against a piece of glass, in a position nearly erect, that it may be enlightened by the sun. You may also colour both sides of the print.

EXPERIMENTS IN MAGNETISM.

[Pg 70]

The Magnetic Wand.

Bore a hole three-tenths of an inch in diameter, through a round stick of wood; or get a hollow cane about eight inches long, and half an inch thick. Provide a small steel rod, and let it be very strongly impregnated with a good magnet: this rod is to be put in the hole you have bored through the wand, and closed at each end by two small ends of ivory that screw on, different in their shapes, that you may better distinguish the poles of the magnetic bar.

When you present the north pole of this wand to the south[E] pole of a magnetic needle, suspended on a pivot, or to a light body swimming on the surface of the water, (in which you have placed a magnetic bar,) that body will approach the wand, and present that end which contains the south end of the bar: but if you present the north or south end of the wand to the north or south end of the needle, it will recede from it.

[E] For the more clearly explaining this, it is to be observed, that the two ends of a magnet are called its poles. When placed on a pivot, in just equilibrium, that end which turns to the north is called the north pole, and the other end the south pole.

The Mysterious Watch.

You desire any person to lend you his watch, and ask him if it will go when laid on the table. He will, no doubt, say it will; in which case, you place it over the end of the magnet, and it will presently stop. You then mark the precise spot where you placed the watch, and, moving the point of the magnet, you give the watch to another person, and desire him to make the experiment; in which he not succeeding, you give it to a third (at the same time replacing the magnet) and he will immediately perform it.

This experiment cannot be effected, unless you use a very strongly impregnated magnetic bar, (which may be purchased at the opticians',) and the balance of the watch must be of steel, which may be easily ascertained by previously opening it, and looking at the works.

The Magnetic Dial.

[Pg 71]

Procure a circle of wood or ivory, about 5 or 6 inches diameter, which must turn quite free on a stand with a circular border; on the ivory or wood circle fix a pasteboard, on which you place, in proper divisions, the hours, as on a dial. There must be a small groove in the circular frame, to receive the pasteboard circle; and observe, that the dial must be made to turn so free, that it may go round without moving the circular border in which it is placed.

Between the pasteboard circle and the bottom of the frame, place a small artificial magnet, that has a hole in its middle. On the outside of the frame, place a small pin, which serves to show when the magnetic needle is to stop. This needle must turn quite free on its pivot, and its two sides should be in exact equilibrium.

Then provide a small bag, with five or six divisions, like a lady's work-bag, but smaller. In one of these divisions put small square pieces of pasteboard, on which are written the numbers from 1 to 12. In each of the other divisions put twelve or more similar pieces, observing that all the pieces in each division must be marked with the same number. The needle being placed upon its pivot, and turned quickly about, it will necessarily stop at that point where the north end of the magnetic bar is placed, and which you previously know, by the situation of the small pin in the circular border.

You then present to any person that division of the bag which contains the several pieces on which is written the number opposite to the north end of the bar, and tell him to draw any one he pleases. Then placing the needle on the pivot, you turn it quickly about, and it must necessarily stop at that particular number.

The Magnetic Cards.

Draw a pasteboard circle; you then provide yourself with two needles, similar to those used in the foregoing experiment, (which you must distinguish by some private mark,) with their opposite points touched with the magnet. When you place that needle whose pointed end is touched, on the pivot described in the centre of the circle, it will stop on one of the four pips, against which you have placed the pin in the frame; then take the needle off, and, placing the other, it will stop on the opposite point.

[Pg 72]

Having matters thus arranged, desire a person to draw a card from a piquet pack, offering that card against which you have placed the pin of the dial, which you may easily do, by having a card a little longer than the rest. If he should not draw it the first time, as he probably may not, you must make some excuse for shuffling them again, such as letting the cards fall, as if by accident, or some other manœuvre, until he fix on the card. You then tell him to keep it close, and not let it be seen. Then give him one of the two needles, and desire him to place it on the pivot, and turn it round, when it will stop at the colour of the card he chose; then taking that needle off, and exchanging it, unperceived, for the other, give it to a second person, telling him to do the same, and it will stop at the name of the identical card the first person chose.

The Magnetic Orrery.

Construct a round box, Fig. 16, about eight inches diameter, and half an inch deep. On the bottom fix a circular pasteboard drawn like the figure. You are likewise to have another pasteboard, drawn exactly the same, which must turn freely in the box, by means of an axis placed on a pivot, one end of which is to be fixed in the centre of the circle.

On each of the seven smaller circles on the pasteboard, which you have fixed at the bottom of the box, place a magnetic bar, two inches long, in the same direction with the diameters of those circles, and their poles, in the situations expressed in the figure.

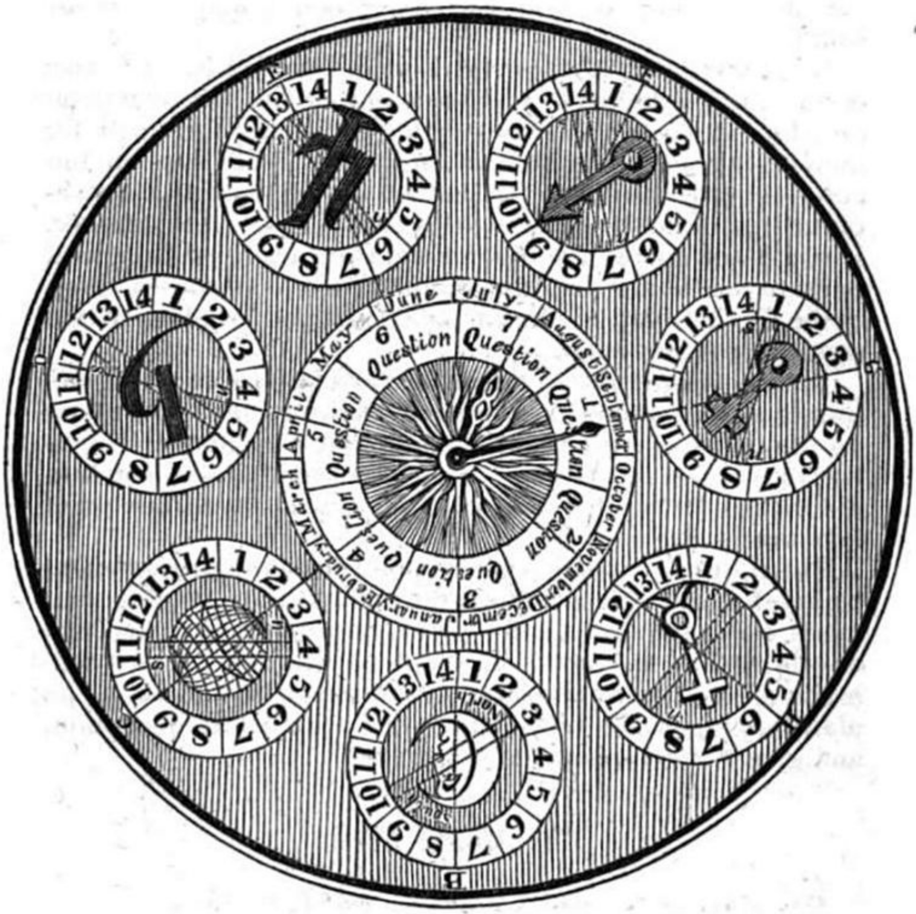
There must be an index like the hour hand of a dial, fixed on the axis of the central circle, by which the pasteboard circle in the box may be turned about; also a needle (forming in the figure the other hand) that will turn freely on the axis, without moving the circular pasteboard.

In each of the places where the word *question* is, write a different question; and in each of the seven circles where the planetary signs are, write two answers to each question; observing, that there must only be seven words in each question: for instance,

In division No. 1, of the circle G, which stands opposite question No. 1, write the first word of the first answer. In the division No. 2, of the next circle, write the second word; and so on to the last, which will be in the seventh division of the seventh circle.

[Pg 73]

Fig. 16.



In the eighth division of the first circle, write the first word of the second answer; in the ninth, the second word of the same answer; and so on to the fourteenth division of the seventh circle, which must contain the last word of that answer.

The same must be done for all the seven questions, and to each of these must be assigned two [Pg 74] answers, the words of which are to be dispersed through the seven circles.

At the centre of each of these circles place a pivot, and have two sets of magnetic needles like the hands of a watch, the pointed end of one set being north, and the other south.

Now, the index of the central circle being directed to any one of the questions, if you place one of the two magnetic needles on each of the seven lesser circles, they will fix themselves according to the directions of the bars on the corresponding circles at the bottom of the box, and consequently point to the seven words that compose the answer. If you place one of the other needles on each circle, it will point to the words that are diametrically opposite to those of the first answer, the north pole being in the place of the south pole of the other.

You therefore present this orrery to any person, and desire him to choose one of the questions there written. You then set the index of the central circle to that question; and, putting one of the needles on each of the seven circles, you turn it about, and when they all settle, the seven words they point to compose the answer.

The moveable needle, whose point in the figure stands at September, is to place against the names of the months; and when the party has fixed upon a question, you place that needle against the month in which he was born, which will make the ceremony appear a sort of magic divination. The planetary signs are merely intended to aid this deception, and give it the appearance of astrology.

The Magic Verse.

The eight words which compose this Latin verse,

> "*Tot sunt tibi dote, quot cœli sidera, virgo,*"[F]

being privately placed in any one of the different combinations of which they are susceptible, and which are 40,320 in number, to tell the order in which they are placed.

Provide a box that shuts with hinges, and is eight inches long, three wide, and half an inch deep, Fig. 17. Have eight pieces of wood, about one-third of an inch thick, two inches long, and one and a half wide, which will therefore, when placed close together, exactly fill the box. In each of these [Pg 75] pieces or tablets place a magnetic bar, with their poles, as is expressed in Fig. 18. The bars being covered over, write on each of the tablets, in the order they then stand, one of the words of the foregoing Latin verse.

[F] "Thy charms, O, Virgin! are as numerous as the stars of heaven."

Fig. 17.

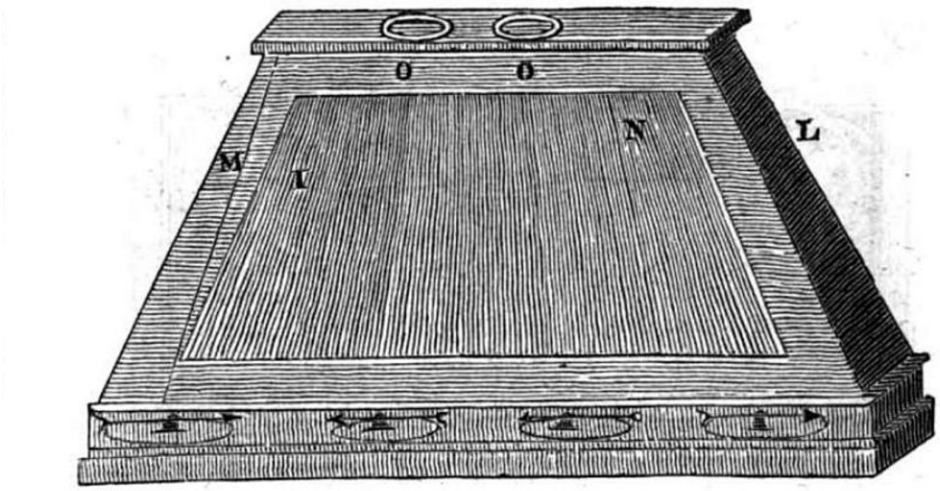
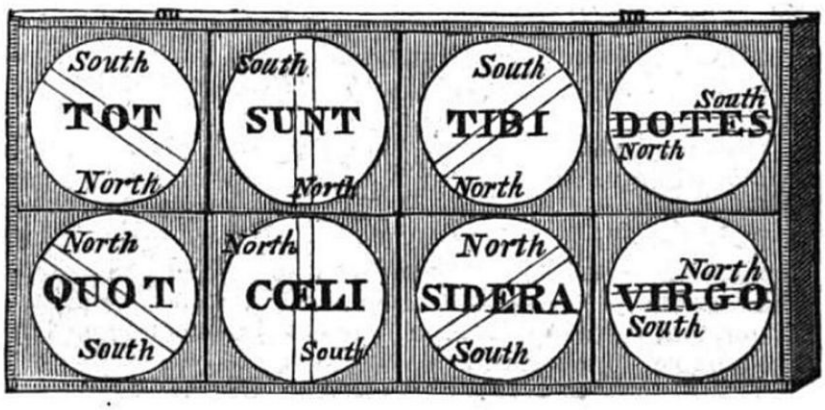
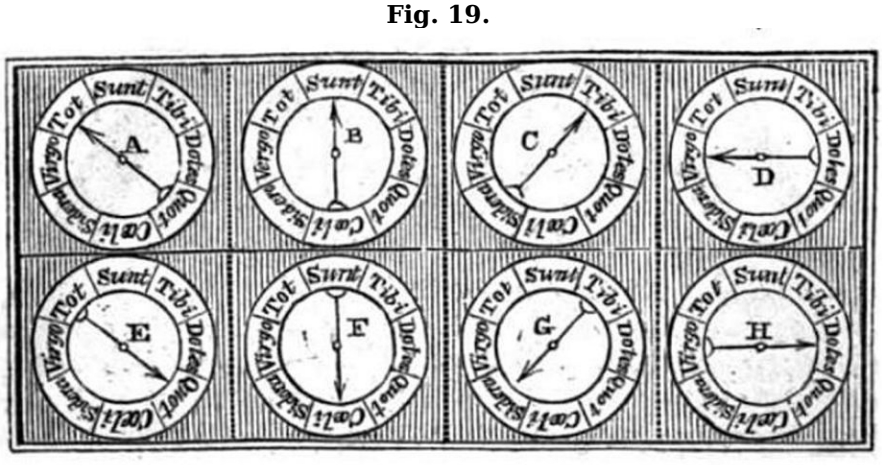


Fig. 18.



On a very thin board of the same dimensions with the box, draw the eight circles, Fig. 19, A B C D E F G H, whose centres should be exactly over those of the eight tablets in the box, when the board is placed upon it. Divide each of those circles into eight parts, as in the figure, and in each of those divisions write one of the words of the Latin verse, and in the precise order expressed in the plate, so that when the board is placed over the box, the eight touched needles placed at the centre of the circles may be regulated by the poles of the bars in the box, and consequently the word that the needle points to in the circle will be the same with that inscribed on the tablet. Cover the board with a glass, to prevent the needles from rising off their pivots, as is done in the sea-compass. [Pg 76]

Fig. 19.



Over the board place four plates of glass, I L M N, Fig. 17, which will give the machine the figure of a truncated pyramid, of eight inches high. Cover it with a glass, or rather a board, in which are placed two lenses, O, of eight inches focus, and distant from each other about half an inch. Line the four plates of glass that compose the sides with very thin paper, that will admit the light, and at the same time prevent the company from seeing the circles on the board.

These preparations being made, you give the box to any one, and tell him to place the tablets, on which the words are written privately, in what position he thinks proper, then to close the box, and, if he please, to wrap it up in paper, seal it, and give it to you. Then placing the board with the pyramid upon it, you immediately tell him the order in which the tablets are placed, by reading the words to which the needles on the circles point. [Pg 77]

INTERESTING EXPERIMENTS WITH THE AIR-PUMP.

We shall not occupy the time of our readers by describing the form and nature of the air-pump; since those persons whose circumstances will enable them to have it, can purchase it properly made at an optician's, at less expense, and with far less trouble, than they can construct, or cause it to be constructed, themselves.

Bottles broken by Air.

Take a square bottle of thin glass, and of any size. Apply it to the hole of the air-pump, and exhaust the air. The bottle will sustain the weight of the external air as long as it is able, but at length it will suddenly burst into very small particles, and with a loud explosion.

An opposite effect will be produced, if the mouth of a bottle be sealed so close that no air can escape; then place it in the receiver, and exhaust the air from its surface. The air which is confined within the bottle, when the external air is drawn off, will act so powerfully as to break the bottle into pieces.

Glass broken by Air.

Lay a square of glass on the top of an open receiver, and exhaust the air. The weight of the external air will press on the glass, and smash it to atoms.

The Hand fixed by Air.

If a person hold his hand on an open receiver, and the air be exhausted, it will be fixed as if pressed by a weight of sixty pounds.

[Pg 78]

Water boiled by Air.

Take water made so warm that you can just bear your hand in it, but that has not been boiled; put it under the receiver, and exhaust the air. Bubbles of air will soon be seen to rise, at first very small, but presently become larger, and will be at last so great, and rise with such rapidity, as to give the water the appearance of boiling. This will continue till the air is let into the receiver, when it will instantly cease.

Aërial Bubbles.

Take a stone, or any heavy substance, and putting it in a large glass with water, place it in the receiver. The air being exhausted, the spring of that which is in the pores of the solid body, by expanding the particles, will make them rise on its surface in numberless globules, which resemble the pearly drops of dew on the tops of the grass. The effect ceases when the air is let into the receiver.

The floating Stone.

To a piece of cork tie a small stone that will just sink it; and, putting it in a vessel of water, place it under the receiver. Then exhausting the receiver, the bubbles of air will expand from its pores, and, adhering to its surface, will render it, together with the stone, lighter than water, and consequently they will rise to the surface, and float.

Withered Fruit restored.

Take a shrivelled apple, and, placing it under the receiver, exhaust the air. The apple will immediately be plumped up, and look as fresh as when first gathered: for this reason, that the pressure of the external air being taken off, the air in the apple extends it, so much indeed that it will sometimes burst. If the air be let into the receiver, the apple will be restored to its pristine shrivelled state.

Vegetable Air-Bubbles.

Put a small branch of the tree with its leaves, or part of a small plant, in a vessel of water, and, placing the vessel in the receiver, exhaust the air. [Pg 79]

When the pressure of the external air is taken off, the spring of that contained in the air-vessels of the plant, by expanding the particles, will make them rise from the orifices of all the vessels for a long time together, and produce a most beautiful appearance.

The Mercurial Wand.

Take a piece of stick, cut it even at each end with a penknife, and immerse it in a vessel of mercury. When the air is pumped out of the receiver, it will at the same time come out of the pores of the wood, through the mercury, as will be visible at each end of the stick. When the air is again let into the receiver, it falls on the surface of the mercury, and forces it into the pores of the wood, to possess the place of the air.

When the rod is taken out, it will be found considerably heavier than before, and that it has changed its colour, being now all over of a bluish hue. If cut transversely, the quicksilver will be seen to glitter in every part of it.

The Magic Bell.

Fix a small bell to the wire that goes through the top of the receiver. If you shake the wire, the bell will ring while the air is in the receiver; but when the air is drawn off, the sound will by degrees become faint, till at last not the least noise can be heard. As you let the air in again, the sound returns.

Feathers heavier than Lead.

At one end of a fine balance, hang a piece of lead, and at the other as many feathers as will poise it; then place the balance in the receiver. As the air is exhausted, the feathers will appear to overweigh the lead, and when all the air is drawn off, the feathers will preponderate, and the lead ascend.

The self-moving Wheel.

Take a circle of tin, about ten inches in diameter, or of any other size that will go into the receiver, and to its circumference fix a number of tin vanes, each about an inch square. Let this wheel be placed between two upright pieces on an axis, whose extremities are quite small, so [Pg 80] that the wheel may turn in a vertical position with the least possible force. Place the wheel and axis in the receiver, and exhaust the air. Let there be a small pipe with a cock; one end of the pipe to be outside the top of the receiver, and the other to come directly over the vanes of the wheel.

When the air is exhausted, turn the cock, and a current will rush against the vanes of the wheel, and set it in motion, which will increase, till the receiver is filled with air.

The Artificial Halo.

Place a candle on one side of the receiver, and let the spectator place himself at a distance from the other side. Directly the air begins to be exhausted, the light of the candle will be refracted in circles of various colours.

The Mercurial Shower.

Cement a piece of wood into the lower part of the neck of an open receiver, and pour mercury over it. After a few strokes of the pump, the pressure of the air on the mercury will force it through the pores of the wood in the form of a beautiful shower. If you take care that the receiver is clear and free from spots or dust, and it is dry weather, it will appear like a fiery shower, when exhibited in a dark room.

Magic Fountain.

Take a tall glass tube, hermetically sealed both at top and bottom, by means of a brass cap screwed on to a stop-cock, and place it on the plate of the pump. When the air is exhausted, turn the cock, take the tube off the plate, and plunge it into a basin of mercury or water. Then the cock being again turned, the fluid, by the pressure of the air, will play upon the tube in the form of a beautiful fountain.

The Exploded Bladder.

Take a glass pipe open at both ends, to one of which tie fast a wet bladder, and let it dry. Then place it on the plate of the pump. While the air presses the bladder equally on both sides, it will lie even and straight; but as soon as the air is exhausted, it will press inwards, and be quite [Pg 81] concave on the upper side. In proportion as the air is exhausted, the bladder will become more stretched; it will soon yield to the incumbent pressure, and burst with a loud explosion. To make this experiment more easy, one part of the bladder should be scraped with a knife, and some of its external fibres taken off.

The Cemented Bladder.

Tie the neck of the bladder to a stop-cock, which is to be screwed to the plate of the pump, and the air exhausted from the bladder; then turn the stop-cock, to prevent the re-entrance of the air,

and unscrew the whole from the pump. The bladder will be transformed into two flat skins, so closely applied together, that the strongest man cannot raise them half an inch from each other; for an ordinary-sized bladder, of six inches across the widest part, will have one side pressed upon the other with a force equal to 396 pounds' weight.

Cork heavier than Lead.

Let a large piece of cork be pendent from one end of a balance beam, and a small piece of lead from the other; the lead should rather preponderate. If this apparatus be placed under a receiver on the pump, you will find that when the air is exhausted, the lead, which seemed the heaviest body, will ascend, and the cork outweigh the lead. Restore the air, and the effect will cease. This phenomenon is only on account of the difference of the size in the two objects. The lead, which owes its heaviness to the operation of the air, yields to a lighter because a larger substance when deprived of its assistance.

The animated Bacchus.

Construct a figure of Bacchus, seated on a cask; let his belly be formed by a bladder, and let a tube proceed from his mouth to the cask. Fill this tube with coloured water or wine, then place the whole under the receiver. Exhaust the air, and the liquor will be thrown up into his mouth. While he is drinking, his belly will expand.

The Artificial Balloon.

Take a bladder containing only a small quantity of air, and a piece of lead to it, sufficient to sink it, if immersed in water. Put this apparatus into a jar of water, and place the whole under a [Pg 82] receiver. Then exhaust the air, and the bladder will expand, become a balloon lighter than the fluid in which it floats, and ascend, carrying the weight with it.

Curious Experiments with a Viper.

Many natural philosophers, in their eagerness to display the powers of science, have overlooked one of the first duties of life, humanity; and, with this view, have tortured and killed many harmless animals, to exemplify the amazing effects of the air-pump. We, however, will not stain the pages of this little work by recommending any such species of cruelty, which in many instances can merely gratify curiosity; but as our readers might like to read the effect on animals, we extract from the learned Boyle an account of his experiment with a viper.

He took a newly-caught viper, and, shutting it up in a small receiver, extracted the air. At first, upon the air being drawn away, the viper began to swell; a short time after it gasped and opened its jaws; it then resumed its former lankness, and began to move up and down within the receiver, as if to seek for air. After a while, it foamed a little, leaving the foam sticking to the inside of the glass; soon after, the body and neck became prodigiously swelled, and a blister appeared on its back. Within an hour and a half from the time the receiver was exhausted, the distended viper moved, being yet alive, though its jaws remained quite stretched; its black tongue reached beyond the mouth, which had also become black in the inside: in this situation it continued for three hours; but on the air being re-admitted, the viper's mouth was presently closed, and soon after opened again; and these motions continued some time, as if there were still some remains of life.

It is thus with animals of every kind; even minute microscopical insects cannot live without air.

Experiments with Sparrows.

Count Morozzo placed successively several full-grown sparrows under a glass receiver, inverted over water. It was filled with atmospheric air, and afterwards with vital air. He found, [Pg 83]

First.—That in *atmospheric* air,	**HOURS**	**MIN.**
The first sparrow lived	3	0
The second sparrow lived	0	3
The third sparrow lived	0	1

The water rose in the vessels eight lines during the life of the first; four during the life of the second; and the third produced no absorption.

Second.—In *vital* air or *oxygen*,	**HOURS**	**MIN.**
The first sparrow lived	5	23
The second	2	10
The third	1	30
The fourth	1	10
The fifth	0	30
The sixth	0	47
The seventh	0	27

The eighth	0	30
The ninth	0	22
The tenth	0	21

The above experiments elicit the following conclusions:—1. That an animal will live longer in vital than in atmospheric air.—2. That one animal can live in air, in which another has died.—3. That, independently of air, some respect must be had to the constitution of the animal; for the sixth lived 47 minutes, the fifth only thirty.—4. That there is either an absorption of air, or the production of a new kind of air, which is absorbed by the water as it rises.

AMUSING EXPERIMENTS IN ELECTRICITY.

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. [Pg 84]

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.

Candle Bombs.

Procure some small glass bubbles, having a neck about an inch long, with very slender bores, by means of which a small quantity of water is to be introduced into them, and the orifice afterwards closed up. This stalk being put through the wick of a burning candle, the flame boils the water into a steam, and the glass is broken with a loud explosion.

The Artificial Spider.

Cut a piece of burnt cork, about the size of a pea, into the shape of a spider; make its legs of linen thread, and put a grain or two of lead in it to give it more weight. Suspend it by a fine line of silk between an electrified arch and an excited stick of wax; and it will jump continually from one body to the other, moving its legs at the same time, as if animated, to the great surprise of the unconscious spectator.

[Pg 85]

The Miraculous Portrait.

Get a large print (suppose of the king) with a frame and glass. Cut the print out at about two inches from the frame all round; then with thin paste fix the border that is left on the inside of the glass, pressing it smooth and close; fill up the vacancy, by covering the glass well with leaf-gold or thin tin-foil, so that it may lie close. Cover likewise the inner edge of the bottom part of the back of the frame with the same tin-foil, and make a communication between that and the tin-foil in the middle of the glass; then put in the board, and that side is finished. Next turn up the glass, and cover the fore-side with tin-foil, exactly over that on the back part; and when it is dry, paste over it the panel of the print that was cut out, observing to bring the corresponding parts of the border and panel together, so that the picture will appear as at first, only part of it behind the glass, and part before. Lastly, hold the print horizontally by the top, and place a little moveable gilt crown on the king's head.

Now, if the tin-foil on both sides of the glass be moderately electrified, and another person take hold of the bottom of the frame with one hand, so that his fingers touch the tin-foil, and with the other hand attempt to take off the crown, he will receive a very smart blow, and fail in the attempt. The operator, who holds the frame by the upper end, where there is no tin-foil, feels nothing of the shock, and can touch the face of the king without danger, which he pretends is a

test of his loyalty.

The Cup of Tantalus.

You place a cup of any sort of metal on a stool of baked wood or a cake of wax. Fill it to the brim with any liquor; let it communicate with the branch by a small chain; and when it is moderately electrified, desire a person to taste the liquor, without touching the cup with his hands, and he will instantly receive a shock on his lips. The motion of the wheel being stopped, you taste the liquor yourself, and desire the rest of the company to do so; you then give your operator (who is concealed in an adjoining room) the signal, and he again charges the cup; you desire the same person to taste the liquor a second time, and he will receive a second shock. [Pg 86]

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 off each other; then join 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.

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.

The Magic Dance.

From the middle of the brass arch suspend three small bells. The two outer bells hang by chains, and the middle one by a silk string, while a chain connects it with the floor. Two small knobs of brass, which serve as clappers, hang by silk strings, one between each two bells. Therefore, when the two outer bells communicating with the conductor are electrified, they will attract the clappers and be struck by them. The clappers being thus loaded with electricity, will be repelled, and fly to discharge themselves upon the middle bell, after which they will be again attracted by the outer bells; and thus, by striking the bells alternately, the ringing may be continued as long as the operator pleases.

You next suspend a plate of metal from the same part of the arch to which the bells are connected; then, at the distance of a few inches from the arch, and exactly under it, place a metal stand *of the same size*. On the stand place several figures of men, animals, or what you please, cut in paper, and pretty sharply pointed at each extremity. When the plate that hangs from the arch is electrified, the figures will dance with astonishing rapidity, and the bells will keep [Pg 87] ringing, to the no small entertainment of the spectators.

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.

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, it 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. [Pg 88]

The Magic Chase.

On the top of a finely-pointed wire, rising perpendicularly from the conductor, let another wire, sharpened 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 be placed upon the wires, so as to turn round with them, when they appear as if in pursuit. The chase may be diversified, and a greater variety of figures 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 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 to 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 [Pg 89] 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.

To exhibit the five following amusements in electricity, the room in which they are performed must be darkened.

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 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 [Pg 90] half an hour, their splendour becoming 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. [Pg 91]

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 to quite fill the receiver. Upon making the discharge, the light is seen to run in a much closer body, the whole coming out at once.

The Illuminated Cylinder.

Provide a glass cylinder, three feet long, and three inches 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 cylinder 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.

The Electric Aurora Borealis.

Make a Torricellian vacuum[G] in a glass tube, about three feet long, and hermetically sealed.[H] 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 interruption, from one end to the other, even to its whole length. [Pg 92] 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.

[G] 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 the mercury runs out, all the space above will be a true vacuum.

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

The Electrical Orrery.

By the motion of circulating points, we may in some measure imitate the revolutions of the heavenly bodies, forming what is called the *Electrical Orrery*. Let a single wire, with the

extremities pointed and turned, be nicely balanced on a point; fix a small glass ball over its centre to represent the sun. At one extremity of the wire, let a small wire be soldered perpendicularly, and on this balance another small wire with its ends pointed and turned, and having a small pith ball in its centre, to represent the earth, and a smaller ball of the same kind at one of the angles, for the moon. Let the whole be supported upon a glass pillar, and be conducted by a chain proceeding from the prime conductor to the wire supporting the glass ball. Now, when the machine is put in motion, the wires will turn round, so that the ball representing the earth will move round the central ball, and the little ball at the angle of the smaller wire will at the same time revolve about the earth.

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 [Pg 93] 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 or 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 appearance whether they be taken from the positive or negative conductor; they sometimes appear like a long line of fire reaching from the prime conductor to the opposed 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. [Pg 94]

The Leyden Phial.

When a nail or piece of thick brass wire, &c., is put into a small apothecary's phial, and electrified, remarkable effects follow; but the phial must be very dry or warm. Rub it once beforehand with your finger, on which put some pounded chalk. If a little mercury, or a few drops of spirit of wine, be put into it, the experiment succeeds the better. As soon as this phial and nail are removed from the electrifying glass, or the prime conductor, to which it has been exposed, is taken away, it throws out a stream of flame so long, that with this burning-machine in your hand, you may take about sixty steps in walking about your room. When it is electrified strongly, you may take it into another room, and there fire spirits of wine with it. If, while it is electrifying, you put your finger, or a piece of gold which you hold in your hand, to the nail, you receive a shock which stuns your arms and shoulders.

A tin tube, or a man placed upon electrics, is electrified much stronger by these means than in the common way. When you present this phial and nail it to a tin tube, fifteen feet long, nothing but experience can make a person believe how strongly it is electrified. Two thin glasses have been broken by the shock of it. It appears extraordinary, that when this phial and nail are in contact with their conducting or non-conducting matter, the strong shock does not follow.

The Self-moving Wheel.

The self-moving wheel is made of a thin round plate of window-glass, seventeen inches in diameter, well gilt on both sides, to within two inches of the circumference. Two small

hemispheres of wood are then fixed with cement, to the middle of the upper and under sides, centrally opposite, and in each of them a thick strong wire, eight or ten inches long, making together the axis of the wheel. It turns horizontally on a point at the lower end of its axis, which rests on a bit of brass, cemented within a glass salt-cellar. The upper end of its axis passes through a hole in a thin brass plate, cemented to a long and strong piece of glass, which keeps it six or eight inches distant from any non-electric, and has a small ball of wax or metal on its top.

In a circle on the table which supports the wheel, are fixed twelve small pillars of glass, at about eleven inches distance, with a thimble on the top of each. On the edge of the wheel is a small [Pg 95] leaden bullet, communicating by a wire with the upper surface of the wheel; and about six inches from it is another bullet, communicating, in like manner, with the under surface. When the wheel is to be charged by the upper surface, a communication must be made from the under surface with the table.

When it is well charged it begins to move. The bullet nearest to a pillar moves towards the thimble on that pillar, and, passing by, electrifies it, and then pushes itself from it. The succeeding bullet, which communicates with the other surface of the glass, more strongly attracts that thimble, on account of its being electrified before by the other bullet; and thus the wheel increases its motion, till the resistance of the air regulates it. It will go half an hour, and make, one minute with another, twenty turns in a minute, which is six hundred turns in the whole, the bullet of the upper surface giving in each turn twelve sparks to the thimbles, which make seven thousand two hundred sparks, and the bullet of the under surface receiving as many from the thimble, these bullets moving in the time nearly two thousand five hundred feet. The thimbles should be well fixed, and in so exact a circle, that the bullets may pass within a very small distance of each of them.

If instead of two bullets you put eight, four communicating with the upper surface, and four with the under surface, placed alternately, (which eight, at about six inches distance, complete the circumference,) the force and swiftness will be greatly increased, the wheel making fifty turns in a minute; but then it will not continue moving so long.

Resin ignited by Electricity.

Wrap some cotton wool, containing as much powdered resin as it will hold, about one of the knobs of a discharging-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 [Pg 96] 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.

The Electric Balloon.

Two balloons, made of the allantoides of a calf, are to be filled with hydrogen gas, of which each contains about two cubic feet. To each of these is to be suspended, by a silken thread about eight feet long, such a weight as is just sufficient to prevent it from rising higher in the air; they are connected, the one with the positive, the other with the negative conductor, by small wires about 30 feet in length; and being kept nearly 20 feet asunder, are placed as far from the machine as the length of the wires will admit. On being electrified, these balloons will rise up in the air as high as the wire will allow, attracting each other, and uniting as it were into one cloud, gently descending.

The Illuminated Water.

Connect one end of a chain with the outside of a charged phial, and let the other end lie on the table. Place the end of another piece of chain at the distance of about a quarter of an inch from the former; and set a glass decanter of water on these separated ends. On making the discharge, the water will appear perfectly luminous.

The electric spark may be rendered visible in water, in the following manner:—Take a glass tube

of about half an inch in diameter, and six inches long; fill it with water, and to each extremity of the tube adapt a cork, which may confine the water; through each cork insert a blunt wire, so that the extremities of the wires within the tube may be very near one another; then, on connecting one of these wires with the coating of a small charged phial, and touching the other wire with the knob of it, the shock will pass through the wires, and cause a vivid spark to appear within their extremities within the tube. The charge in this experiment must be very weak, or there will be danger of bursting the tube. [Pg 97]

The 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 a 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. [Pg 98]

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

The Electric Explosion.

Take a card, a quire of paper, or the cover of a book; and keep it close to the outside coating of a charged jar: put one knob of the discharging-rod upon the card, quire of paper, &c., so that, between the knob and coating of the jar, the thickness of that card or quire of paper only is interposed; lastly, by bringing the other knob of the discharged rod near the knob of the jar, make the discharge, and the electric spark will pierce a hole (or perhaps several) quite through the card or quire of paper. This hole has a bur raised on each side, except the card, &c., be pressed hard between the discharging-rod and the jar. If this experiment be made with two cards instead of one, which, however, must be kept very little distant from one another, each of the cards, after the explosion, will be found pierced with one or more holes, and each hole will have burs on both surfaces of each card. The hole, or holes, are larger or smaller, according as the card, &c., is more damp or more dry. It is remarkable, that if the nostrils are presented to it, they will be affected with a sulphurous, or rather a phosphoric smell, just like that produced by an excited electric.

If, instead of paper, a very thin plate of glass, resin, sealing-wax, or the like, be interposed between the knob of the discharging-rod and the outside coating of the jar, on making the discharge, this will be broken in several pieces.

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 electometer 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 maybe 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 [Pg 99]

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 page 92.)**

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 electrifying 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 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.

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 [Pg 100] 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 candle 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 [Pg 101] 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.

AMUSEMENTS WITH CARDS.

Many of the following recreations are performed by arithmetical calculations, and may therefore be considered as connected with science; but as it has been the aim of this work to unite amusement with instruction, some experiments on this subject are introduced, the performance of which depends on dexterity of hand. As this is only to be acquired by practice, and, after all, is merely a mechanical operation, the study of it will produce little useful knowledge, though it may afford much entertainment; but as it must be gratifying to know the method by which they are performed by those persons skilled in such manœuvres, who publicly exhibit them to the astonishment of the spectator, they are presented to our readers, that when they recognize them

at any of these exhibitions, their eyes may not be in danger of deceiving their judgment.

To tell the Number of Points on Three Cards, placed under Three different Parcels of Cards.

You first premise that the ace counts for eleven; the court cards ten each; and the others according to the number of their pips. You then propose to any person in company to choose three cards, and to place over each as many as will make the number of the points of that card, fifteen; take the remaining cards, and, under the appearance of looking for a particular card, count how many there are, and by adding sixteen to that number, you will have the amount of the pips on the three cards. For example:

Suppose a person choose a seven, a ten, and an ace; then over the seven he must place eight cards; over the ten, five cards; and over the ace, four cards. In this instance there will remain twelve cards; to which if you add sixteen it will make twenty-eight, which is the amount of the pips on the three cards.

[Pg 102]

The Ten Duplicates.

Select any twenty cards; let any person shuffle them; lay them by pairs on the board, without looking at them. You next desire several persons, (as many persons as there are pairs on the table,) each to look at different pairs and remember what cards compose them. You then take up all the cards in the order they lay, and replace them with their faces uppermost on the table, according to the order of the letters in the following words:

M U T U S
1 2 3 4 5
D E D I T
6 7 8 9 10
N O M E N
11 12 13 14 15
C O C I S
16 17 18 19 20

(These words convey no meaning.)—You will observe, that they contain ten letters repeated, or two of each sort. You therefore ask each person which row or rows the cards he looked at are in; if he say the first, you know they must be the second and fourth, there being two letters of a sort (two U's) in that row; if he say the second and fourth, they must be the ninth and nineteenth, (two I's,) and so of the rest. This amusement, which is very simple, and requires very little practice, will be found to excite, in those who are unacquainted with the key, the greatest astonishment.

The readiest way is to have a fac-simile of the key drawn on a card, to which you refer.

To tell how many Cards a Person takes out of a Pack, and to specify each Card.

To perform this, you must so dispose a PIQUET pack of cards, that you can easily remember the order in which they are placed. Suppose, for instance, they are placed according to the words in the following line,

Seven Aces, Eight Kings, Nine Queens, and Ten Knaves;

and that every card be of a different suite, following each other in this order: spades, clubs, hearts, and diamonds. Then the eight first cards will be the seven of spades, ace of clubs, eight of hearts, king of diamonds, nine of spades, queen of clubs, ten of hearts, and knave of diamonds, and so of the rest.

[Pg 103]

You show that the cards are placed promiscuously, and you offer them with their backs upward to any one, that he may draw what quantity he pleases; you then dexterously look at the card that precedes and that which follows those he has taken. When he has carefully counted the cards, which is not to be done in your presence, (and, in order to give you time for recollection, you tell him to do it twice over, that he may be certain,) you then take them from him, mix them with the pack, shuffle, and tell him to shuffle.

During all this time you recollect, by the foregoing line, all the cards he took out; and as you lay them down, one by one, you name each card.

Unless a person has a most excellent memory, he had better not attempt the performance of the above amusement, as the least forgetfulness will spoil the whole, and make the operator appear ridiculous.

A Hundred different Names being written on the Cards, to tell the particular Name any Person thought of.

Write on ten cards a hundred different names, observing that the last name on each card begins with one of the letters in the word INDROMACUS, which letters, in the order they stand, answer the numbers 1 to 10, thus:

I N D R O M A C U S
1 2 3 4 5 6 7 8 9 10

On ten other cards write the same names, with this restriction, that the first name on every card must be taken from the first of the other cards, whose last name begins with I; the second name must be taken from that whose last name begins with N; and so of the rest. Then let any person choose a card out of the first ten, and after he has fixed on a name, give it to you again, when you carefully note the last name, by which you know the number of that card. You then take the other ten cards, and, after shuffling them, show them to the person, and ask if he sees the name he chose, and when he answers in the affirmative, you look to that name which is the same in [Pg 104] number from the top with the number of the card he took from the other parcel, and that will be the name he fixed on.

Instead of ten cards there may be twenty to each parcel, by adding duplicates to each card; which will make it appear more mysterious, and will not at all embarrass it, as you have only to remember the last name on each card. Instead of names you may write questions on one of the parcels, and answers on the other.

Several different Cards being fixed on by different Persons, to name that on which each Person fixed.

There must be as many different cards shown to *each person*, as there are cards to choose; so that, if there are three persons, you must show three cards to each person, telling the first to retain *one* in his memory. You then lay those three cards down, and show three others to the second person, and three others to the third. Next take up the first person's cards, and lay them down separately, one by one, with their faces upwards; place the second person's cards over the first, and the third over the second's, so that there will be one card in each parcel belonging to each person. You then ask each of them in which parcel his card is, and by the answer you immediately know which card it is; for the first person's will always be the first, the second person's the second, and the third person's the third in that parcel where each says his card is.

This amusement may be performed with a single person, by letting him fix on three, four, or more cards. In this case you must show him as many parcels as he is to choose cards, and every parcel must consist of that number, out of which he is to fix on one; and you then proceed as before, he telling you the parcel that contains each of his cards.

To name the Rank of a Card that a Person has drawn from a Piquet Pack.

The rank of a card means whether it be an ace, king, queen, &c. You therefore first fix a certain number to each card; thus you call the king four, the queen three, the knave two, the ace one, and the others according to the number of their pips. [Pg 105]

You then shuffle the cards, and let a person draw any one of them; then turning up the remaining cards, you add the number of the first to that of the second, the second to the third, and so on, till it amounts to ten, which you then reject, and begin again; or if it be more, reject the ten, and carry the remainder to the next card, and so on to the last; and to the last amount add four, and subtract that sum from ten, if it be less, or from twenty, if it be more than ten, and the remainder will be the number of the card that was drawn; as for example, if the remainder be two, the card drawn was a knave; if three, a queen, and so on.

To tell the Amount of the Numbers of any two Cards drawn from a common Pack.

Each court card in this amusement counts for ten, and the other cards according to the number of their pips. Let the person who draws the cards add as many more cards to each of those he has drawn as will make each of their numbers twenty-five. Then take the remaining cards in your hand, and, seeming to search for some card among them, tell them over to yourself, and their number will be the amount of the two cards drawn.

For example.—Suppose the person has drawn a ten and a seven, then he must add fifteen cards to the first, to make the number twenty-five, and eighteen to the last, for the same reason; now fifteen and eighteen make thirty-three, and the two cards themselves make thirty-five, which deducted from fifty-two, leave seventeen, which must be the number of the remaining cards, and also of the two cards drawn.

You may perform this amusement without touching the cards, thus:

Let the person who has drawn the two cards deduct the number of each of them from twenty-six, which is half the number of the pack, and after adding the remainders together, let him tell you the amount, which you privately deduct from fifty-two, the total number of all the cards, and the remainder will be the amount of the two cards.

Example.—Suppose the two cards to be as before, ten and seven; then the person deducting ten from twenty-six, there remain sixteen, and deducting seven from twenty-six, there remain nineteen; these two remainders added together make thirty-five, which you subtract from fifty-two; and there must remain seventeen for the amount of the two cards, as before. [Pg 106]

To tell the Amount of the Numbers of any Three Cards that a Person shall draw from the Pack.

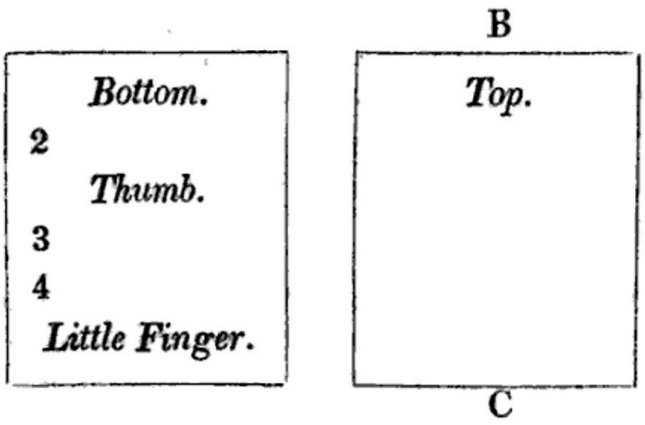
After the person has drawn his three cards, draw one yourself and lay it aside, for it is necessary that the number of the remaining cards be divisible by three, which they will not be in a pack of fifty-two cards, if only three be drawn. The card you draw, you may call the confederate, and pretend it is by the aid of that card you discover the amount of the others. Then tell the party to add as many more to each of his cards as will make its number sixteen, which is the third part of the remaining forty-eight cards; therefore, suppose he has drawn a ten, a seven, and a six; then, to the first he must add six cards, to the second nine, and to the third ten, which together make twenty-five, and the four cards drawn being added to them make twenty-nine. You then take the remaining cards, and, telling them over, as in the last amusement, you find their number to be twenty-three, the amount of the three cards the person drew.

This amusement may also be performed without touching the cards, thus:—When the party has drawn his three cards, and you have drawn one, let him deduct the number of each of the cards he has drawn from seventeen, which is one-third of the pack after you have drawn your card; and let him tell you the amount of the several remainders, to which you privately add one to the card you drew, and, deducting that amount from fifty-two, (the whole number of the cards,) the remainder will be the amount of the three cards drawn.

Example.—Suppose the three cards to be ten, seven, and six, as before; then, each of those numbers subtracted from seventeen, the remainders will be respectively, seven, ten, and eleven, which, added together, make twenty-eight, to which the single card you drew being reckoned as one, and added, makes twenty-nine; and that number deducted from fifty-two, leaves twenty-three, which is the amount of the three cards the party drew.

The following amusements principally depend on dexterity of hand; and, as what is termed *making the pass*, will be necessary to be acquired, to enable the operator to perform many of them, we subjoin the following explanation of this term: [Pg 107]

How to make the Pass.—Hold the pack of cards in your right hand, so that the palm of your hand may be under the cards: place the thumb of that hand on one side of the pack; the first, second, and third fingers on the other side, and your little finger between those cards that are to be brought to the top, and the rest of the pack. Then place your left hand over the cards in such a manner that the thumb may be at C, the fore-finger at A, and the other fingers at B, as in the following figure:



The hands and the two parts of the cards being thus disposed, you draw off the lower cards, confined by the little finger and the other parts of the right hand, and place them, with an imperceptible motion, on the top of the pack.

But before you attempt any of the tricks that depend on *making the pass*, you must have great practice, and be able to perform it so dexterously and expeditiously, that the eye cannot detect the movement of the hand; or you may, instead of deceiving others, expose yourself.

The Long Card.—Another stratagem, connected with the performance of many of the following tricks, is what is termed the *Long Card*; that is, a card, either a trifle longer or wider than the other cards, not perceptible to the eye of the spectator, but easily to be distinguished by the touch of the operator.

The Divining Card.

Provide a pack in which there is a long card; open it at that part where the long card is, and present the pack to a person in such a manner that he will naturally draw that card. You then tell him to put it into any part of the pack, and shuffle the cards. You take the pack, and offer the same card in like manner to a second or third person, taking care that they do not stand near enough to see the card each other draws. [Pg 108]

You then draw several cards yourself, among which is the long card, and ask each of the parties if his card be among those cards, and he will naturally say *yes*, as they have all drawn the same card. You then shuffle all the cards together, and, cutting them at the long card, you hold it before the first person, so that the others may not see it, and tell him that is his card. You then put it in the pack, shuffle it, cut it again at the same card, and hold it to the second person.

You can perform this recreation without the long card, in the following manner:

Let a person draw any card, and replace it in the pack. You then *make the pass*, (see p. 107,) and bring that card to the top of the pack, and shuffle them, without losing sight of that card. You then offer that card to a second person, that he may draw it, and put it in the middle of the pack. You *make the pass*, and shuffle the cards a second time in the same manner, and offer the card to a third person, and so again to a fourth or fifth.

The Four Confederate Cards.

A person draws four cards from the pack, and you tell him to remember one of them. He then returns them to the pack, and you dexterously place two under and two on the top of the pack. Under the bottom ones you place four cards of any sort, and then, taking eight or ten from the bottom cards, you spread them on the table, and ask the person if the card he fixed on be among them. If he say *no*, you are sure it is one of the two cards on the top. You then pass those two cards to the bottom and, drawing off the lowest of them, you ask if that is not his card. If he again say *no*, you take up that card, and bid him draw his card from the bottom of the pack. If, on the contrary, he say his cards *are* among those you *first* drew from the bottom, you must dexterously take up the four cards you put under them, and, placing those on the top, let the other two be the bottom cards of the pack, which you are to draw in the manner before described.

The Numerical Cards.

Let the long card be the sixteenth in the pack of piquet cards. Take ten or twelve cards from the top of the pack, and, spreading them on the table, desire a person to think on any one of them, [Pg 109] and to observe the number it is from the first card. Make the pass at the long card, which will then be at the bottom. Then ask the party the number his card was at, and, counting to yourself from that number to sixteen, turn the cards up, one by one, from the bottom. Then stop at the seventeenth card, and ask the person if he has seen his card, when he will say *no*. You then ask him how many more cards you shall draw before his card appears; and when he has named the number, you draw the card aside with your finger, turn up the number of cards he proposed, and throw down the card he fixed on.

The Card found out by the Point of the Sword.

When a card has been drawn, you place it under the long card, and by shuffling them dexterously, you bring it to the top of the pack. Then lay or throw the pack on the ground, observing where the top card lies. A handkerchief is then bound round your eyes, which ought to be done by a confederate, in such a way that you can see the ground. A sword is put into your hand, with which you touch several of the cards, as if in doubt, but never losing sight of the top card, in which at last you fix the point of the sword, and present it to the party who drew it.

The Card hit upon by the Guess.

Spread part of the pack before a person, in such way that only one court card is visible; and so arrange it, that it shall appear the most prominent and striking card. You desire him to think on one; and observe if he fix his eye on the court card. When he tells you he has determined on one, shuffle the cards, and, turning them up one by one, when you come to the court card tell him that is the one.

If he does not seem to fix his eye on the court card, you should not hazard the experiment; but frame an excuse for performing some other amusement; neither should it be attempted with those who are conversant with these sort of deceptions.

The Card changed by Word of Command.

You must have two cards of the same sort in the pack, (say the king of spades.) Place one next the bottom card, (say seven of hearts,) and the other at top. Shuffle the cards without displacing [Pg 110] those three, and show a person that the bottom card is the seven of hearts. This card you dexterously slip aside with your finger, which you have previously wetted, and, taking the king of spades from the bottom, which the person supposes to be the seven of hearts, lay it on the table, telling him to cover it with his hand.

Shuffle the cards again, without displacing the first and last card, and, shifting the other king of spades from the top to the bottom, show it to another person. You then draw that privately away, and, taking the bottom card, which will then be the seven of hearts, you lay that on the table, and tell the second person (who believes it to be the king of spades) to cover it with his hand.

You then command the cards to change places; and when the two parties take off their hands and

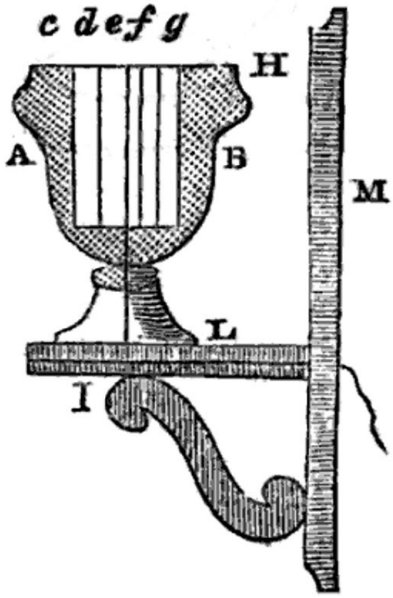
turn up the cards, they will see, to their great astonishment, that your commands are obeyed.

The Three Magical Parties.

Offer the long card to a person, that he may draw it, and replace it in any part of the pack he pleases. *Make the pass*, and bring that card to the top. Next divide the pack in three parcels, putting the long card in the middle heap. You then ask the person which of the three heaps his card shall be in. He will, probably, say the middle; in which case you immediately show it to him. But if he say either of the others, you take all the cards in your hand, placing the parcel he has named over the other two, and observing to put your little finger between that and the middle heap, at the top of which is the card he drew. You then ask at what number in that heap he will have his card appear. If, for example, he say the sixth, you tell down five cards from the top of the pack, and then, dexterously making the pass, you bring the long card to the top, and tell it down as the sixth.

The Magic Vase.

Fig. 20.



Construct a vase of wood, or pasteboard, see Fig. 20. On the inside let there be five divisions; two of them, *c d*, to be large enough to admit a pack of cards each; and the other three, *e f g*, only large enough to contain a single card. Place this vase on a bracket, L, which is fastened to the partition M. Fix a silken thread at H, the other end of which passes down the division *d*, and, over the pulley I, runs along the bracket L, and goes out behind the partition M.

[Pg 111]

Take three cards from the piquet pack, and place one of them in each of the divisions *e f g*, making the silk thread or line go under each of them. In the division *c* put the remainder of the pack.

You then get another pack of cards, at the top of which are to be three cards, the same as those in the three small divisions: and, making the pass, bring them to the middle of the pack. Let them be drawn by three persons; let them shuffle all the cards; after which place the pack in the division *d*, and tell the parties that the cards they drew will rise at their command, separately, from the vase.

A confederate behind the partition then gently drawing the line, the three cards will then gradually appear from the vase; then taking the cards from *c*, you show that those three are gone from the pack.

The vase must be placed so high that the company cannot see the inside.

The Divining Perspective Glass.

Procure a small perspective-glass, wide enough, where the object-glass is placed, to hold the following table:

1,131	10,132	19,133
2,231	11,232	20,233
3,331	12,332	21,333
4,121	13,122	22,123
5,221	14,222	23,223
6,321	15,322	24,323
7,111	16,112	25,113
8,211	17,212	26,213
9,311	18,312	27,313

[Pg 112]

Take a pack of twenty-seven cards; give them to a person, bid him fix, on one, shuffle them, and return them to you. Arrange the twenty-seven cards in three parcels, by laying one down, alternately, on each parcel; but before you lay each card down, show it to the person, without seeing it yourself. When you have completed the three parcels, ask him at what number, from one to twenty-seven, he will have his card appear, and in which heap it then is. You then look at the heap through your glass; and if the first of the three numbers, which stands against the number it is to appear at, be one, put that heap at top; if the number be at two, put it in the middle; and if it be three, put it at the bottom. Next divide the cards into three heaps, in the same manner, a second and third time, and his card will be at the number he chose.

Example.—Suppose the person wishes his card to be the twentieth from the top; and the first time of making the heaps, he says it is in the third heap; you then look at the table in the perspective, and you see that the first figure is two; you, therefore, put that heap in the middle of the pack. The second and third times, you in like manner put the heap in which he says it is, at bottom; the number each time being three. Then looking at the pack with your glass, as if to discover which the card was, you lay the cards down, one by one, and the twentieth will be the

card fixed on.

The Card in the Ring.

Get a ring, made of any metal, in which is set a large transparent stone or piece of glass, to the bottom of which is fastened a small piece of black silk; under the silk is to be the figure of a small card; and the silk must be so constructed that it may be either drawn aside or spread, by turning the stone round.

You then cause a person to draw the same sort of card as that at the bottom of the ring; and tell him to burn it in the candle. Now, the ring being so constructed that the silk conceals the card underneath it, you first show him the ring, that he may see it is not there, and tell him you will make it appear; then rubbing the ashes of the card on the ring, you manage to turn the stone or glass dexterously round, and exhibit to him the small card at the bottom.

[Pg 113]

The Card in the Mirror.

Provide a mirror, either round or oval, the frame of which must be at least as wide as a card, and the glass must be wider than the distance between the frame, by at least the width of a card. The glass in the middle must be made to move in two grooves, and so much of the quicksilver must be scraped off, as is equal to the size of a common card. You then paste over the part where the quicksilver is rubbed off, a piece of pasteboard, on which is a cord, that must exactly fit the space, which must at first be placed behind the frame.

Fix this mirror against a partition, through which two strings are to go, by which an assistant in an adjoining room can easily move the glass in the grooves, and make the card appear or disappear at pleasure. Or it may be done without an assistant, if a table be placed against the partition, and a string from the glass be made to pass through a leg of it, and communicate with a small trigger, which you may easily push down with your foot, and at the same time wiping the glass with your handkerchief, under the pretence that the card may appear more conspicuous; which will also serve most effectually to disguise the operation.

Having every thing thus arranged, you contrive to make a person draw the same sort of card as that fixed to the mirror; if you do not succeed in this with a stranger, make some pretence for shuffling the cards again, and present the pack to a confederate, who, of course, will draw the card you wish, and who is to show it to two or three persons next to him, under the pretence that it might slip his memory. This card you place in the middle of the pack, then *make the pass*, and bring it to the bottom. Direct the person to look for his card in the mirror, which the confederate behind the partition is to draw slowly forward; or if you perform the operation yourself, press the trigger with your foot, and the card will appear as if placed between the glass and the quicksilver. While the glass is drawing forward, you slide off the card from the bottom of the pack, and convey it away.

The Card in the Opera Glass.

Procure an opera-glass, two inches and a half long; the tube to be made of ivory, so thin that it may appear transparent. Place it in a magnifying glass, of such a power, and at such a distance, that a card, three-quarters of an inch long, may appear like a common-sized card. At the bottom [Pg 114] of the tube lay a circle of black pasteboard, to which fasten a small card, with the pips, or figures, on both sides, and in such a manner, that by turning the table, either side of the glass may be visible.

You then offer two cards to two persons, similar to the double card in the glass. You put them in the pack again, or convey them to your pocket; and after a few flourishing motions you tell the persons you have conveyed their cards into the glass; then you show each person his card in the glass, by turning it in the proper position.

You may easily induce the parties to draw the two cards you wish, by placing them first on the top of the pack, and then, by making the pass, bringing them to the middle.

When you can make the pass in a dexterous manner, it is preferable to the long card, which obliges the operator to change the pack frequently, as, if the same card is always drawn, it may excite suspicion.

To separate the two Colours of a Pack of Cards by one Cut.

To perform this amusement, all the cards of one colour must be cut something narrower at one end than the other. You show the cards, and give them to any one, that he may shuffle them; then holding them between your hands, one hand being at each extremity, with one motion you separate the hearts and diamonds from the spades and clubs.

The Metamorphosed Cards.

In the middle of a pack place a card that is something wider than the rest, which we will suppose to be the knave of spades, under which place the seven of diamonds, and under that the ten of

clubs. On the top of the pack put cards similar to these, and others on which are painted different objects, *viz.*:

First card	A bird
Second	A seven of diamonds
Third	A flower
Fourth	Another seven of diamonds
Fifth	A bird
Sixth	A ten of clubs
Seventh	A flower
Eighth	Another ten of clubs;

then seven or eight indifferent cards, the knave of spades, which is the wide card, the seven of diamonds, the ten of clubs, and the rest any indifferent cards. [Pg 115]

Two persons are to draw the two cards that are under the wide card, which are the seven of diamonds and the ten of clubs. You take the pack in your left hand, and open it at the wide end, as you open a book, and tell the person who drew the seven of diamonds to place it in that opening. You then blow on the cards, and, without closing them, instantly bring the card which is at top, and on which a bird is painted, over that seven of diamonds. To do this dexterously, you must wet the middle finger of your left hand, with which you are to bring the card to the middle of the pack. You then bid the person look at his card, and when he has remarked the change, to place it where it was before. Then blow on the cards a second time, and, bringing the seven of diamonds, which is at the top of the pack, to the opening, you bid him look at his card again, when he will see it is that which he drew. You may do the same with all the other painted cards, either with the same person, or with him who drew the ten of clubs.

The whole artifice consists in bringing the card at the top of the pack to the opening in the middle, by the wet finger, which requires no great practice. Observe, not to let the pack go out of your hands.

To discover the Card which is drawn, by the Throw of a Die.

Prepare a pack of cards, in which there are only six sorts of cards. Dispose these cards in such manner that each of the six different cards shall follow each other, and let the last of each suite be a long card. The cards being thus disposed, it follows, that if you divide them into six parcels, by cutting at each of the long cards, those parcels will all consist of similar cards.

Let a person draw a card from the pack, and let him replace it in the parcel from whence it was drawn, by dexterously offering that part. Cut the cards several times, so that a long card be always at bottom. Divide the cards in this manner into six heaps, and giving a die to the person who drew the card, tell him that the point he throws shall indicate the parcel in which is the card he drew; then take up the parcel and show him the card. [Pg 116]

To tell the Number of the Cards by their Weight.

Take a parcel of cards, suppose forty, among which insert two long cards; let the first be, for example, the fifteenth, and the other the twenty-sixth from the top. Seem to shuffle the cards, and then cutting them at the first long card, poise those you have cut off in your left hand, and say, "There should be here fifteen cards." Cut them again at the second long card, and say, "There are here only eleven cards." Then poising the remainder, you say, "Here are fourteen cards."

The Four Inseparable Kings.

Take the four kings, and behind the last of them place two other cards, so that they may not be seen. Then spread open the four kings to the company, and put the six cards at the bottom of the pack. Draw one of the kings, and put it at the top of the pack. Draw one of the two cards at the bottom, and put it towards the middle. Draw the other, and put it at some distance from the last, and then show that there remains a king at bottom. Then let any one cut the cards, and as there remains three kings at bottom, they will then be altogether in the middle of the pack.

To change the Cards which several Persons have drawn from the Pack.

On the top of the pack put any card you please—suppose the queen of clubs; make the pass, bring that card to the middle of the pack, and offer it to a person to draw. Then, by cutting the cards, bring the queen again to the middle of the pack. Make the pass a second time, bring it to the top, and shuffle the cards without displacing those on the top. Make the pass a third time, bring it to the middle of the pack and offer it to a second person to draw, who must be at a proper distance from the first person, that he may not perceive it is the same card. After the like manner let five persons draw the same card.

Shuffle the pack without losing sight of the queen of clubs, and, laying down four other cards with the queen, ask each person if he see his card there? They will all reply, "Yes," as they all drew the queen of clubs. Place four of those cards on the pack, and, drawing the queen privately

away, you approach the first person, and showing him that card, so that the others cannot see it, ask if that be his card; then patting it on the top of the pack, blow on it, or give it a stroke with your hand, and show it in the same manner to the second person, and so of the rest. [Pg 117]

The Card discovered under the Handkerchief.

Let a person draw any card from the rest, and put it in the middle of the pack; you make the pass at that place, and the card will consequently be at top; then placing the pack on the table, cover it with a handkerchief; and, putting your hand under it, take off the top card, and after seeming to search among the cards for some time, draw it out.

This amusement may be performed by putting the cards in another person's pocket, after the pass is made. Several cards may also be drawn and placed together in the middle of the pack, and the pass then made.

The Convertible Aces.

On the ace of spades fix, with soap, a heart, and on the ace of hearts a spade, in such a manner that they will easily slip off.

Show these two aces to the company; then, taking the ace of spades, you desire a person to put his foot upon it, and as you place it on the ground, draw away the spade. In like manner you place the seeming ace of hearts under the foot of another person. You then command the two cards to change their places; and that they obey your command, the two persons, on taking up their cards, will have ocular demonstration.

A deception similar to this is sometimes practised with one card, suppose the ace of spades, over which a heart is pasted lightly. After showing a person the card, you let him hold one end of it, and you hold the other, and while you amuse him with discourse, you slide off the heart. Then laying the card on the table, you bid him cover it with his hand; you then knock under the table, and command the heart to turn into the ace of spades.

To tell the Card that a Person has touched with his Finger.

This amusement is to be performed by confederacy. You previously agree with your confederate on certain signs, by which he is to denote the suite, and the particular card of each suite; thus: if he touch the first button of his coat, it signifies an ace; if the second, a king, &c.; and then again, if he take out his handkerchief, it denotes the suite to be hearts; if he take snuff, diamonds, &c. These preliminaries being settled, you give the pack to a person who is near your confederate, and tell him to separate any one card from the rest, while you are absent, and draw his finger once over it. He is then to return you the pack, and while you are shuffling the cards, you carefully note the signals made by your confederate; then turning the cards over one by one, you directly fix on the card he touched. [Pg 118]

The Card in the Pocket-book.

A confederate is previously to know the card you have taken from the pack, and put into your pocket-book. You then present the pack to him, and desire him to fix on a card, (which we will suppose to be the queen of diamonds,) and place the pack on the table. You then ask him the name of the card, and when he says the queen of diamonds, you ask him if he be not mistaken, and if he be sure that the card is in the pack: when he replies in the affirmative, you say, "It might be there when you looked over the cards, but I believe it is now in my pocket;" then desire a third person to put his hand in your pocket, and take out your book, and when it is opened the card will appear.

The Card in the Egg.

Take a card, the same as your long card, and, rolling it up very close, put it in an egg, by making a hole as small as possible, and which you are to fill up carefully with white wax. You then offer the long card to be drawn, and when it is replaced in the pack, you shuffle the cards several times, giving the egg to the person who drew the card, and while he is breaking it, you privately withdraw the long card, that it may appear, upon examining the cards, to have gone from the pack into the egg. This may be rendered more surprising by having several eggs, in each of which is placed a card of the same sort, and then giving the person the liberty to choose which egg he thinks fit.

This deception may be still further diversified, by having, as most public performers have, a confederate, who is previously to know the egg in which the card is placed; for you may then break the other eggs, and show that the only one that contains a card is that in which you directed it to be. [Pg 119]

The Card discovered by the Touch or Smell.

You offer the long card, or any other that you know, and as the person who has drawn it holds it

in his hand, you pretend to feel the pips or figure on the under side, by your fore-finger; or you sagaciously smell to it, and then pronounce what card it is.

If it be the long card, you may give the pack to the person who drew it, and leave him at liberty either to replace it or not. Then taking the pack, you feel immediately whether it be there or not, and, shuffling the cards in a careless manner, without looking at them, you pronounce accordingly.

The Inverted Cards.

Prepare a pack of cards, by cutting one end of them about one-tenth of an inch narrower than the other; then offer the pack to any one, that he may draw a card; place the pack on the table, and observe carefully if he turn the card while he is looking at it; if he do not, when you take the pack from the table, you offer the other end of it for him to insert that card; but if he turn the card, you then offer him the same end of the pack. You afterwards offer the cards to a second or third person, for them to draw or replace a card in the same manner. You then let any one shuffle the cards, and, taking them again into your own hand, as you turn them up one by one, you easily perceive by the touch which are those cards that have been inverted, and, laying the first of them down on the table, you ask the person if that card be his; and if he say *no*, you ask the same of the second person; and if he say *no*, you tell the third person it is his card; and so of the second or third cards. You shall lay the pack on the table after each person has drawn his card, and turn it dexterously in taking it up, when it is to be turned, that the experiment may not appear to depend on the cards being inverted.

The Transmuted Cards.

In a common pack of cards let the ace of hearts and nine of spades be something larger than the rest. With the juice of lemon draw over the ace of hearts a spade, large enough to cover it entirely, and on each side draw four other spades. [Pg 120]

Present the pack to two persons, so adroitly, that one of them shall draw the ace of hearts, and the other the nine of spades, and tell him who draws the latter, to burn it on a chafing-dish. You then take the ashes of that card, put them into a small metal box, and give it to him that has the ace of hearts, that he may himself put that card into the box and fasten it. Then put the box for a short time on the chafing-dish, and let the person who put the card in it take it off, and take out the card, which he will see is changed into the nine of spades.

The Convertible Cards.

To perform this amusement you must observe, that there are several letters which may be changed into others, without any appearance of the alteration, as the *a* into *d*, the *c* into *a*, *e*, *d*, *g*, *o*, or *q*; the *i* into *b*, *d*, or *l*; the *l* into *t*; the *o* into *a*, *d*, *g*, or *q*; the *v* into *y*, &c.

Take a parcel of cards, suppose twenty, and on one of them write with juice of lemon or onion, or vitriol and water, the word law, (these letters should not be joined;) and on the other, with the same ink, the words *old woman*; then holding them to the fire, they both become visible. Now, you will observe, that by altering the *a* in the word *law* into *d*, and adding *o* before the *l*, and *oman* after the *w*, it becomes *old woman*. Therefore you make those alterations with the invisible ink, and let it remain so. On the rest of the cards you write any words you think fit.

Present the cards in such manner to two persons, that one of them shall draw the word *law*, and the other the words *old woman*. You then tell the person who drew the word *law*, that it shall disappear, and the words on the other card shall be written in its place; and, that you may not change the cards, desire each of the parties to write his name on his card. Then putting the cards together, and holding them before the fire, as if to dry the names just written, the word *law* will presently change into *old woman*.

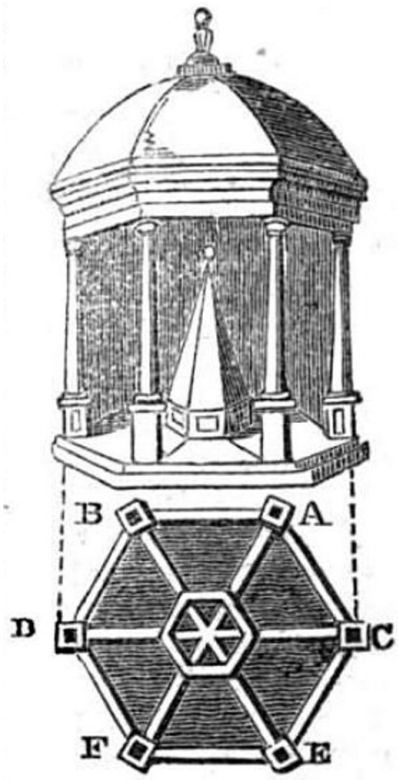
The Enchanted Palace.

On the six-sided plane A B C D E F, Fig. 21, draw six semi-diameters; and on each of these place perpendicularly two plane mirrors, which must join exactly at the centre, and which, placed back to back, must be as thin as possible. Decorate the exterior boundary of this piece, (which is at the extremity of the angles of the hexagon,) with six columns, that at the same time serve to support the mirrors by grooves formed on their inner sides. Add to these columns their entablatures, and cover the edifice in whatever manner you please. In each one of these six triangular spaces, contained between two mirrors, place little figures of pasteboard, in relief, representing such subjects, as, when seen in an hexagonal form, will produce an agreeable effect. To these add small figures of enamel, and take particular care to conceal by some object that has no relation to the subject, the place where the mirrors join, which, as before observed, all meet in the common centre.

Fig. 21. [Pg 121]

When you look into any one of the six openings of this palace, the objects there contained, being reflected six times, will seem entirely to fill up the whole of the building. This illusion will appear very remarkable, especially if the objects chosen are properly adapted to the effect which the mirrors are intended to produce.

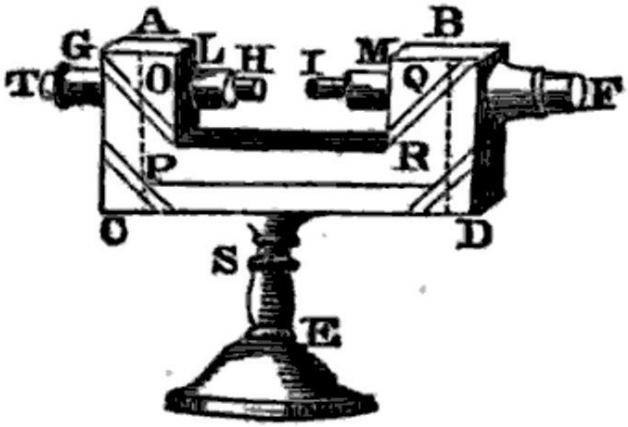
If you place between two of these mirrors part of a fortification, as a curtain, and two demi-bastions, you will see an entire citadel with six bastions; or if you place part of a ball-room, ornamented with chandeliers and figures, all these objects being here multiplied, will afford a very pleasing prospect.



Opaque Bodies seemingly Transparent.

Within the case A B C D, place four mirrors O P Q R, Fig. 22, so disposed, that they may each make an angle of 45 degrees, that is, that they may be half-way inclined from the perpendicular, as in the figure. In each of the two extremities A B, make a circular overture; in one of which fix the tube G L, in the other the tube M F, and observe, that in each of these is to be inserted another tube, as H and I. [*Observe.* These four tubes must terminate in the substance of the case, and not enter the inside, that they may not hinder the effect of the mirrors. The four-fold reflection of the rays of light from the mirrors, darkens in some degree the brightness of the object; some light is also lost by the magnifying power of the perspective. If, therefore, instead of the object-glass at G, and concave eye-glass at F, plain glasses were substituted, the magnifying power of the perspective will be taken away, and the object appear brighter.] [Pg 122]

Fig. 22.



Furnish the first of these tubes with an object-glass at G, and a concave eye-glass at F. You are to observe, that in regulating the focus of these glasses with regard to the length of the tube, you are to suppose it equal to the line G, or visual pointed ray, which entering at the aperture G is reflected by the four mirrors, and goes out at the other aperture F, where the eye-glass is placed. Put any glass you please into the two ends of the moveable tubes H and L; and lastly, place the machine on stand E, moveable at the point S, that it may be elevated or lowered at pleasure.

When the eye is placed at F, and you look through the tube, the rays of light that proceed from the object T, passing through the glass G, are successively reflected by the mirrors O P Q and R to the eye at F, and there point the object T in its proper situation, and these rays appear to proceed directly from that object.

The two moveable tubes H and I, at the extremity of which a glass is placed, serve only to disguise the illusion, for they have no communication with the interior of the machine. This instrument being moveable on the stand E, may be directed to any object; and if furnished with proper glasses, will answer the purpose of common perspective. [Pg 123]

The two moveable tubes, H and I, being brought together, the machine is directed towards any

object; and, desiring a person to look at the end F, you ask him if he sees that object distinctly. You then separate the two moveable tubes, and, leaving space between them sufficiently wide to place your hand or any other solid body, you tell him that the machine has the power of making objects visible through the most opaque body; and as a proof, you desire him to look at the same object, when to his great surprise he will see it as distinctly as if no solid body interposed.

This experiment is the more extraordinary as it is very difficult to conceive how the effect is produced; the two arms of the case appearing to be made for the purpose of supporting the perspective-glass; and to whatever object it be directed, the effect is still the same.

The Deforming Mirrors.

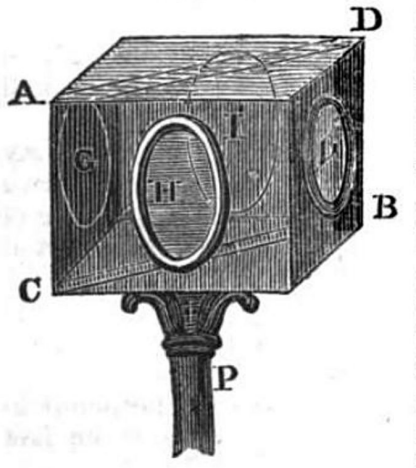
If a person look in a concave mirror placed perpendicularly to another, (that is, supposing one mirror to be laid on the floor, and the other attached to the ceiling,) his face will appear entirely deformed. If the mirror be a little inclined, so as to make an angle of 80 degrees, (that is, one-ninth part from the perpendicular,) he will then see all the parts of his face, except the nose and forehead. If it be inclined to 60 degrees; (that is, one-third part,) he will appear with three noses and six eyes: in short, the apparent deformity will vary at each degree of inclination, and when the glass comes to 45 degrees, (that is, half-way down,) the face will vanish. If, instead of placing the two mirrors in this situation, they are so disposed that their junction may be vertical, then different inclinations will produce other effects, as the situation of the object relative is quite different.

The Magic Tube.

Procure a small tube of glass, whose canal is extremely narrow, and open at both ends; let one end of it be plunged in water, and the water within the tube will rise to a considerable height above the external surface: or if two or more tubes be immersed in the same fluid, the one with a narrow canal, and the other wider, the water will ascend higher in the former than the latter. [Pg 124]

The Magician's Mirror.

Fig. 23.



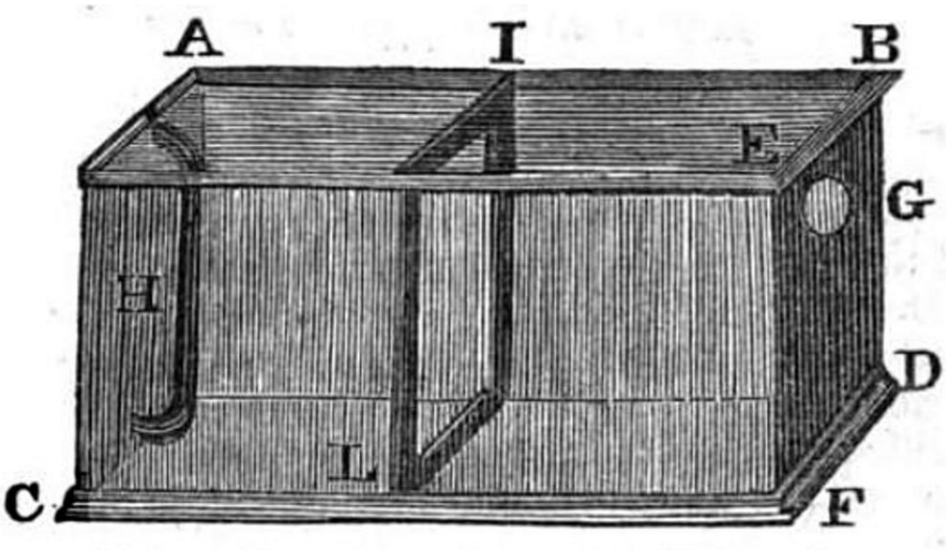
Construct a box of wood, of a cubical shape, A B C D, Fig. 23, of about fifteen inches every way. Let it be fixed to the pedestal P, at the usual height of a man's head. In each side of this box let there be an opening, of an oval form, ten inches high, and seven wide. In this box place two mirrors, A D, with their backs against each other. Let them cross the box in a diagonal line, and in a vertical position. Decorate the openings in the side of this box with four oval frames and transparent glasses, and cover each with a curtain so contrived as all to draw up together.

Place four persons in front of the four sides, and at equal distances from the box, and then draw them up that they may see themselves in the mirrors, when each of them, instead of his own figure, will see that of the person next to him, but who will appear to him to be placed on the opposite side. Their confusion will be the greater, as it will be very difficult, if not impossible, for them to discover the mirrors concealed in the box. The reason of this phenomenon is evident; for though the rays of light may be turned aside by a mirror, yet they always *appear* to proceed in right lines.

The Perspective Mirror.

Provide a box, A B C D, Fig. 24, of about two feet long, 15 inches wide, and 12 inches high. At the end A C, place the concave mirror, the focus of whose parallel rays is 18 inches from the reflecting surface. At I L place a pasteboard, blacked, in which a hole is cut, sufficiently large to see on the mirror H the object placed at B E F D. Cover the top of the box, from A to I, close, that the mirror H may be entirely darkened. The other part, I B, must be covered with glass, under which is placed a gauze, or oiled paper, to prevent the inside from being seen. Make an aperture at G, near the top of the side E B, beneath which, on the inside, place in succession, paintings of vistas, landscapes, figures, &c., so that they may be in front of the mirror H. Let the box be placed that the objects may be strongly illuminated by the sun, or by wax-lights placed under the enclosed part of the box A I. By this simple construction, the objects placed at G D will be thrown into their natural perspective, and if the subjects be properly chosen and well executed, the appearance will be both wonderful and pleasing. [Pg 125]

Fig. 24.



Gunpowder Exploded by Reflection.

Place two concave mirrors at about 12 or 15 feet distance from each other, and let the axis of each be in the same line. In the focus of one of them place a live coal, and in the focus of the other place some gunpowder. With a pair of double bellows, which make a continual blast, keep constantly blowing the coal, and notwithstanding the distance between them, the powder will presently take fire.

The Igniting Mirrors.

The rays of a luminous body placed in the focus of concave mirror, being reflected in parallel lines, and a second mirror being placed diametrically opposite to the first, will set fire to a combustible body, by collecting those rays in the focus. [Pg 126]

The Armed Apparition.

If a person with a drawn sword place himself before a large concave mirror, but further from it than its focus, he will see an inverted image of himself in the air, between him and the mirror, of a less size than himself. If he steadily present the sword towards the centre of the mirror, an image of the sword will come out from it, point to point, as if to fence with him; and by his pushing the sword nearer, the image will appear to come nearer to him, and almost to touch his breast. If the mirror be turned 45 degrees, or one-eighth round, the reflected image will go out perpendicularly to the direction of the sword presented, and apparently come to another person placed in the direction of the motion of the image, who, if he be unacquainted with the experiment, and does not see the original sword, will be much surprised and alarmed.

The Phantom.

You inform a person that at a certain hour, and in a certain place, he shall see the apparition of a deceased friend, (whose portrait you possess.) In order to produce this phantom, there must be a door which opens into an apartment to which there is a considerable descent. Under that door you are to place the portrait, which must be inverted and strongly illuminated, that it may be brightly reflected by the mirror, which must be large and well polished. Then having introduced the incredulous spectator at another door, and placed him in the proper point of view, you suddenly throw open the door, when to his great surprise he will view the apparition of his friend.

The Distorting Mirror.

Opticians sometimes grind a glass mirror concave in one direction only, or longitudinally; it is in fact a concave portion of a cylinder, the breadth of which may be considered that of the mirror. A person looking at his face in this mirror, in the direction of its concavity, will see it curiously distorted in a very lengthened appearance; and by turning the cylindrical mirror a quarter round, his visage will appear distorted another way, by an apparent increase in width only. If in a very near situation before it, you put your finger on the right hand side of your nose, it will appear the same in the mirror; but if in a distant situation, somewhat beyond the centre of concavity, you again look at your face in the mirror, your finger will appear to be removed to the other side of your nose. [Pg 127]

Water colder than Ice.

Put a lump of ice into an equal quantity of water, heated to 176 degrees, the result will be, that the fluid will be no hotter than water just beginning to freeze; but if a little sea salt be added to the water, and it be heated only to 166 or 170, a fluid will be produced *colder than the ice was at*

first.

Exploding Salt.

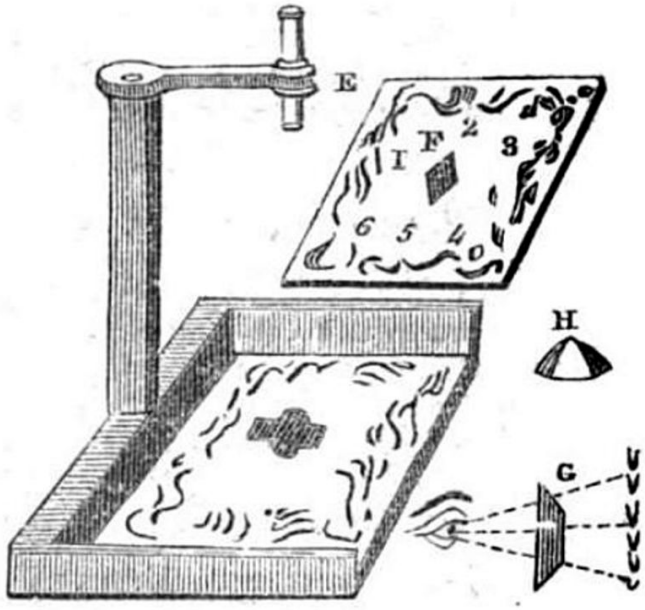
If a small quantity of powdered charcoal and hyper-oxymuriate of potash be rubbed together in a mortar, an explosion will be produced, and the charcoal inflamed. Three parts of this salt, and one of sulphur, rubbed together in a mortar, produce a violent detonation. If struck with a hammer on an anvil, there is an explosion like the report of a pistol.

When concentrated sulphuric acid is poured upon this salt, there is a considerable explosion; it is thrown about to a great distance, sometimes with a red flame; and there is exhaled a brown vapour, accompanied with a strong odour.

Dioptrical Paradox.

Construct a machine similar to that in Fig. 25. Its effect will be, that a print, or an ornamented drawing, with any object, such as an ace of diamonds, &c. in the centre F, will be seen as an ace of clubs when placed in the machine, and viewed through a single plane glass only, contained in the tube E. The glass in the tube F, which produces this surprising change, is somewhat on the principle of the common multiplying glass, as represented at G, which, by the number of its inclined surfaces, and from the refractive power of the rays proceeding from the objects placed before it shows it in a multiplied state. The only difference is, that the sides of this glass are flat, [Pg 128] and diverge upwards from the base to a point in the axis of the glass like a cone; it has six sides, and each side, from its angular position to the eye, has the property of refracting from the border of the print F, such a portion of it (designedly placed there) as will make a part in the composition of the figure to be represented; for the hexagonal and conical figure of this glass prevents any part of the ace of diamonds being seen; consequently the ace of clubs being previously and mechanically drawn in the circle of refraction in six different parts of the border, at 1, 2, 3, 4, 5, 6, and artfully disguised in the ornamental border, by blending them with it, the glass in the tube at E will change the appearance of the ace of diamonds, F, into the ace of clubs, G. In the same manner many other prints undergo similar changes, according to the will of an ingenious draughtsman who may design them. The figure of the glass is shown at H.

Fig. 25.



To show the Spots in the Sun's Disk by its Image in the Camera Obscura.

Put the object-glass of a ten or twelve feet telescope into the scioptric ball, and turn it about till it be directly opposite the sun. Then place the pasteboard mentioned in page 16, in the focus of the [Pg 129] lens, and you will see a clear bright image of the sun, about an inch diameter, in which the spots on the sun's surface will be exactly described.

As this image is too bright to be seen with pleasure by the naked eye, you may view it through a lens whose focus is at six or eight inches distance, which, while it prevents the light from being offensive, will, by magnifying both the image and the spot, make them appear to greater advantage.

The Diagonal Opera Glass.

By the diagonal position of a plane mirror, a curious opera-glass is constructed, by which any person may be viewed in a theatre or public company without knowing it. It consists only in placing a concave glass near the plane mirror, in the end of a short round tube, and a convex

glass in a hole in the side of the tube, then holding the end of the tube with the glass to the eye, all objects next to the hole in the side will be reflected so as to appear in a direct line forward, or in a position at right angles to the person's situation who is looked at. Plane glasses, instead of a convex and concave, may be used; in this case the size of the object will not be increased, but it will appear brighter.

To observe an Eclipse of the Sun, without Injury to the Eye.

Take a burning-glass, or spectacle-glass, that magnifies very much; hold it before a book or pasteboard, twice the distance of its focus, and you will see the round body of the sun, and the manner in which the moon passes between the glass and the sun, during the whole eclipse.

The Burnt Writing restored.

Cover the outside of a small memorandum book with black paper, and in one of its inside covers make a flap, to open secretly, and observe there must be nothing over the flap but the black paper that covers the book.

Mix soot with black or brown soap, with which rub the side of the black paper next the flap; then wipe it clean, that a white paper pressed against it will not receive any mark. [Pg 130]

Provide a black-lead pencil that will not mark without pressing hard on the paper. Have likewise a small box, about the size of a memorandum book, and that opens on both sides, but on one of them by a private method. Give a person a pencil and a slip of thin paper, on which he is to write what he thinks proper; you present him the memorandum book at the same time, that he may not write on the bare paper. You tell him to keep what he writes to himself, and direct him to burn it on the iron plate laid on a chafing-dish of coals, and give you the ashes. You then go into another room to fetch your magic box, before described, and take with you the memorandum book.

Having previously placed a paper under the flap in the cover of the book, when he presses hard with the pencil, to write on his paper, every stroke, by means of the stuff rubbed on the black paper, will appear on that under the flap. You therefore take it out, and put it into one side of the box.

You then return to the other room, and taking a slip of black paper, you put it into the other side of the box, strewing the ashes of the burnt paper over it. Then shaking the box for a few moments, and at the same time turning it dexterously over, you open the other side, and show the person the paper you first put in, the writing on which he will readily acknowledge to be his.

If there be a press or cupboard that communicates with the next room, you need only put the book in the press, and your assistant will open it, and put the paper in the box, which you presently after take out, and perform the rest of the amusement as before.

There may likewise be a flap on the other cover of the book; and you may rub the paper against that with red lead. In this case you give the person the choice of writing either with a black or red pencil; and present him the proper side of the book accordingly.

The Opaque Box made Transparent.

Make a box three or four inches long, and two or three wide, and have a sort of perspective-glass, the bottom of which is the same size with the box, and slides out, that you may privately place a paper on it. The sides of this perspective are to be of glass, covered on the inside with fine paper. [Pg 131]

Let a person write on a slip of paper, putting your memorandum book under it, as in the last amusement; then give him the little box, and let him put what he has written into it. In the mean time you put the memorandum book into the press, where the perspective is already placed. Your assistant then takes the paper out of the book, and puts it at the bottom of the perspective; which you presently take out of the press, and direct the person to put the little box that contains the paper under it. You then look in at the top of the perspective, and feigning to see through the top of the box, you read what is written on the paper at the bottom of the perspective.

With this perspective box you may perform another amusement, which is, by having in a bag twelve or more ivory counters, numbered, which you show to the company, that they may see all the numbers are different. You tell a person to draw any one of them, and keep it close in his hand. You then put the bag in the press, when your assistant examines the counters, and sees which is wanting, and puts another of the same number at the bottom of the perspective, which you then take out, and placing the person's hand close to it, look in at the top, and pretending to see through his hand, you name the number on the counter in it.

The Transposable Pieces.

Take two guineas and two shillings, and grind part of them away, on one side only, so that they may be but half the common thickness; and observe, that they must be quite thin at the edge; then rivet a guinea and a shilling together. Lay one of these double pieces, with the shilling upwards, on the palm of your hand, at the bottom of your three first fingers, and lay the other piece with the guinea upwards in the like manner, in the other hand. Let the company take notice

in which hand is the guinea, and in which is the shilling. Then as you shut your hands, you naturally turn the pieces over, and when you open them again, the shilling and the guinea will appear to have changed their places. [Pg 132]

The Penetrative Guinea.

Provide a large tin box, of the size of a large snuff-box, and in this place eight other boxes, which will go easily into each other, and let the least of them be of a size to hold a guinea. Each of these boxes should shut with a hinge, and to the least of them there must be a small lock, that is fastened with a spring, but cannot be opened without a key;—observe, that all these boxes must shut so freely, that they may be all closed at once. Place these boxes in each other, with their tops open, in the drawer of the table on which you make your experiments; or, if you please, in your pocket, in such a manner that they cannot be displaced.

Then ask a person to lend you a new guinea, and desire him to mark it, that it may not be changed. You take this piece in one hand, and in the other you have another of the same appearance, and putting your hand into the drawer, you slip the piece that is marked into the least box, and shutting them all at once, you take them out; then showing the piece you have in your hand, and which the company suppose to be the same that was marked, you pretend to make it pass through the box, and dexterously convey it away.

You then present the box, for the spectators do not yet know there are more than one, to any person in company, who, when he opens it, finds another, and another, till he comes to the last, but that he cannot open without the key, which you then give him, and retiring to a distant part of the room, you tell him to take out the guinea himself, and see if it be that which he marked.

This amusement may be made more surprising, by putting the key into the snuff-box of one of the company, which you may do by asking him for a pinch of snuff, and at the same time conceal the key, which must be very small, among the snuff; and when the person, who is to open the box, asks for the key, you tell him that one of the company has it in his snuff-box. This part of the amusement may likewise be performed by means of a confederate.

To make Pictures of Birds with their Natural Feathers.

First take thin board or panel, of deal or wainscot, well seasoned, that it may not shrink; then paste white paper smoothly on it, and let it dry; if the colour of the wood show through, paste a [Pg 133] second paper over it. When the paper is dry, get ready any bird that you would represent, and draw the outline as exact as you can on the papered panel. You then paint the ground-work, stump of a tree, the bill and legs, their proper colour, with water-colours, leaving the body to be covered with its own natural feathers. In the space you have left for the body, you lay on very thick gum-water, letting each coat dry before you lay on another, and so continuing until the gum is as thick as a shilling. Then take the feathers off the bird; and, as you proceed, draw a camels'-hair pencil, dipped in gum-water, over the coat of gum that you have laid on the paper, that it may more readily adhere. As you strip the bird, you must fix the feathers in their proper places on the board, and you shave the shafts or stems of the larger feathers, that they may lie flat. The most ready way to perform the operation, is to provide yourself with a pair of steel pliars to take up and lay on the feathers with. You should prepare some small leaden weights to lay on the feathers, that they may more readily adhere to, and lie flat on, the gum. The part where the eye is must be supplied by a small piece of paper, coloured and shaped like one; or you may, probably, be able to get a glass bead that will answer the purpose better. In order that the feathers may lie smooth and regular, when the whole is perfectly dry, lay a book, or a flat board, with a weight on it.

The Art of Bronzing.

Bronzing is that process by which figures of plaster-of-paris, wood, &c. are made to have the appearance of copper or brass. The method is as follows:

Dissolve copper filings in aqua fortis. When the copper has impregnated the acid, pour off the solution, and put into it some pieces of iron, or iron filings. The effect of this will be to sink the powder to the bottom of the acid. Pour off the liquor, and wash the powder in successive quantities of fresh water. When the powder is dry, it is to be rubbed on the figure with a soft cloth, or piece of leather; but observe, that previously to the application of the bronze powder, a dark blackish sort of green is first to be laid on the figure: and if you wish the powder to adhere stronger, mix it with gum-water, lay it on like paint, with a camels'-hair brush, or previously trace [Pg 134] the parts to be bronzed with gold size, and when nearly dry, rub the powder over it.

Method of taking the Impression of Butterflies on Paper.

Clip the wings off the butterfly, lay them on clean, in the form of a butterfly when flying. Spread some thick clean gum-water on another piece of paper, press it on the wings, and it will take them up; lay a piece of white paper over it, and rub it gently with your finger, or the smooth handle of a knife. The bodies are to be drawn in the space which you leave between the wings.

To soften Horn.

To one pound of wood-ashes, add two pounds of quick lime; put them into a quart of water. Let the whole boil till reduced to one-third. Then dip a feather in, and if, on drawing it out, the plume should come off, it is a proof that it is boiled enough; if not, let it boil a little longer. When it is settled, filter it off, and in the liquor thus strained put in shavings of horn. Let them soak for three days; and, first anointing your hands with oil, work the horn into a mass, and print or mould it into any shape you please.

To make Moulds of Horn.

If you wish to take the impression of any coin, medal, &c., previously anoint it with oil; then lay the horn shavings over it in its softened state. When dry, the impression will be sunk into the horn; and this will serve as a mould to re-produce, either by plaster-of-paris, putty and glue, or isinglass and ground egg-shells, the exact resemblance of the coin or medal.

To cast Figures in Imitation of Ivory.

Make isinglass and strong brandy into a paste, with powder of egg-shells, very finely ground. You may give it what colour you please; but cast it warm into your mould, which you previously oil over. Leave the figure in the mould till dry, and you will find, on taking it out, that it bears a very strong resemblance to ivory. [Pg 135]

To extract the Silver out of a Ring that is thick gilded, so that the Gold may remain entire.

Take a silver ring that is thick gilded. Make a little hole through the gold into the silver; then put the ring into aqua fortis, in a warm place: it will dissolve the silver, and the gold will remain whole.

To soften Iron or Steel.

Either of the following simple methods will make iron or steel as soft as lead:

1. Anoint it all over with tallow; temper it in a gentle charcoal fire, and let it cool of itself.
2. Take a little clay, cover your iron with it, temper it in a charcoal fire.
3. When the iron or steel is red-hot, strew hellebore on it.
4. Quench the iron or steel in the juice or water of common beans.

To take a Plaster-of-Paris Cast from a Person's Face.

The person must lie on his back, and his hair be tied behind. Into each nostril put a conical piece of paper, open at each end to allow of breathing. The face is to be lightly oiled over, and the plaster being properly prepared is to be poured over the face, (taking care that the eyes are shut,) till it is a quarter of an inch thick. In a few minutes the plaster may be removed. In this a mould is to be formed, from which a second cast is to be taken, that will furnish casts exactly like the original.

Curious Experiment with a Glass of Water.

Saturate a certain quantity of water in a moderate heat, with three ounces of sugar; and when it will no longer receive that, there is still room in it for two ounces of salt of tartar, and after that for an ounce and a drachm of green vitriol, nearly six drachms of nitre, the same of sal-ammoniac, two drachms and a scruple of alum, and a drachm and half of borax. [Pg 136]

To make Artificial Coruscations.

There is a method of producing artificial coruscations, or sparkling fiery meteors, which will be visible, not only in the dark but at noon-day, and that from two liquors actually cold. The method is this:—Fifteen grains of solid phosphorus are to be melted in about a drachm of water: when this is cold, pour upon it two ounces of oil of vitriol; let these be shaken together in a large phial, and they will at first heat, and afterwards will throw up fiery balls in great number, which will adhere like so many stars to the sides of the glass, and continue burning a considerable time; after this, if a small quantity of oil of turpentine be poured in without shaking the phial, the mixture will of itself take fire, and burn very furiously. The vessels should be large and open at the top.

Another Method.

Artificial coruscations may also be produced by means of oil of vitriol and iron, in the following manner:—Take a glass vessel capable of holding three quarts: put into this three ounces of oil of vitriol, and twelve ounces of water, then warming the mixture a little, throw in at several times two ounces, or more, of clear iron filings: upon this, an ebullition and white vapours will arise; then present a lighted candle to the mouth of the vessel, and the vapour will take fire, and afford a bright fulmination or flash; like lightning. Applying the candle in this manner several times, the

effect will always be the same; and sometimes the fire will fill the whole body of the glass, and even circulate to the bottom of the liquor; at others, it will only reach a little down its neck. The great caution to be used in making this experiment, is the making the vapour of a proper heat; for if made too cold few vapours will arise; and, if made too hot, they will arise too fast, and will only take fire in the neck of the glass, without any remarkable coruscation.

To produce Fire from Cane.

The Chinese rattans, which are used, when split, for making cane chairs, will, when dry, if struck against each other, give fire; and are used accordingly in some places, in lieu of flint and steel. [Pg 137]

To make an Eolian Harp.

This instrument may be made by almost any carpenter: it consists of a long narrow box of very thin deal, about five or six inches deep, with a circle in the middle of the upper side, of an inch and a half in diameter, in which are to be drilled small holes. On this side, seven, ten, or more strings, of very fine gut, are stretched over bridges at each end, like the bridges of a fiddle, and screwed up or relaxed with screw pins. The strings must be all tuned to one and the same note, and the instrument be placed in some current of air, where the wind can pass over its strings with freedom. A window, of which the width is exactly equal to the length of the harp, with the sash just raised to give the air admission, is a proper situation. When the air blows upon these strings, with different degrees of force, it will excite different tones of sounds; sometimes the blast brings out all the tones in full concert, and sometimes it sinks them to the softest murmurs.

To show the Pressure of the Atmosphere.

Invert a tall glass or jar in a dish of water, and place a lighted taper under it: as the taper consumes the air in the jar its pressure becomes less on the water immediately under the jar; while the pressure of the atmosphere on the water *without* the circle of the jar remaining the same, part of the water in the dish will be forced up into the jar, to supply the place of the air which the taper has consumed. Nothing but the pressure of the atmosphere could thus cause part of the water to rise within the jar, above its own level.

Subaqueous Exhalation.

Pour a little clear water into a small glass tumbler, and put one or two small pieces of phosphoret of lime into it. In a short time, flashes of fire will dart from the surface of the water, and terminate in ringlets of smoke, which will ascend in regular succession. [Pg 138]

Remarkable Properties in certain Plants.

Plants, when forced from their natural position, are endowed with a power to restore themselves. A hop-plant, twisting round a stick, directs its course from south to west, as the sun does. Untwist it, and tie it in the opposite direction, it dies. Leave it loose in the wrong direction, it recovers its natural direction in a single night. Twist a branch of a tree so as to invert its leaves, and fix it in that position; if left in any degree loose, it untwists itself gradually, till the leaves be restored to their natural position. What better can an animal do for its welfare? A root of a tree meeting with a ditch in its progress, is laid open to the air; what follows? It alters its course like a rational being, dips into the ground, surrounds the ditch, rises on the opposite side of its wonted distance from the surface, and then proceeds in its original direction. Lay a wet sponge near a root exposed to the air; the root will direct its course to the sponge; change the place of the sponge, the root varies its direction. Thrust a pole into the ground at a moderate distance from a climbing plant; the plant directs its course to the pole, lays hold of it, and rises on its natural height. A honeysuckle proceeds in its course, till it be too long for supporting its weight, and then strengthens itself by shooting into a spiral. If it meet with another plant of the same kind, they coalesce for mutual support; the one screwing to the right, the other to the left. If a honeysuckle twig meet with a dead branch, it screws from the right to the left. The claspers of briony shoot into the spiral, and lay hold of whatever comes in their way, for support. If, after completing a spiral of three rounds, they meet with nothing, they try again, by altering their course.

Flowers curiously affected by the Sun and the Weather.

The petals of many flowers expand in the sun, but contract all night, or on the approach of rain; after the seeds are fecundated the petals no longer contract. All the trefoil may serve as a barometer to the husbandman; they always contract their leaves on an impending storm. [Pg 139]

Easy Method of obtaining Flowers of different Colours from the same Stem.

Scoop out the pith from a small twig of elder, and having split it lengthwise, fill each of the parts with small seeds that produce flowers of different colours, but that blossom nearly at the same time. Surround them with earth; and then tying together the two bits of wood, plant the whole in a pot filled with earth, properly prepared.

A Luminous Bottle, which will show the Hour on a Watch in the Dark.

Throw a bit of phosphorus, of the size of a pea, into a long glass phial, and pour boiling oil carefully over it, till the phial is one-third filled. The phial must be carefully corked, and when used should be unstopped, to admit the external air, and closed again. The empty space of the phial will then appear luminous, and give as much light as an ordinary lamp. Each time that the light disappears, on removing the stopper it will instantly re-appear. In cold weather the bottle should be warmed in the hands before the stopper is removed. A phial thus prepared may be used every night for six months.

To make Luminous Writing in the Dark.

Fix a small piece of solid phosphorus in a quill, and write with it upon paper; if the paper be carried into a dark room, the writing will appear beautifully luminous.

The Sublimated Tree.

Into a large glass jar inverted upon a flat brick tile, and containing near its top a branch of fresh rosemary, or any other such shrub, moistened with water, introduce a flat thick piece of heated iron, on which place some gum benzoin, in gross powder. The benzoin, in consequence of the heat, will be separated, and ascend in white fumes, which will at length condense, and form a most beautiful appearance upon the leaves of the vegetable. [Pg 140]

Easy and curious Methods of foretelling Rainy or Fine Weather.

If a line be made of good whipcord, that is well dried, and a plummet affixed to the end of it, and then hung against a wainscot, and a line drawn under it, exactly where the plummet reaches, in very moderate weather it will be found to rise above it before rain, and to sink below when the weather is likely to become fair. But the best instrument of all, is a good pair of scales, in one of which let there be a brass weight of a pound, and in the other a pound of salt, or of saltpetre, well dried; a stand being placed under the scale, so as to hinder it falling too low. When it is inclined to rain, the salt will swell, and sink the scale: when the weather is growing fair, the brass weight will regain its ascendancy.

Contrivance for a Watch Lamp, perfectly safe, which will show the Hour of the Night, without any trouble, to a person lying in Bed.

It consists of a stand, with three claws, the pillar of which is made hollow, for the purpose of receiving a water candlestick of an inch diameter. On the top of the pillar, by means of two hinges and a bolt, is fixed on a small proportionate table, a box of six sides, lined with brass, tin, or any shining metal, nine inches deep, and six inches in diameter. In the centre of one of these sides is fixed a lens, double convex, of at least three inches and a half diameter. The centre of the side directly opposite to the lens is perforated so as to receive the dial-plate of the watch, the body of which is confined on the outside, by means of a hollow slide. When the box is lighted by a common watch-light, the figures are magnified nearly to the size of those of an ordinary clock.

Curious Experiment with a Tulip.

The bulb of a tulip in every respect resembles buds, except in their being produced under ground, and include the leaves and flower in miniature, which are to be expanded in the ensuing spring. By cautiously cutting in the early spring, through the concentric coats of a tulip root, longitudinally from the top to the base, and taking them off successively, the whole flower of the [Pg 141] next summer's tulip is beautifully seen by the naked eye, with its petals, pistal, and stamina.

The Travelling of Sound experimentally proved.

There is probably no substance which is not in some measure a conductor of sound; but sound is much enfeebled by passing from one medium to another. If a man, stopping one of his ears with his finger, stop the other also by pressing it against the end of a long stick, and a watch be applied to the opposite end of the stick, or a piece of timber, be it ever so long, the beating of the watch will be distinctly heard; whereas, in the usual way, it can scarcely be heard at the distance of fifteen or eighteen feet. The same effect will take place if he stops both his ears with his hands, and rest his teeth, his temple, or the gristly part of one of his ears against the end of a stick. Instead of a watch, a gentle scratch may be made at one end of a pole or rod, and the person who keeps his ear in close contact with the other end of the pole, will hear it very plainly. Thus, persons who are dull of hearing, may, by applying their teeth to some part of a harpsichord, or other sounding body, hear the sound much better than otherwise.

If a person tie a strip of flannel about a yard long, round a poker, then press with his thumbs and fingers the ends of the flannel into his ears, while he swings the poker against an iron fender, he will hear a sound very like that of a large church bell.

To produce Metallic Lead from the Powder.

Take one ounce of red lead, and half a drachm of charcoal in powder, incorporate them well in a mortar, and then fill the bowl of a tobacco-pipe with the mixture. Submit it to an intense heat, in a common fire, and when melted, pour it out upon a slab, and the result will be metallic lead completely revived.

To diversify the Colours of Flowers.

Fill a vessel of what size or shape you please, with good rich earth, which has been dried and sifted in the sun, then plant in the same a slip or branch of a plant bearing a white flower, (for such only can be tinged,) and use no other water to water it with, but such as is tinged with red, if you desire red flowers; with blue, if blue flowers, &c. With this coloured water, water the plant [Pg 142] twice a day, morning and evening, and remove it into the house at night, so that it drink not of the morning or evening dew for three weeks. You will then experience, that it will produce flowers, not altogether tinctured with that colour wherewith you watered it, but partly with that, and partly with the natural.

How far Sound travels in a Minute.

However it may be with regard to the theories of sound, experience has taught us, that it travels at about the rate of 1142 feet in a second, or nearly thirteen miles in a minute. The method of calculating its progress is easily made known: when a gun is discharged at a distance, we see the fire long before we hear the sound; if, then, we know the distance of the place, and know the time of the interval between our first seeing the fire, and then hearing the report, this will show us exactly the time the sound has been travelling to us. For instance, if the gun be discharged a mile off, the moment the flash is seen I take a watch and count the seconds till I hear the sound; the number of seconds is the time the sound has been travelling a mile.

Easy Method of making a Rain Gauge.

A very simple rain gauge, and one which will answer all practical purposes, consists of a copper funnel the area of whose opening is exactly ten square inches: this funnel is fixed in a bottle, and the quantity of rain caught is ascertained by multiplying the weight in ounces by 173, which gives the depth in inches and parts of an inch. In fixing these gauges, care must be taken that the rain may have free access to them: hence the tops of buildings are usually the best places. When the quantities of rain collected in them at different places are compared, the instruments ought to be fixed at the same heights above the ground at both places, because at different heights the quantities are always different, even at the same place.

To make beautiful Transparent coloured Water.

The following liquors, which are coloured, being mixed, produce colours very different from their own. The yellow tincture of saffron, and the red tincture of roses, when mixed, produce a green. [Pg 143] Blue tincture of violets, and brown spirit of sulphur, produce a crimson. Red tincture of roses, and brown spirits of hartshorn, make a blue. Blue tincture of violets, and blue solution of copper, give a violet colour. Blue tincture of cyanus, and blue spirit of sal-ammoniac coloured, make green. Blue solution of Hungarian vitriol, and brown ley of potash, make yellow. Blue solution of Hungarian vitriol, and red tincture of roses, make black; and blue tincture of cyanus, and green solution of copper, produce red.

Curious Experiment on Rays of Light.

That the rays of light flow in all directions from different bodies, without interrupting one another, is plain from the following experiment:—Make a little hole in a thin plate of metal, and set the plate upright on a table, facing a row of lighted candles standing near together; then place a sheet of paper or pasteboard at a little distance from the other side of the plate; and the rays of all the candles, flowing through the hole, will form as many specks of light on the paper as there are candles before the plate; each speck as distinct and large as if there were only one candle to cast one speck; which shows that the rays do not obstruct each other in their motions, although they all cross in the same hole.

The Power of Water.

Let a strong small iron tube of twenty feet in height be inserted into the bung-hole of a cask, and the aperture round so strongly closed, that it shall be water-tight; pour water into the cask till it is full, through the pipe; also continue filling the pipe till the cask bursts, which will be when the water is within a foot of the top of the tube. In this experiment the water, on bursting the vessel, will fly about with considerable violence.

The Pressure of Water.

The pressure of water may be known to every one who will only take the trouble to look at the cock of a water-butt when turned: if the tub or cistern be full, the water runs with much greater [Pg 144] velocity through the cock, and a vessel will be filled from it in a shorter time than when it is only

half-full, although the cock, in both cases, is equally replete with the fluid during the time the vessel is filling. From this also is understood, how a hole or leak, near the keel of a ship, admits the water much quicker, and with greater violence, than one of the same size near what the mariners call the water's edge.

Refraction of Light.

In the middle of an empty basin put a piece of money, and then retire from it till the edge of the basin hides the piece from your sight: then keep your head steady, let another person fill the basin gently with water; as the water rises in the basin the money will come in view; and when of a sufficient height in the basin, the whole of the piece will be in sight.

Wonderful Nature of Lightning.

If two persons, standing in a room, looking different ways, and a loud clap of thunder, accompanied with zigzag lightning, happen, they will both distinctly see the flash at the same time; not only the illumination, but the very form of the lightning itself, and every angle it makes in its course will be as distinctly perceptible, as though they had both looked directly at the cloud from whence it proceeded. If a person happened at that time to be looking on a book, or other object, which he held in his hand, he would distinctly see the form of the lightning between him and the object at which he looked. This property seems peculiar to lightning, as it does not apply to any other kind of fire whatever.

To show that the White of Eggs contains an Alkali.

Add to a wine-glass half full of tincture of red cabbage a small quantity of the white of an egg, either in a liquid state or rendered concrete by boiling. The tincture will lose its blue colour and become changed to green, because the white of the egg contains soda. [Pg 145]

Two Inodorous Bodies become very Pungent and Odorous by Mixture.

When equal parts of muriate of ammonia and unslaked lime, both substances destitute of odour, are intimately blended together in a mortar, a very pungent gas (ammonia) becomes evolved.

Interesting Experiment for the Microscope.

The embryo grain of wheat, at the time of blossoming, being carefully taken out of the husk, will be found to have a small downy tuft at its extremity, which, when viewed in a microscope, greatly resembles the branches of thorn, spreading archwise, in opposite directions. By expanding a few of the grains, and selecting the most perfect, a very pretty microscopic object will be obtained for preservation.

The Travelling of Light.

Light travels at the rate of a hundred and fifty thousand miles in a single second; and it is seven minutes in passing from the sun to the earth, which is nearly a distance of seventy millions of miles. Such is the rapidity with which these rays dart themselves forward that a journey they thus perform in less than eight minutes, a ball from the mouth of a cannon would not complete in several weeks! But the minuteness of the particles of light are still several degrees beyond their velocity; and they are therefore harmless, because so very small. A ray of light is nothing more than a constant stream of minute parts, still flowing from the luminary, so inconceivably little, that a candle in a single second of time, has been said to diffuse several hundreds of millions more particles of light, than there could be grains in the whole earth, if it were entirely one heap of sand. The sun furnishes them, and the stars also, without appearing in the least to consume, by granting us the supply. Its light is diffused in a wide sphere, and seems inexhaustible.

Calculation of the Mass of Water contained in the Sea.

If we would have an idea of the enormous quantity of water which the sea contains, let us suppose a common and general depth of the ocean; by computing it at only 200 fathoms, or the tenth part of a mile, we shall see that there is sufficient water to cover the whole globe to the height of 503 feet of water; and if we were to reduce this water into one mass, we should find that it forms a globe of more than sixty thousand miles diameter. [Pg 146]

Different Degrees of Heat imbibed from the Sun's Rays by Cloths of different Colours.

Walk but a quarter of an hour in your garden, when the sun shines, with a part of your dress white, and a part black; then apply your hand to them alternately, and you will find a very great difference in their warmth. The black will be quite hot to the touch, and the white still cool.

Try to fire paper with a burning-glass; if it be white, you will not easily burn it; but if you bring the focus to a black spot, or upon letters, written or printed, the paper will immediately be on fire under the letters.

Thus, fullers and dyers find black cloths, of equal thickness with white ones, and hung out equally wet, dry in the sun much sooner than the white, being more readily heated by the sun's rays. It is the same before a fire, the heat of which sooner penetrates black stockings than white ones, and so is apt sooner to burn a man's shins. Also beer much sooner warms in a black mug set before the fire than a white one, or in a bright silver tankard. Take a number of little square pieces of cloth from a tailor's pattern card, of various colours; say black, deep blue, lighter blue, green, purple, red, yellow, white, and other colours, or shades of colours; lay them all out upon the snow in a bright sun-shiny morning; in a few hours, the black being warmed most by the sun will be sunk so low as to be below the stroke of the sun's rays; the dark blue almost as low; the lighter blue not quite so much as the dark; the other colours less, as they are lighter; and the quite white remain on the surface of the snow, as it will not have entered it at all.

Alternate Illusion.

With a convex lens of about an inch focus, look attentively at a silver seal, on which a cipher is engraved. It will at first appear cut in, as to the naked eye; but if you continue to observe it some [Pg 147] time, without changing your situation, it will seem to be in relief, and the lights and shades will appear the same as they did before. If you regard it with the same attention still longer, it will again appear to be engraved: and so on alternately.

If you look off the seal for a few moments, when you view it again, instead of seeing it, as at first, engraved, it will appear in relief.

If, while you are turned towards the light, you suddenly incline the seal, while you continue to regard it, those parts that seemed to be engraved will immediately appear in relief: and if, when you are regarding these seemingly prominent parts, you turn yourself so that the light may fall on the right hand, you will see the shadows on the same side from whence the light comes, which will appear not a little extraordinary. In like manner the shadows will appear on the left, if the light fall on that side. If instead of a seal you look at a piece of money, these alterations will not be visible, in whatever situation you place yourself.

Alarum.

Against the wall of a room, near the ceiling, fix a wheel of twelve or eighteen inches diameter; on the rim of which place a number of bells in tune, and, if you please, of different sizes. To the axis of this wheel there should be fixed a fly to regulate its motion; and round the circumference there must be wound a rope, to the end of which is hung a weight.

Near to the wheel let a stand be fixed, on which is an upright piece that holds a balance or moveable lever, on one end of which rests the weight just mentioned; and to the other end must hang an inverted hollow cone, or funnel, the aperture of which is very small. This cone must be graduated on the inside, that the sand put in may answer to the number of hours it is to run. Against the upright piece, on the side next the cone, there must be fixed a check, to prevent it from descending. This stand, together with the wheel, may be enclosed in a case, and so contrived, as to be moved from one room to another with very little trouble.

It is evident, from the construction of this machine, that when a certain quantity of the sand is run out, the weight will descend, and put the wheel in motion, which motion will continue till the [Pg 148] weight comes to the ground. If the wheel be required to continue longer in motion, two or more pulleys may be added, over which the rope may run.

Musical Cascade.

Where there is a natural cascade, near the lower stream, but not in it, let there be placed a large wheel, equal to the breadth of the cascade: the diameter of this wheel, for about a foot from each end, must be much less than that of the middle part; and all the water from the cascade must be made to fall on the ends. The water that falls on the wheel may pass through pipes, so that part of it may be made occasionally to pass over or fall short of the wheel, as you would have the time of the music quicker or slower. The remaining part of the wheel, which is to be kept free from the water, must consist of bars, on which are placed stops that strike against the bells: these stops must likewise be moveable. It is evident from the construction of this machine, that the water falling on the floats at the end of the wheel, will make the stops, which are adapted to different tunes, strike the notes of those tunes on the respective bells. Two or three sets of bells may here be placed on the same line, when the cascade is sufficiently wide.

Where there is not a natural cascade, one may be artificially constructed, by raising part of the ground, wherever there is a descent of water; whether it be a stream that supplies a reservoir or fountain, or serves domestic uses; or if it be refuse water that has already served some other purpose.

Writing on Glass by the Rays of the Sun.

Dissolve chalk in aqua fortis, to the consistence of milk, and add to that a strong solution of silver. Keep this liquor in a glass decanter well stopped. Then cut out from a paper the letters you would have appear, and paste the paper on the decanter, which you are to place in the sun, in

such a manner that its rays may pass through the spaces cut out of the paper, and fall on the surface of the liquor. The part of the glass through which the rays pass will turn black, and that under the paper will remain white. You must observe not to move the bottle during the time of [Pg 149] the operation.

To produce the Appearance of a Flower from its Ashes.

Make a tin box, with a cover that takes off. Let this box be supported by a pedestal of the same metal, and on which there is a little door. In the front of this box is to be a glass.

In a groove, at a small distance from this glass, place a double glass, made in the same manner as described in p. 13, (*Magic Picture.*) Between the front and back glasses place a small upright tin tube, supported by a cross piece. Let there be also a small chafing-dish placed in the pedestal. The box is to be opened behind. You privately place a flower in the tin tube, but not so near the front glass as to be in the least degree visible, and presenting one that resembles it to any person, desire him to burn it on the coals in a chafing-dish.

You then strew some powder over the coals, which may be supposed to aid the ashes in producing the flower; and put the chafing-dish in the pedestal under the box. As the heat by degrees melts the composition between the glasses, the flower will gradually appear, but when the chafing-dish is taken away, and the powder of the ashes is supposed to be removed, the flower soon disappears.

You may present several flowers, and let the person choose any one of them. In this case, while he is burning the flower, you fetch the box from another apartment, and at the same time put in a corresponding flower, which will make the experiment still more surprising.

Imitative Fire-works.

Take a paper that is blacked on both sides, or instead of black, the paper may be coloured on each side with a deep blue, which will be still better for such as are to be seen through transparent papers. It must be of a proper size for the figure you intend to exhibit. In this paper cut out with a penknife several spaces, and with a piercer make a number of holes, rather long than round, and at no regular distance from each other.

To represent revolving pyramids and globes, the paper must be cut through with a penknife, and [Pg 150] the space cut out between each spiral should be three or four times as wide as the spirals themselves. You must observe to cut them so that the pyramid or globe may appear to turn on its axis. The columns that are represented in pieces of architecture, or in jets of fire, must be cut in the same manner, if they are to be represented as turning on their axis.

In like manner may be exhibited a great variety of ornaments, ciphers, and medallions, which, when properly coloured, cannot fail of producing the most pleasing effect. There should not be a very great diversity of colours, as they would not produce the most agreeable appearance.

When these pieces are drawn on a large scale, the architecture or ornaments may be shaded; and, to represent different shades, pieces of coloured paper must be pasted over each other, which will produce an effect that would not be expected from transparent paintings. Five or six pieces of paper pasted over each other will be sufficient to represent the strongest shades.

To give these pieces the different motions they require, you must first consider the nature of each piece; if, for example, you have cut out the figure of the sun, or of a star, you must construct a wire wheel of the same diameter with these pieces; over this wheel you paste a very thin paper, on which is drawn, with black ink, the spiral figure. The wheel thus prepared, is to be placed behind the sun or star, in such a manner that its axis may be exactly opposite the centre of either of these figures. This wheel may be turned by any method you think proper.

Now, the wheel being placed directly behind the sun, for example, and very near to it, is to be turned regularly round, and strongly illuminated by candles placed behind it. The lines that form the spiral will then appear, through the spaces cut out from the sun, to proceed from its centre to its circumference, and will resemble sparks of fire that incessantly succeed each other. The same effect will be produced by the star or by any other figure where the fire is not to appear as proceeding from the circumference of the centre.

These two pieces, as well as those that follow, may be of any size, provided you observe the proportion between the parts of the figure and the spiral, which must be wider in larger figures than in small. If the sun, for example, have from six to twelve inches diameter, the width of the strokes that form the spiral need not be more than one-twentieth part of an inch, and the spaces [Pg 151] between them, that form transparent parts, about two-tenths of an inch. If the sun be two feet diameter, the strokes should be one-eighth of an inch, and the space between, one quarter of an inch; and if the figure be six feet diameter, the strokes should be one quarter of an inch and the spaces five-twelfths of an inch. These pieces have a pleasing effect, when represented of a small size, but the deception is more striking when they are of large dimensions.

It will be proper to place those pieces, when of a small size, in a box quite closed on every side, that none of the light may be diffused in the chamber: for which purpose it will be convenient to have a tin door behind the box, to which the candlesticks may be soldered, and the candles more easily lighted.

The several figures cut out should be placed in frames, that they may be put, alternately, in a groove in the forepart of the box; or there may be two grooves, that the second piece may be put in before the first is taken out.

The wheel must be carefully concealed from the eye of the spectator.

Where there is an opportunity of representing these artificial fires by a hole in the partition, they will doubtless have a much more striking effect, as the spectator cannot then conjecture by what means they are produced.

It is easy to conceive that by extending this method, wheels may be constructed with three or four spirals, to which may be given different directions. It is manifest also that, on the same principle, a great variety of transparent figures may be contrived, and which may be all placed before the spiral lines.

To represent Cascades of Fire.

In cutting out cascades, you must take care to preserve a natural inequality in the parts cut out; for if, to save time, you should make all the holes with the same pointed tool, the uniformity of the parts will not fail to produce a disagreeable effect. As these cascades are very pleasing when well executed, so they are highly disgusting when imperfect. These are the most difficult pieces to cut out.

To produce the apparent motion of these cascades, instead of drawing a spiral, you must have a slip of strong paper, of such length as you judge convenient. In this paper there must be a greater number of holes near each other, and made with pointed tools of different dimensions. [Pg 152]

At each end of the paper, a part of the same size with the cascade must be left uncut; and towards those parts the holes must be made at a greater distance from each other.

When the cascade that is cut out is placed before the scroll of paper just mentioned, and it is entirely wound upon the roller, the part of the paper that is then between being quite opaque, no part of the cascade will be visible; but as the winch is gently turned, and regularly round, the transparent part of the paper will give to the cascade the appearance of fire that descends in the same direction; and the illusion will be so strong, that the spectators will think they see a cascade of fire; especially if the figure be judiciously cut out.

The Oracular Mirror.

Provide a round mirror of about three inches in diameter and whose frame is an inch wide. Line the under part of the frame, in which holes are to be cut, with very thin glass; behind this glass let a mirror of about two inches diameter be placed, which is to be moveable, so that by inclining the frame to either side, part of the mirror will be visible behind the glass on that side.

Then take Spanish chalk, or cypress vitriol, of which you make a pencil, and with this you may write on a glass, and rub it off with a cloth, and by breathing on the glass, the writing will appear and disappear several times. With this pencil write on one side of the mirror, before it is put in the frame, the word *yes*, and on the other side, *no*; and wipe them off with a cloth.

You propose to a person to ask any question of this mirror that can be answered by the words *yes* or *no*. Then turning the glass to one side, and putting your mouth close to it, as if to repeat the question softly, you breathe on it, and the word yes or no will immediately appear. This mirror will serve for many other agreeable amusements.

The Hour of the Day or Night told by a suspended Shilling.

However improbable the following experiment may appear, it has been proved by repeated trials: [Pg 153]

Sling a shilling or sixpence at the end of a piece of thread by means of a loop. Then resting your elbow on a table, hold the other end of the thread betwixt your fore-finger and thumb, observing to let it pass across the ball of the thumb, and thus suspend the shilling into an empty goblet. Observe, your hand must be perfectly steady; and if you find it difficult to keep it in an immoveable posture, it is useless to attempt the experiment. Premising, however, that the shilling is properly suspended, you will observe, that when it has recovered its equilibrium, it will for a moment be stationary: it will then of its own accord, and without the least agency from the person holding it, assume the action of a pendulum, vibrating from side to side of the glass, and, after a few seconds, will strike the hour nearest to the time of day; for instance, if the time be twenty-five minutes past six, it will strike six; if thirty-five minutes past six, it will strike seven; and so on of any other hour.

It is necessary to observe, that the thread should lie over the pulse of the thumb, and this may in some measure account for the *vibration* of the shilling; but to what cause its striking the precise hour is to be traced, remains unexplained; for it is no less astonishing than true, that when it has struck the proper number, its vibration ceases, it acquires a kind of rotatory motion, and at last becomes stationary, as before.

Of Lightning, and the best Method of guarding against its mischievous Effects.

Experiments made in electricity first gave philosophers a suspicion, that the matter of lightning was the same with the electric matter. Experiments afterwards made on lightning obtained from the clouds by pointed rods, received into bottles, and subjected to every trial, have since proved this suspicion to be perfectly well founded; and that, whatever properties we find in electricity, are also the properties of lightning.

This matter of lightning, or of electricity, is an extreme subtle fluid, penetrating other bodies, and subsisting in them, equally diffused.

When, by any operation of art or nature, there happens to be a greater proportion of this fluid in one body than in another, the body which has most will communicate to that which has least, till the proportion becomes equal, provided the distance between them be not too great; or, if it be too great, till there be proper conductors to convey it from one to the other. [Pg 154]

If the communication be through the air, without any conductor, a bright light is seen between the bodies, and a sound is heard. In small experiments, we call this light and sound the electric spark and snap; but in the great operations of nature, the light is what we call *lightning*, and the sound (produced at the same time, though generally arriving later at our ears than the light does in our eyes) is, with its echoes, called *thunder*.

If the communication of this fluid be by a conductor, it may be without either light or sound, the subtle fluid passing in the substance of the conductor.

If the conductor be good, and of sufficient bigness, the fluid passes through it without hurting it. If otherwise, it is damaged or destroyed.

All metals, and water, are good conductors. Other bodies may become conductors by having some quantity of water in them, as wood and other materials used in building, but not having much water in them, are not good conductors, and therefore are often damaged in the operation.

Glass, wax, silk, wool, hair, feathers, and even wood perfectly dry, are non-conductors: that is, they resist instead of facilitating the passage of this subtle fluid.

When this fluid has an opportunity of passing through two conductors, one good and sufficient, as of metal, the other not so good, it passes in the best, and will follow in any direction.

The distance at which a body charged with this fluid will discharge itself suddenly, striking through the air into another body that is not charged, or not so highly charged, is different according to the quantity of the fluid, the dimensions and form of the bodies themselves, and the state of the air between them. This distance, whatever it happens to be between any two bodies, is called their striking *distance*, as, till they come within that distance of each other, no stroke will be made.

The clouds have often more of this fluid in proportion than the earth: in which case, as soon as they come near enough, (that is, within the striking distance,) or meet with a conductor, the fluid quits them and strikes into the earth. A cloud fully charged with this fluid, if so high as to be beyond the striking distance from the earth, passes quietly without making noise or giving light, [Pg 155] unless it meet with other clouds that have less.

Tall trees and lofty buildings, as the towers and spires of churches, become sometimes conductors between the clouds and the earth; but, not being good ones, that is, not conveying the fluid freely, they are often damaged.

Buildings that have their roofs covered with lead, or other metal, and spouts of metal continued from the roof into the ground to carry off the water, are never hurt by lightning, as, whenever it falls on such a building, it passes in the metals and not in the walls.

When other buildings happen to be within the striking distance from such clouds, the fluid passes in the walls, whether of wood, brick, or stone, quitting the wall only when it can find better conductors near them, as metal rods, bolts, and hinges of windows or doors, gilding on wainscot, or frames of pictures, the silvering on the backs of looking-glasses, the wires for bells, and the bodies of animals, so containing watery fluids. And in passing through the house it follows the direction of these conductors, taking as many in its way as can assist in its passage, whether in a straight or crooked line, leaping from one to the other, if not far distant from each other, only rending the wall in the spaces where these partial good conductors are too distant from each other.

An iron rod being placed on the outside of a building, from the highest part continued down into the moist earth, in any direction, straight or crooked, following the form of the roof or other parts of the building, will receive the lightning at its upper end, attracting it so as to prevent its striking any other part; and, affording it a good conveyance into the earth, will prevent its damaging any part of the building.

A small quantity of metal is found able to conduct a quantity of this fluid. A wire no higher than a goose-quill has been known to conduct (with safety to the building, as far as the wire was continued) a quantity of lightning that did prodigious damage both above and below it; and probably larger rods are not necessary, though it is common in America to make them of half an inch, some three-quarters, or an inch, diameter.

The rod may be fastened to the wall, chimney, &c., with staples of iron. The lightning will not

[Pg 156]

leave the rod (a good conductor) to pass into the wall (a bad conductor) through those staples. It would rather, if any were in the wall, pass out of it into the rod, to get more readily by that conductor into the earth.

If the building be very large and extensive, two or more rods may be placed in different parts, for greater security.

Small ragged parts of clouds, suspended in the air between the great body of clouds and the earth, (like leaf gold in electrical experiments,) often serve as partial conductors for the lightning, which proceeds from one of them to another, and by their help comes within the striking distance to the earth or a building. It therefore strikes, through those conductors, a building that would otherwise be out of the striking distance.

Long sharp points communicating with the earth, and presented to such parts of clouds, drawing silently from them the fluid they are charged with, they are then attracted to the cloud, and may leave the distance so great as to be beyond the reach of striking.

It is therefore that we elevate the upper end of the rod, six or eight feet above the highest part of the building, tapering it gradually to a fine sharp point, which is gilt, to prevent its rusting.

Thus the pointed rod either presents a stroke from the cloud, or if a stroke be made, conducts it to the earth, with safety to the building.

The lower end of the rod should enter the earth so deep as to come at the moist part, perhaps two or three feet; and if bent when under the surface, so as to go in a horizontal line six or eight feet from the wall, and then bent again downwards three or four feet, it will prevent damage to any of the stones of the foundation.

A person apprehensive of danger from lightning, happening during the time of thunder to be in a house not so secured, will do well to avoid sitting near the chimney, near a looking-glass, or any gilt pictures or wainscot; the safest place is in the middle of the room, (so it be not under a metal lustre suspended by a chain,) sitting in one chair and laying the feet up in another. It is still safer to bring two or three mattresses or beds into the middle of the room, and, folding them up double, place the chair upon them; for they, not being so good conductors as the walls, the lightning will not choose an interrupted course through the air of the room and the bedding, when it can go through a continued better conductor, the wall. But where it can be had, a hammock or swinging-bed, suspended by silk cords equally distant from the walls on every side, [Pg 157] and from the ceiling and floor above and below, affords the safest situation a person can have in any room whatever; and what, indeed, may be deemed quite free from danger of any stroke by lightning.

The Leech, a Prognosticator of the Weather.

Confine a leech in a large phial, three parts filled with rain water, regularly changed twice a week, and placed on a window frame, fronting the north. In fair and frosty weather it lies motionless, and rolled up in a spiral form, at the bottom of the glass: but prior to rain or snow, it creeps up to the top, where if the rain will be heavy and of some continuance, it remains a considerable time; if trifling, it quickly descends. Should the rain or snow be accompanied with wind, it darts about its habitation with amazing celerity, and seldom ceases until it begins to blow hard. If a storm of thunder or lightning be approaching, it is exceedingly agitated, and expresses its feelings in violent convulsive starts, at the top of the glass. It is remarkable that however fine and serene the weather may be, and not the least indication to change, either from the sky, the barometer, or any other cause whatsoever, yet, if the animal ever shift its position, or move in a desultory manner, so certain will the coincident results occur, within thirty-six hours, frequently within twenty-four, and sometimes in twelve; though its motions chiefly depend on the fall and duration of the wet, and the strength of the wind.

The Awn of Barley an Hydrometer.

The awn of barley is furnished with stiff points, which, like the teeth of a saw, are all turned towards the point of it; as this long awn lies upon the ground, it extends itself in the moist air of night, and pushes forward the barley-corn, which it adheres to in the day; it shortens as it dries; and, as these points prevent it from receding, it draws up its pointed end, and thus, creeping like a worm, will travel many feet from the parent stem. That very ingenious mechanic philosopher, Mr. Edgworth, once made on this principle a wooden automaton: its back consisted of soft fir-wood, about an inch square, and four feet long, made of pieces cut the cross-way in respect to the fibres of the wood, and glued together; it had two feet before, and two behind, which supported the back horizontally, but were placed with their extremities, which were armed with sharp [Pg 158] points of iron, bending backwards. Hence, in moist weather, the back lengthened, and the two foremost feet were pushed forwards; in dry weather the hinder feet were drawn after, as the obliquity of the points of the feet prevented it from receding.

The Power of Water when reduced to Vapour by Heat.

Whatever force water may have while its parts remain together, is nothing, if compared to the almost incredible power with which its parts are endued, when they are reduced to vapour by

heat. Those steams which we see rising from the surface of boiling water, and which to us appear feeble, yet, if properly conducted, acquire immense force. In the same manner as gunpowder has but small effect, if suffered to expand at large, so the steam issuing from water is impotent, where it is permitted to evaporate into the air; but where confined in a narrow compass, as, for instance, where it rises in an iron tube shut up on every side, it there exerts all the wonders of its strength. *Muschenbrook* has proved by experiment, that the force of gunpowder is feeble when compared to that of rising steam. A hundred and forty pounds of gunpowder blew up a weight of thirty thousand pounds: but, on the other hand, a hundred and forty pounds of water, converted by heat into steam, lifted a weight of seventy-seven thousand pounds; and would lift a much greater, if there were means of giving the steam more heat with safety; for the hotter the steam the greater is its force.

Artificial Memory.

In travelling along a road, the sight of the more remarkable scenes we meet with, frequently puts us in mind of the subjects we were thinking or talking of when we last saw them. Such facts, which were perfectly familiar, even to the vulgar, might very naturally suggest the possibility of assisting the memory, by establishing a connexion between the ideas we wish to remember, and certain sensible objects, which have been found from experience to make a permanent impression on the mind. It was said, that a person contrived a method of committing to memory the sermons which he was accustomed to hear, by fixing his attention, during the different heads of the discourse, on different compartments of the roof of the church, in such a manner as, that when he afterwards saw the roof, or remembered the order in which its compartments were disposed, he recollected the method which the preacher had observed in treating his subject. [Pg 159] This contrivance was perfectly analogous to the topical memory of the ancients; an art which, whatever be the opinion we entertain of its use, is certainly entitled, in a high degree, to the praise of ingenuity.

Suppose you fix in your memory the different apartments in some very large building, and that you had accustomed yourself to think of these apartments always in the same invariable order. Suppose further, that, in preparing yourself for a public discourse, in which you had occasion to treat of a great variety of particulars, you were anxious to fix in your memory the order you proposed to observe in the communication of your ideas. It is evident, that by a proper division of your subject into heads, and by connecting each head with a particular apartment, (which you could easily do, by conceiving yourself to be sitting in the apartment while you were studying the part of your discourse you mean to connect with it,) the habitual order in which these apartments occurred to your thoughts, would present to you in the proper arrangement, and without any effort on your part, the ideas of which you were to treat. It is also obvious, that very little practice would enable you to avail yourself of this contrivance, without any embarrassment or distraction of your attention.

To procure Hydrogen Gas.

Provide a phial with a cork stopper, through which is thrust a piece of tobacco-pipe. Into the phial put a few pieces of zinc, or small iron nails; on this pour a mixture, of equal parts of sulphuric acid (oil of vitriol) and water, previously mixed in a tea-cup, to prevent accidents. Replace the cork stopper, with a piece of tobacco-pipe in it; the hydrogen gas will then be liberated through the pipe into a small steam. Apply the flame of a candle or taper to this steam, and it will immediately take fire, and burn with a clear flame until all the hydrogen in the phial be exhausted. In this experiment the zinc or iron, by the action of the acid, becomes oxygenized, and is dissolved, thus taking the oxygen from the sulphuric acid and water; the hydrogen (the other constituent part of the water) is thereby liberated, and ascends.

To fill a Bladder with Hydrogen Gas.

Apply a bladder, previously wetted and compressed, in order to squeeze out all the common air, to the piece of tobacco-pipe inserted in the cork stopper of the phial, (as described in the [Pg 160] experiment above.) The bladder will thus be filled with hydrogen gas.

Exploding Gas Bubbles.

Adapt the end of a common tobacco-pipe to a bladder filled with hydrogen gas, and dip the bowl of the pipe into soap-suds, prepared as if for blowing up soap bubbles; squeeze out small portions of gas from the bladder into the soap-suds, and the bubbles will ascend into the air with very great rapidity, until they are out of sight. If a lighted taper or candle be applied to the bubbles as they ascend from the bowl of the pipe, they will explode with a loud noise.

Another Method.

Put a small quantity of phosphorus and some potash, dissolved in water, into a retort; apply the flame of a candle or lamp to the bottom of the retort, until the contents boil. The phosphuretted hydrogen gas will then rise, and may be collected in receivers. But it, instead of receiving the gas into a jar, you let it simply ascend into water, the bubbles of gas will then explode in succession,

as they reach the surface of the water, and a beautiful white smoke will be formed, which rises slowly and majestically to the ceiling. If bits of phosphorus are kept some hours in hydrogen gas, phosphorized hydrogen gas is produced: and if bubbles of this gas are thrown up into the receiver of an air-pump, previously filled with oxygen gas, a brilliant bluish flame will immediately fill the jar.

Singular Impression on the visual Nerves by a Luminous Object.

If, while sitting in a room, you look earnestly at the middle of a window, a little while, when the day is bright, and then shut your eyes, the figure of the window will still remain in your eye, and so distinct that you may count the panes. A remarkable circumstance attending this experiment is, that the impression of forms is better retained than that of colours; for, after the eyes are shut, when you first discern the image of the window, the panes appear dark, and the cross-bars of the sashes, with the window frames and walls, appear white and bright; but if you still add to the darkness of the eyes, by covering them with your hand, the reverse instantly takes place—the panes appear luminous, and the cross-bars dark; and by removing the hand, they are again reversed. [Pg 161]

Curious Effects of Oil upon Water, and Water upon Oil.

Fasten a piece of pack-thread round a tumbler, with strings of the same from each side, meeting above it in a knot at about a foot distance from the top of the tumbler. Then putting in as much water as will fill about one-third part of the tumbler, lift it up by the knot, and swing it to and fro in the air; the water will keep its place as steadily in the glass as if it were ice. But pour gently in upon the water about as much oil, and then again swing it in the air as before, the tranquillity before possessed by the water will be transferred to the surface of the oil, and the water under it will be violently agitated.

Another curious Experiment with Oil and Water.

Drop a small quantity of oil into water agitated by the wind; it will immediately spread itself with surprising swiftness upon the surface, and the oil, though scarcely more than a tea-spoonful, will produce an instant calm over a space several yards square. It should be done on the windward side of the pond or river, and you will observe it extend to the size of nearly half an acre, making it appear as smooth as a looking-glass. One remarkable circumstance in this experiment is the sudden, wide, and forcible spreading of a drop of oil on the surface of the water; for if a drop of oil be put upon a highly polished marble table, or a looking-glass, laid horizontally, the drop remains in its place, spreading very little, but when dropped on water it spreads instantly many feet round, becoming so thin as to produce the prismatic colours for a considerable space, and beyond them so much thinner as to be invisible, except in its effect in smoothing the waves at a much greater distance. It seems as if a repulsion of its particles took place as soon as it touched the water, and so strong as to act on other bodies swimming on the surface, as straw, leaves, chips, &c., forcing them to recede every way from the drop, as from a centre, leaving a large clear space.

Remarkable Effects on the visual Nerves, by looking through differently-coloured Glasses.

After looking through green spectacles, the white paper of a book will, on first taking them off, appear to have a blush of red; and after looking through red glasses, a greenish cast. This seems to intimate a relation between green and red, not yet explained. [Pg 162]

Weather Table.

NEW AND FULL MOON.	SUMMER.	WINTER.
If the new or full moon enters into the first or last quarter of the hour of 12 at noon ..	Very rainy	Snow and rain.
If between the hours of .... (P.M.) 2 and 4	Changeable	Fair and mild.
4 and 6	Fair	Fair.
6 and 8	Fair, if wind at N.W. ... / Rainy, if wind at S. or S.W.	Fair and frosty, if wind at N. or N.E. / Rain or snow, if S. or S.W.
8 and 10	Ditto	Ditto.
10	Fair	Fair and frosty.
(A.M.) 2	Ditto	Hard frost, unless wind S.S.W.
2 and 4	Cold, with frequent showers	
4 and 6	Rain	Ditto, ditto.
6 and 8	Wind and Rain	Stormy weather.
8 and 10	Changeable	Cold and rain, if wind N.; snow if E.
10 and 12	Frequent showers	Cold, with high wind.

A COMPLETE [Pg 163]

SYSTEM OF PYROTECHNY;

OR THE

ART OF MAKING FIRE-WORKS.

In the art of making fire-works, great attention must be paid to the well-mixing of the materials—without which all labour is thrown away; to the purity of the articles; and to the proper quantities of each. Sulphur, to be good, must be of a high colour, and crack and bounce when held in the hand. For small fire-works, such as may be bought in the flour will be found quite good enough, but for the larger kinds, the lump brimstone ground is preferable.

Benzoin is used in fire-works, more for its pleasant scent than any material use for the purposes of fire. It may be procured at the chemists, ready for use. The oil is also used in wet composition, for stars, &c.

Of Sulphur, or Brimstone.

Sulphur is by nature the food of fire, and one of the principal ingredients in gunpowder, and in almost all compositions of fire-works; therefore, great care ought to be taken of its being good, and brought to the highest perfection. Now, to know when the sulphur is good, you are to observe that it be of a high yellow; and if, when held in one's hand, it crackles and bounces, it is a sign that it is fresh and good: but as the method of reducing brimstone to a powder is very troublesome, it is better to buy the flour ready made, which is done in large quantities, and in great perfection; but when a great quantity of fire-works is to be made, it is best to use the lump brimstone ground, in the same manner as gunpowder. [Pg 164]

Of Saltpetre.

Saltpetre being the principal ingredient in fire-works, and a volatile body by reason of its aqueous and aërial parts, is easily rarefied by fire; but not so soon when foul and gross, as when purified from its gross and earthy parts, which greatly retard its velocity; therefore, when any quantity of fire-works is intended to be made, it would be necessary first to examine the saltpetre; for if it be not well cleansed from all impurities, and of a good sort, your works will not have their proper effect.

To pulverize Saltpetre.

Take a copper kettle, the bottom being spherical, and put into it fourteen pounds of refined saltpetre, with two quarts or five pints of clean water; then put the kettle on a slow fire, and when the saltpetre is dissolved, if any impurities arise, skim them off, and keep constantly stirring it with two large spatulas, till all the water exhales; and when done enough, it will appear like white sand, and as fine as flour; but if it should boil too fast, take the kettle off the fire, and

set it on some wet sand, which will prevent the nitre from sticking to the kettle. When you have pulverized a quantity of saltpetre, be careful to keep it in a dry place.

To prepare Charcoal for Fire-works.

Charcoal is a preservative, by which the saltpetre and brimstone are made into gunpowder, by preventing the sulphur from suffocating the strong and windy exhalation of the nitre. There are several sorts of wood made use of for this purpose; some prefer hazel, others willow, and others alder. The method of burning the wood is this: cut it in pieces of two or three feet long, then slit each piece in four parts; scale off the bark and hard knots, and dry them in the sun, or in an oven; then make in the earth a square hole, and line it with bricks, in which lay the wood crossing one another, and set it on fire; when thoroughly lighted, and in a flame, cover the whole with boards, and fling earth over them close, to prevent the air from getting in, yet so as not to fall among the charcoal; and when it has lain thus for twenty-four hours, take out the coals and lay [Pg 165] them in a dry place for use. It is to be observed, that charcoal for fire-works must always be soft and well burnt, which may be bought ready done.

Of Gunpowder, &c.

Gunpowder being a principal ingredient in fire-works, it will not be improper to give a short definition of its strange explosive force, and cause of action, which, according to Dr. Shaw's opinion of the chemical cause of the explosive force of gunpowder, is as follows:—"Each grain of gunpowder consisting of a certain proportion of sulphur, nitre, and coal, the coal presently taking fire, upon contact of the smallest spark; at which time both the sulphur and the nitre immediately melt, and by means of the coal interposed between them, burst into flame; which spreading from grain to grain, propagates the same effect almost instantaneously, whence the whole mass of powder comes to be fired; and as nitre contains a large proportion both of air and water, which are now violently rarefied by the heat, a kind of fiery explosive blast is thus produced, wherein the nitre seems, by its aqueous and aërial parts, to act as bellows to the other inflammable bodies (sulphur and coal) to blow them into a flame, and carry off their whole substance in smoke and vapour."

How to meal Gunpowder, Brimstone, and Charcoal.

There have been many methods used to grind these ingredients to a powder for fire-works, such as large mortars and pestles made of ebony, and other hard woods; but none of these methods have proved so effectual and speedy as the last invention, that of the mealing table. This table is made of elm, with a rim round its edge four or five inches high; and at the narrow end is a slider which runs in a groove and forms part of the rim; so that when you have taken out of the table as much powder as you conveniently can, with a copper shovel, you may sweep all clean out at the slider. When you are going to meal a quantity of powder, observe not to put too much on the table at once; but when you have put in a good proportion, take a muller and rub it therewith till all the grains are broken; sift it in a lawn sieve, that has a receiver and top to it; and that which does not pass through the sieve, return again to the table and grind it more, till you have brought [Pg 166] it all fine enough to go through the sieve. Brimstone and charcoal are ground in the same manner as gunpowder, only the muller must be made of ebony, for these ingredients being harder than powder, would stick in the grain of the elm and be very difficult to grind; and as the brimstone is apt to stick and clog to the table, it would be best to keep one for that purpose only, by which means you will always have your brimstone clean and well ground.

Spur Fire.

This fire is the most beautiful of any composition yet known. As it requires great trouble to bring it to perfection, particular care must be paid to the following instructions. They are made generally in cases about six inches long, but not driven very hard.

CHARGE.	*lb.*	*oz.*		CHARGE.	*lb.*	*oz.*
Saltpetre	4	0		Saltpetre	1	0
Sulphur	2	0	or	Sulphur	0	8
Lamp-black	1	8		Lamp-black	4 quarts.	

This composition is very difficult to mix. The saltpetre and brimstone must be first sifted together, and then put into a marble mortar, and the lamp-black with them, which you work down by degrees with a wooden pestle, till all the ingredients appear of one colour, which will be something greyish, but very near black; then drive a little into a case for trial, and fire it in a dark place; and if the sparks, which are called stars or pinks, come out in clusters, and afterwards spread well without any other sparks, it is a sign of its being good, otherwise, not; for if any drossy sparks appear, and the stars not full, it is then not mixed enough; but if the pinks are very small, and soon break, it is a sign that you have rubbed it too much.

This mixture, when rubbed too much, will be too fierce, and hardly show any stars; and, on the contrary, when not mixed enough, will be too weak, and throw out an obscure smoke, and lumps of dross, without any stars. The reason of this charge being called the spur fire is, because the sparks it yields have a great resemblance to the rowel of a spur, from whence it takes its name.

As the beauty of this composition cannot be seen at so great a distance as brilliant fire, it has a better effect in a room than in the open air, and may be fired in a chamber without any danger; it is of so innocent a nature, that, although an improper phrase, it may be called a cold fire; and so extraordinary is the fire produced from this composition, that, if well made, the sparks will not burn a handkerchief when held in the midst of them; you may hold them in your hand while burning, with as much safety as a candle; and if you put your hand within a foot of the case, you will feel the sparks fall like drops of rain. [Pg 167]

To make Touch Paper.

Dissolve in some spirits of wine or vinegar, a little saltpetre; then take some purple or blue paper, wet it with the above liquor, and when dry it will be fit for use. When you paste this paper on any of your works, take care that the paste does not touch that part which is to burn.

The method of using this paper is, by cutting it into slips, long enough to go once round the mouth of the serpent, cracker, &c. When you paste on these slips, leave a little, above the mouth of the case, not pasted; then prime the case with meal-powder (see p. 165) and twist the paper to a point.

Of such Ingredients as show themselves in Sparks, when rammed into choked Cases.

The set colours of fire produced by sparks are divided into four sorts, viz., the black, white, grey, and red; the black charges are composed of two ingredients, which are meal-powder and charcoal; the white of three, viz., saltpetre, sulphur, and charcoal; the grey of four, viz., meal-powder, saltpetre, brimstone, and charcoal; and the red of three, viz., meal-powder, charcoal, and saw-dust.

There are, besides these four regular or set charges, two others which are distinguished by the names of compound and brilliant charges; the compound charge being made of many ingredients, such as meal-powder, saltpetre, brimstone, charcoal, saw-dust, sea-coal, antimony, glass-dust, brass-dust, steel-filings, cast-iron, tanners' dust, &c., or any thing that will yield sparks; all which must be managed with discretion. The brilliant fires are composed of meal-powder, saltpetre, brimstone, and steel-dust; or with meal-powder, and steel-filings only. [Pg 168]

Of the Method of mixing Compositions.

The performance of the principal part of fire-works depends much on the compositions being well mixed; therefore, great care ought to be taken in this part of the work, particularly in the composition for sky-rockets. When you have four or five pounds of ingredients to mix, which is a sufficient quantity at a time, (for a larger proportion will not do so well,) first put the different ingredients together, then work them about with your hands, till you think they are pretty well incorporated: after which, put them into a lawn sieve with a receiver and top to it; and if, after it is sifted, any should remain that will not pass through the sieve, grind it again till fine enough; and if it be twice sifted it will not be amiss; but the compositions for wheels and common works are not so material, nor need be so fine. But in all fixed works, from which the fire is to play regular, the ingredients must be very fine, and great care taken in mixing them well together: and observe, that, in all compositions wherein are steel or iron filings, the hands must not touch; nor will any works which have iron or steel in their charge, keep long in damp weather, without being properly prepared, according to the following directions:—

It may sometimes happen, that fire-works may be required to be kept a long time, or sent abroad; neither of which could be done with brilliant fires, if made with filings unprepared; for this reason, that the saltpetre being of a damp nature, it causes the iron to rust, the natural consequence of which is, that when the works are fired, there will appear but very few brilliant sparks, but instead of them a number of red and drossy sparks; and besides, the charge will be so much weakened, that if this should happen to wheels, the fire will not be strong enough to force them round; to prevent such accidents, prepare your filings after the following manner:—Melt in a glazed earthen pan some brimstone over a slow fire, and when melted, throw in some filings, which keep stirring about till they are covered with brimstone; this you must do while it is on the fire; then take it off, and stir it very quick till cold, when you must roll it on a board with a wooden roller, till you have broken it as fine as corn powder; after which, sift from it as much of the brimstone as you can. There is another method of preparing filings, so as to keep two or three months in winter; this may be done by rubbing them between the strongest sort of brown paper, which has been previously moistened with linseed oil. [Pg 169]

N.B. If the brimstone should take fire, you may put it out, by covering the pan close at top. It is not of much consequence what quantity of brimstone you use, provided there is enough to give each grain of iron a coat; but as much as will cover the bottom of a pan of about one foot diameter, will do for five or six pounds of filings. Cast-iron for gerbes will be preserved by the above method.

To make Crackers.

Cut some stout cartridge-paper into pieces three inches and a half broad, and one foot long; one edge of each of these pieces fold down lengthwise about three-quarters of an inch broad; then

fold the double edge down a quarter of an inch, and turn the single edge back half over the double fold; open it, and lay all along the channel, which is formed by the foldings of the paper, some meal-powder; then fold it over and over till all the paper is doubled up, rubbing it down every turn; this being done, bend it backwards and forwards, two inches and a half or thereabouts, at a time, as often as the paper will allow; hold all these folds flat and close, and with a small pinching cord, give one turn round the middle of the cracker, and pinch it close; bind it with packthread, as tight as you can; then in the place where it was pinched, prime one end, and cap it with touch-paper. When these crackers are fired, they will give a report at every turn of the paper; if you would have a great number of bounces, you must cut the paper longer, or join them after they are made; but if they are made very long before they are pinched, you must have a piece of wood with a groove in it, deep enough to let in half the cracker; this will hold it straight while it is pinching.

To make Squibs and Serpents.

First make the cases, of about six inches in length, by rolling slips of stout cartridge-paper three times round a roller, and pasting the last fold; tying it near the bottom as tight as possible, and making it air-tight at the end, by sealing-wax. Then take of gunpowder half a pound, charcoal one ounce, brimstone one ounce, and steel-filings half an ounce, (or in like proportion,) grind them with a muller, or pound them in a mortar. Your cases being dry and ready, first put a thimble-full [Pg 170] of your powder, and ram it hard down with a ruler; then fill the case to the top with the aforesaid mixture, ramming it hard down in the course of filling, two or three times; when this is done point with touch-paper, which should be pasted on that part which touches the case, otherwise it is liable to drop off.

Sky-Rockets.

Rockets being of the fire-works most in use, we shall give them the preference in description. As the performance of rockets depends much upon their moulds, they should be made according to the following proportions:—Taking the diameter of the orifice, its height should be equal to six diameters and two-thirds: the choke, one diameter and one-third of this model, will serve for every rocket from 4 oz. to 6 lb.—For instance:—suppose the diameter of a rocket of 1 lb. be 1½ inch, then its length being 6 diameters and two-thirds, the length of the case must be 10⅓ inches, and the choke 2¼ inches. Your rammer must have a collar of brass, to prevent the wood from splitting.

Method of rolling Rocket Cases.—The cases must be made of the strongest cartridge-paper, and rolled dry. The case of a middling-sized rocket will take up paper of four or five sheets thick; having cut your papers to a proper size, and the last sheet with a slope at one end, fold down one end, and lay your former on the double edge, and when you have rolled on the paper within two or three turns, lay the next sheet on that part which is loose, and roll it all on. Then, in order to roll the case as hard as possible, place it on a table, and with a smooth board roll it for some time forwards on the table, till it becomes quite hard and firm. This must be done with every sheet. You have next to choke the case; for which purpose draw your former a little distance from the bottom, then, with a cord, once round the case, pull it rather easy at first, and harder, till you have closed the end. To make it easy, you may dip the ends of the inner sheets in water before rolling, then bind it with small twine.

Having thus pinched and tied the case so as not to give way, put it into the mould without its foot, and with a mallet drive the former hard on the end-piece, which will force the neck close and smooth. This done, cut the case to its proper length, allowing from the neck to the edge of the [Pg 171] mouth half a diameter, which is equal to the height of the nipple; then take out the former, and drive the case over the piercer with a long rammer, and the vent will be of a proper size.

Having formed your cases, we will now proceed to the description of the ingredients necessary for the rocket.

Of mixing the Composition.—The performance of the principal part of fire-works depends much on the compositions being well mixed; therefore, great care must be taken in this part of the work, particularly for the composition for sky-rockets. When you have four or five pounds of ingredients to mix, which is a sufficient quantity at a time, (for a large proportion will not do so well,) first put the different ingredients together, then work them about with your hands, till you think they are pretty well incorporated; after which, put them into a lawn sieve with a receiver and top to it; and if, after it is sifted, any remains that will not pass through the sieve, grind it again till it is fine enough; and if it be twice sifted it will not be amiss; but the compositions for wheels and common works are not so material, nor need be so fine. But in all fixed works, from which the fire is to play regular, the ingredients must be very fine, and great care taken in mixing them well together; and observe, that in all compositions wherein are iron filings, the hand must not touch them; nor will any works which have iron or steel in their charge keep long in damp weather.

To drive or ram Rockets.—Rockets are filled hollow, otherwise they would not ascend, and there is not a part that requires greater attention than this stage of the process. One blow more or less with the mallet will spoil the ascent.

The charge of rockets must always be driven above the piercer, and on it must be rammed a thin

head of clay; through the middle of which bore a small hole to the composition, that when the charge is burnt to the top, it may communicate its fire through the hole to the stars in the head. To a rocket of four ounces, give to each ladle-full of charge 16 strokes; to a rocket of 1 lb., 28; to a 2-pounder, 36; to a 4-pounder, 42; and to a 6-pounder, 56; but rockets of a larger sort cannot be driven well by hand, but must be rammed with a machine made in the same manner as those for driving piles.

The method of ramming wheel cases, or any other sort in which the charge is driven solid, is the same as sky-rockets.

When you load the heads of your rockets with stars, rains, serpents, crackers, scrolls, or any thing else, according to your fancy, remember always to put a ladle-full of meal-powder into each head, which will be enough to burst the head and disperse the stars, or whatever it contains. [Pg 172]

Decorations for Sky-rockets.—Sky-rockets may be decorated according to fancy. Some are headed with stars of different sorts, such as tailed, brilliant, white, blue, and yellow stars, &c. Some with gold and silver rains; others with serpents, crackers, fire-scrolls, and marrons; and some with small rockets and other devices, as the maker pleases.

LENGTH OF ROCKET-STICKS.

For rockets of	lb.	oz.	the stick must be	ft.	in.	long
4	0		12	10		
2	0		9	4		
1	0		8	2		
0	8		6	6		
0	4		5	3		

Having your sticks ready, cut on one of the flat sides at the top a groove the length of the rocket, and as broad as the stick will allow; then on the opposite flat side cut two notches, for the cord which ties on the rocket to lie in; one of these notches must be near the top of the stick, and the other facing the neck of the rocket; the distance between these notches may be easily known, for the top of the stick should always touch the head of the rocket. When your rockets and sticks are ready, lay the rockets in the grooves in the sticks, and tie them on. We will now proceed to the charge for sky-rockets.

ROCKETS OF FOUR OUNCES.

	lb.	oz.
Meal-powder	1	4
Saltpetre	0	4
Charcoal	0	2

ROCKETS OF EIGHT OUNCES.

	lb.	oz.
Meal-powder	1	0
Saltpetre	0	4
Brimstone	0	3
Charcoal	0	1½

ONE POUND.

	lb.	oz.
Meal-powder	2	0
Saltpetre	0	8
Brimstone	0	4
Charcoal	0	2
Steel-filings	0	1½

[Pg 173]

SKY-ROCKETS IN GENERAL.

	lb.	oz.
Saltpetre	4	0
Brimstone	1½	0
Charcoal	1	12
Meal-powder	0	2

LARGE SKY-ROCKETS.

	lb.	oz.

	lb.	oz.
Saltpetre	4	0
Meal-powder	1	0
Brimstone	1	0

ROCKETS OF A MIDDLING SIZE.

	lb.	oz.
Meal-powder	1	0
Charcoal	1	0
Saltpetre	3	0
Sulphur	2	0

ROCKET STARS.

WHITE STARS.

	lb.	oz.
Meal-powder	0	4
Saltpetre	0	12
Sulphur vivum	0	6
Oil of spike	0	2
Camphor	0	5

BLUE STARS.

	lb.	oz.
Meal-powder	0	8
Saltpetre	0	4
Sulphur	0	2
Spirits of wine	0	2
Oil of spike	0	2

VARIEGATED STARS.

	lb.	oz.
Meal-powder	0	3½
Saltpetre	0	4
Sulphur vivum	0	2
Camphor	0	2

BRILLIANT STARS.

	lb.	oz.
Saltpetre	0	8½
Sulphur	0	1½
Meal-powder	0	0¾

Worked up with spirits of wine only.

COMMON STARS.

	lb.	oz.
Saltpetre	1	0
Brimstone	0	4
Antimony	0	4¾
Isinglass	0	0½
Camphor	0	0¼
Spirits of wine	0	0¼

[Pg 174]

TAILED STARS.

	lb.	oz.
Meal-powder	0	2
Brimstone	0	2
Saltpetre	0	2
Charcoal (coarsely ground)	0	0¾

STARS OF A FINE COLOUR.

	lb.	oz.
Sulphur	0	1
Meal-powder	0	1
Saltpetre	0	1
Camphor	0	0¼
Oil of turpentine	0	0¼

RAINS.

GOLD RAIN FOR SKY-ROCKETS.

	lb.	oz.
Saltpetre	0	8
Brimstone	0	2
Glass-dust	0	1
Antimony	0	0¾
Brass-dust	0	0¼
Saw-dust	0	0¼

SILVER RAIN.

	lb.	oz.
Saltpetre	0	8
Brimstone	0	2
Charcoal	0	4
Steel-dust	0	0¼

To fix one Rocket on the top of another.—When sky-rockets are fixed one on the top of another, they are called *towering rockets*, on account of their mounting so very high. Towering rockets are made after this manner: Fix on a pound rocket a head without a collar; then take a four-ounce rocket, which may be headed or bounced, and rub the mouth of it with meal-powder wetted with spirit of wine: this done, put it in the head of a large rocket with its mouth downwards; but before it is put in, stick a bit of quick-match in the hole of the clay of the pound rocket, which match should be long enough to go a little way up the bore of the small rocket, to fire it when the large rocket is burnt out. As the four-ounce rocket is too small to fill the head of the other, roll round it as much tow as will make it stand upright in the centre of the head: the rocket being thus fixed, paste a single paper round the opening of the top of the head of the large rocket. The large rocket must have only half a diameter of charge rammed above the piercer; for, if filled to the usual height, it would turn before the small one takes fire, and entirely destroy the intended [Pg 175] effect: when one rocket is headed with another, there will be no occasion for any blowing powder; for the force with which it goes off will be sufficient to disengage it from the head of the first fired rocket. The sticks for these rockets must be a little longer than for those headed with stars, rains, &c.

Caduceous Rockets.—They are such as, in rising, form two spiral lines, by reason of their being placed obliquely, one opposite to the other; and their counterpoise in the centre, which causes them to rise in a vertical direction. Rockets for this purpose must have their ends choked close, without either head or bounce; for a weight at the top would be a great obstruction to their mounting. No caduceous rockets ascend so high as single, because of their serpentine motion, and likewise the resistance of air, which is much greater than two rockets of the same size would meet with if fired singly.

The sticks for this purpose must have all their sides equal, and the sides should be equal to the breadth of a stick proper for a sky-rocket of the same weight as those you intend to use, and made to taper downwards as usual, long enough to balance them, one length of a rocket from the cross stick, which must be placed from the large stick six diameters of one of the rockets, and its length seven diameters; so that each rocket, when tied on, may form, with the large stick, an angle of 60 degrees. In tying on the rockets, place their heads on the opposite side of the cross stick; then carry a leader from the mouth of one into that of the other. When these rockets are to be fired, suspend them between two hooks, or nails, then burn the leader through the middle, and both will take fire at the same time. Rockets of 1 lb. are a good size for this use.

Honorary Rockets.—These are the same as sky-rockets, except that they carry no head nor report, but are closed at top, on which is fixed a cone; then on the case, close to the top of the stick, is tied on a two-ounce case, about five or six inches long, filled with a strong charge, and pinched close at both ends; then in the reverse side, at each end, bore a hole in the same manner as in tourbillons, to be presently described; from each hole carry a leader into the top of the rocket. When the rocket is fired, and arrived to its proper height, it will give fire to the case at top; which will cause both rocket and stick to spin very fast in their return, and represent a worm of fire descending to the ground. [Pg 176]

There is another method of placing the small case, which is by letting the stick rise a little above the top of the rocket, and tying the case to it, so as to rest on the rocket: these rockets have no

cones.

A third method by which they are managed is this: in the top of a rocket fix a piece of wood, in which drive a small iron spindle; then make a hole in the middle of the small case, through which is put the spindle; then fix on the top of it a nut, to keep the case from falling off; when this is done, the case will turn very fast, without the rocket: but this method does not answer so well as either of the former.

To make a Rocket form an Arch in rising.—Having some rockets made, headed according to fancy, and tied on their sticks, get some sheet tin, and cut it into round pieces about three or four inches diameter; then on the stick of each rocket, under the mouth of the case, fix one of these pieces of tin 16 inches from the rocket's neck, and support it by a wooden bracket, as strong as possible: the use of this is, that when the rocket is ascending, the fire may play with greater force on the tin, which will divide the tail in such a manner that it will form an arch as it mounts, and will have a very good effect when well managed; if there is a short piece of port fire, of a strong charge, tied to the end of the stick, it will make a great addition; but this must be lighted before the rocket is fired.

To make several Rockets rise together.—Take six, or any number of sky-rockets, of any size; then cut some strong packthread into pieces of three or four yards long, and tie each end of these pieces to a rocket in this manner:

Having tied one end of the packthread round the body of one rocket, and the other end to another, take a second piece of packthread, and make one end of it fast to one of the rockets already tied, and the other end to a third rocket, so that all the rockets, except the two on the outside, will be fastened to the two pieces of packthread: the length of thread from one rocket to the other may be what the maker pleases; but the rockets must be all of a size, and their heads filled with the same weight of stars, rains, &c.

Having thus done, fix in the mouth of each rocket a leader of the same length; and when about to fire them, hang them almost close; then tie the ends of the leaders together, and prime them; this prime being fired, all the rockets will mount at the same time, and divide as far as the strings will allow; and this division they keep, provided they are all rammed alike, and well made. They are [Pg 177] sometimes called chained rockets.

To fix several Rockets to the same Stick.—Two, three, or six sky-rockets, fixed on one stick, and fired together, make a grand and beautiful appearance; for the tails of all will seem but as one of an immense size, and the breaking of so many heads at once will resemble the bursting of an air-balloon. The management of this device requires a skilful hand; but if the following instructions be well observed, even by those who have not made a great progress in this art, there will be no doubt of the rockets having the desired effect.

Rockets for this purpose must be made with the greatest exactness, all rammed by the same hand, in the same mould, and filled with the same proportion of composition: and after they are filled and headed, must all be of the same weight. The stick must also be well made (and proportioned) to the following directions; first, supposing the rockets to be half-pounders, whose sticks are six feet six inches long, then if two, three, or six of these are to be fixed on one stick, let the length of it be nine feet nine inches; then cut the top of it into as many sides as there are rockets, and let the length of each side be equal to the length of one of the rockets without its head; and in each side cut a groove (as usual;) then from the grooves plane it round, down to the bottom, where its thickness must be equal to half the top of the round part. As their thickness cannot be exactly ascertained, we shall give a rule, which generally answers for any number of rockets above two; the rule is this: that the stick at top must be thick enough, when the grooves are cut, for all the rockets to lie, without pressing each other, though as near as possible.

When only two rockets are to be fixed on one stick, let the length of the stick be the last given proportion, but shaped after the common method, and the breadth and thickness double the usual dimensions. The point of poise must be in the usual place (let the number of rockets be what it will;) if sticks made by the above directions should be too heavy, plane them thinner; and if too light, make them thicker; but always make them of the same length.

When more than two rockets are tied on one stick, there will be some danger of their flying up without the stick, unless the following precaution is taken: For cases being placed on all sides, there can be no notches for the cord which ties on the rockets to lie in: therefore, instead of notches, drive a small nail in each side of the stick, between the necks of the cases, and let the [Pg 178] cord, which goes round their necks, be brought close under the nails; by this means the rockets will be as secure as when tied on singly. The rockets being thus fixed, carry a quick-match, without a pipe, from the mouth of one rocket to the other; this match being lighted will give fire to all at once.

Though the directions already given may be sufficient for these rockets, we shall here add an improvement on a very essential part of this device, which is, that of hanging the rockets to be fired; for before the following method was contrived, many attempts proved unsuccessful. Instead, therefore, of the old and common manner of hanging them on nails or hooks, make use of the following contrivance: Have a ring made of strong iron wire, large enough for the stick to go in as far as the mouths of the rockets; then have another ring supported by a small iron, at some distance from the post or stand to which it is fixed; then have another ring fit to receive and guide the small end of the stick. Rockets thus suspended will have nothing to obstruct their fire;

but when they are hung on nails or hooks, in such a manner that some of their mouths or against or upon a rail, there can be no certainty of their rising in a vertical direction.

To fire Rockets without Sticks.—You must have a stand, of a block of wood, a foot diameter, and make the bottom flat, so that it may stand steady: in the centre of the top of this block draw a circle two inches and a half diameter, and divide the circumference of it into three equal parts; then take three pieces of thick iron wire, each about three feet long, and drive them into the block, one at each point made on the circle; when these wires are driven in deep enough to hold them fast and upright, so that the distance from one to the other is the same at top as at bottom, the stand is complete.

The stand being thus made, prepare the rockets thus: Take some common sky-rockets of any size, and head them as you please; then get some balls of lead, and tie to each a small wire two or two feet and a half long, and the other end of each wire tie to the neck of a rocket. These balls answer the purpose of sticks, when made of a proper weight, which is about two-thirds the weight of the rocket; but when they are of a proper size, they will balance the rocket in the same manner as a stick, at the usual point of poise. To fire these, hand them one at a time, between the tops of the wires, letting their heads rest on the point of the wires, and the balls hang down between them: if [Pg 179] the wires should be too wide for the rockets, press them together till they fit; and if too close, force them open; the wires for this purpose must be softened, so as not to have any spring, or they will not keep their position when pressed close or opened.

Scrolls for Rockets.—Cases for scrolls should be made four or five inches in length, and their interior diameters three-eighths of an inch: one end of these cases must be pinched quite close before beginning to fill; and when filled, close the other end; then in the opposite sides make a small hole at each end, to the composition, as in tourbillons, and prime them with wet meal-powder. You may put in the head of the rocket as many of these cases as it will contain: being fired, they turn very quick in the air, and form a scroll or spiral line. They are generally filled with a strong charge, as that of serpents or brilliant fire.

Stands for Rockets.—Care must be taken, in placing the rockets, when they are to be fired, to give them a vertical direction at their first setting out; which may be managed thus: Have two rails of wood, of any length, supported at each end by a perpendicular leg, so that the rails may be horizontal, and let the distance from one to the other be almost equal to the length of the sticks of the rockets intended to be fired; then in the front of the top rail drive square hooks at eight inches distance, with their points turned sidewise, so that when the rockets are hung on them, the points will be before the sticks, and keep them from falling or being blown off by the wind; in the front of the rail at bottom must be staples, driven perpendicularly under the hooks at top; through these staples put the small ends of the rocket-sticks. Rockets are fired by applying a lighted port-fire to their mouths.

Table-Rockets.—Table-rockets are designed merely to show the truth of driving, and the judgment of a fire-worker; they having no other effect, when fired, than spinning round in the same place where they began, till they are burnt out, and showing nothing more than a horizontal circle of fire.

The method of making these rockets is thus:—Have a cone turned out of hard wood two inches and a half in diameter, and as much high; round the base of it drive a line; on this line fix four spokes, each two inches long, so as to stand one opposite the other; then fill four nine-inch one-pound cases with any strong composition, within two inches of the top: these cases are made like [Pg 180] tourbillons, and must be rammed with the greatest exactness.

The rockets being filled, fix their open ends on the short spokes; then in the side of each case bore a hole near the clay; all these holes, or vents, must be so made that the fire of each case may act the same way; from these vents carry leaders to the top of the cone, and tie them together. When the rockets are to be fired, set them on a smooth table, and light the leaders in the middle, and all the cases will fire together and spin on the point of the cone.

These rockets may be made to rise like tourbillons, by making the cases shorter, and boring four holes in the under side of each at equal distances; this being done they are called *double tourbillons*.

Note.—All the vents in the under side of the cases must be lighted at once, and the sharp point of the cone cut off; at which place make it spherical.

WHEELS.

Wheel-cases are made to any length; which must always depend on the size of the wheel, but must not exceed the length of each angle.

Charge for wheel-cases, from 2 oz. to 4 lb.

	lb.	oz.
Meal-powder	4	0
Saltpetre	1	0
Brimstone	0	8
Charcoal	0	4

The filings in this composition may be varied by using a portion of sea-coal, glass-dust, saw-dust, &c., or a combination of the whole.

SLOW FIRE FOR WHEELS.

	lb.	oz.
Saltpetre	0	4
Brimstone	0	2
Meal-powder	0	1½

or, 1 oz. of brimstone may be used with 1 oz. of antimony.

DEAD FIRE FOR WHEELS.

	oz.	dr.
Saltpetre	4¼	0
Brimstone	0¼	0
Lapis-caliminaris	0	2
Antimony	0	2

Single Vertical Wheels.—There are different sorts of vertical wheels; some having their fells of a circular form, others of an hexagonal, octagonal, or decagonal form, or of any number of sides, [Pg 181] according to the length of the cases you design for the wheel; the spokes being fixed in the nave, nail slips of tin, with their edges turned up so as to form grooves for the cases to lie in; form the end of one spoke to that of another; then tie the cases in the grooves head to tail, in the same manner as those on the horizontal water-wheel; so that the cases, successively taking fire from one another, will keep the wheel in an equal rotation. Two of these wheels are very often fired together, one on each side of a building, and both lighted at the same time, and all the cases filled alike, to make them keep time together; as they will, if made by the following directions: In all the cases of both wheels, except the first, on each wheel drive two or three ladlesful of slow fire, in any part of the case; but be careful to ram the same quantity in each case; and in the end of one of the cases, on each wheel, you may ram one ladleful of dead-fire composition, which must be very lightly driven; you may also make many changes of fire by this method.

Let the hole in the nave of the wheel be lined with brass, and made to turn on a smooth iron spindle. On the end of this spindle let there be a nut, to screw off and on; when you have put the wheel on the spindle, screw on the nut, which will keep the wheel from flying off. Let the mouth of the first case be a little raised. Vertical wheels are made from ten inches to three feet diameter, and the size of the cases must differ accordingly; four-ounce cases will do for wheels of 14 or 16 inches diameter, which is the proportion generally used. The best wood for wheels of all sorts is a light and dry beech.

Horizontal Wheels.—They are best when their fells are made circular; in the middle of the top of the nave must be a pintle, turned out of the same piece as the nave, two inches long, and equal in diameter to the bore of one of the cases of the wheel; there must be a hole bored up the centre of the nave, within half an inch of the top of the pintle. The wheel being made; nail at the end of each spoke (of which there should be six or eight) a piece of wood, with a groove cut in it to receive the case. Fix these pieces in such a manner that half the cases may incline upwards and half downwards, and that, when they are tied on, their heads and tails may come very nearly together: from the tail of one case to the mouth of the other carry a leader, which should be secured with pasted paper. Besides these pipes, it will be necessary to put a little meal-powder [Pg 182] within the pasted paper, to blow off the pipe, that there may be no obstruction to the fire from the cases. By means of these pipes the cases will successively take fire, burning one upwards and the other downwards. On the pintle fix a case of the same sort as those on the wheel; this case must be fired by a leader from the mouth of the last case on the wheel, which case must play downwards: instead of a common case in the middle, you may put a case of Chinese fire, long enough to burn as long as two or three of the cases on the wheel.

Horizontal wheels are often fired two at a time, and made to keep time like vertical wheels, only they are made without any slow or dead fire; 10 or 12 inches will be enough for the diameter of wheels with six spokes.

Spiral Wheels.—They are only double horizontal wheels, and made thus: the nave must be about six inches long, and rather thicker than the single sort; instead of the pintle at top, make a hole for the case to be fixed in, and two sets of spokes, one set near the top of the nave, and the other near the bottom. At the end of each spoke cut a groove wherein you tie the cases, there being no fell: the spokes should not be more than two inches and a half long from the naves, so that the wheel may not be more than eight or nine inches diameter; the cases are placed in such a manner, that those at top play down, and those at bottom play up; but let the third or fourth case play horizontally. The case in the middle may begin with any of the others; six spokes will be enough for each set, so that the wheel may consist of 12 cases, besides that on the top: the cases six inches each.

Plural Wheels.—Plural wheels are made to turn horizontally, and to consist of three sets of spokes, placed six at top, six at bottom, and four in the middle; which last must be a little shorter than the rest: let the diameter of the wheel be 10 inches: the cases must be tied on the ends of

the spokes in grooves cut on purpose, or on pieces of wood nailed on the ends of the spokes, with grooves cut in them as usual: in clothing these wheels, make the upper set of cases play obliquely downwards, the bottom set obliquely upwards, and the middle set horizontally. In placing the leaders, they must be managed so that the cases may burn thus, viz., first up, then down, then horizontal, and so on with the rest. But another change may be made, by driving in the end of the eighth case two or three ladlesful of slow fire, to burn till the wheel has stopped its course; then let the other cases be fixed the contrary way, which will make the wheel run back again; for the case at top you may put a small gerbe; and let the cases on the spokes be short, and filled with a strong brilliant charge. [Pg 183]

Illuminated Spiral Wheel.—First have a circular horizontal wheel made two feet diameter, with a hole quite through the nave; then take three thin pieces of deal, three feet long each, and three-fourths of an inch broad each: nail one end of each of these pieces to the fell of the wheel, at an equal distance from one another, and the other end nail to a block with a hole in its bottom, which must be perpendicular to that in the block of the wheel, but not so large. The wheel being thus made, have a loop planed down very thin and flat; then nail one end of it into the fell of the wheel, and wind it round the three sticks in a spiral line from the wheel to the block at top; on the top of this block fix a case of Chinese fire; on the wheel you may place any number of cases, which must incline downwards, and burn two at a time. If the wheel should consist of ten cases, you may let the illuminations and Chinese fire begin with the second cases. The spindle for this wheel must be a little longer than the cone, and made very smooth at top, on which the upper block is to turn, and the whole weight of the wheel to rest.

Double Spiral Wheels.—For these wheels, the block or nave must be as long as the height of the worms, or spiral lines, but must be made very thin, and as light as possible. In this block must be fixed several spokes, which must diminish in length, from the wheel to the top, so as not to exceed the surface of a cone of the same height. To the ends of these spokes nail the worms, which must cross each other several times: close these worms with illuminations, the same as those on the single wheels; but the horizontal wheel you may clothe as you like. At the top of the worm place a case of spur-fire, or an amber light.

Balloon Wheels.—They are made to turn horizontally: they must be made two feet diameter, without any spokes, and very strong, with any number of sides. On the top of a wheel range and fix in pots, three inches diameter and seven inches high each, as many of these as there are cases on the wheel: near the bottom of each pot make a small vent; into each of these vents carry a leader from the tail of each case; load some of the pots with stars, and some with serpents, crackers, &c. As the wheels turn, the pots will successively be fired, and throw into the air a great variety of fires. [Pg 184]

BALLOON CASES.

You must have an oval former, turned of smooth wood; then paste a quantity of brown or cartridge-paper, and let it lie till the paste has soaked all through; this done, rub the former with soap or grease, to prevent the paper from sticking to it; then lay the paper on in small slips, till you have made it one-third of the thickness of the shell intended. Having thus done, set it to dry; and when dry, cut it round the middle, leaving about one inch not cut, which will make the halves join much better than if quite separated. When you have some ready to join, place the halves even together, and let that dry; then lay on paper all over as before, everywhere equal. When the shell is thoroughly dry, burn a vent at top with a square iron.

Shells that are designed for stars only, may be made quite round, and the thinner they are at the opening the better; for if they are too strong, the stars are apt to break at the bursting of the shell. Balloons must always be made to go easy into the mortars.

MORTARS.

These mortars must be made of pasteboard, with a small copper chamber at bottom, in which the powder is to be placed, on which the balloon is to be put. In the centre of the bottom of this chamber make a small hole a little down the foot: the hole must be met by another of the same size as the foot. Then putting a quick-match, or touch-string, of touch-paper, into the hole, your mortar will be ready to be fired.

To load Air Balloons with Stars, Serpents, &c., &c.—When you fill your shells, you must first put in the serpents, rains, &c., or whatever they are composed of, then the blowing powder; but the shells must not be quite filled. All those things must be put in at the fuse-hole, but marrons being too large to go in at the fuse-hole, must be put in before the inside shall be joined. When the shells are loaded, glue and drive in the fuses very tight. The number and quantities of each article for the different shells are as follows:

BALLOONS ILLUMINATED.

	oz.
Meal-powder	1
Corn-powder	0½
Powder for the mortar	2

1 oz. driven or rolled stars, or as many as will fill the shell. [Pg 185]

BALLOONS OR SERPENTS.

	oz.
Meal-powder	1
Corn-powder	1
Powder for the mortar	2½

Aigrettes.

Mortars to throw aigrettes are generally made of pasteboard, of the same thickness as balloon mortars, and two diameters and a half long in the inside from the top of the foot: the foot must be made of elm without a chamber, but flat at top, and in the same proportions as those for balloon mortars; these mortars must also be bound round with a cord: sometimes eight or nine of these mortars, of about three or four inches diameter, are bound all together, so as to appear but one; but when they are made for this purpose, the bottom of the foot must be of the same diameter as the mortars, and only half a diameter high. The mortars being bound well together, fix them on a heavy solid block of wood. To load these mortars, first put on the inside bottom of each a piece of paper, and on it spread one ounce and a half of meal and corn-powder mixed; then tie the serpents up in parcels with quick-match, and put them in the mortar with their mouths downwards; but take care the parcels do not fit too tight in the mortars, and that all the serpents have been well primed with powder wetted with spirit of wine. On the top of the serpents in each mortar lay some paper or tow; then carry a leader from one mortar to the other all round, and then from all the outside mortars into that in the middle: these leaders must be put between the cases and the sides of the mortar, down to the powder at bottom: in the centre of the middle mortar fix a fire-pump, or brilliant fountain, which must be open at bottom, and long enough to project out of the mouth of the mortar; then paste papers on the tops of all the mortars.

Mortars thus prepared are called a *nest of serpents*. When these mortars are to be fired, light the fire-pump, which when consumed will communicate to all the mortars at once by means of the leaders. For mortars of 8, 9, or 10 inches diameter, the serpents should be made in one and two-ounce cases, six or seven inches long, and fired by a leader brought out of the mouth of the mortar, and turned down on the outside, and the end of it covered with paper, to prevent the sparks of the other works from setting it on fire. For a six-inch mortar, let the quantity of powder [Pg 186] for firing be two ounces; for an eight-inch, two ounces and three-quarters; and for a ten-inch, three ounces and three-quarters. Care must be taken in these, as well as small mortars, not to put in the serpents too tight, for fear of bursting the mortars. These mortars may be loaded with stars, crackers, &c.

If the mortars, when loaded, are sent to any distance, or liable to be much moved, the firing powder should be secured from getting amongst the serpents, which would endanger the mortars, as well as hurt their performance. To prevent this, load the mortars thus: First put in the firing powder, and spread it equally about; then cut a round piece of blue touch-paper, equal to the exterior diameter of the mortar, and draw on it a circle equal to the interior diameter of the mortar, and notch it all round as far as that circle: then paste that part which is notched, and put it down the mortar close to the powder, and stick the pasted edge to the mortar: this will keep the powder always smooth at bottom, so that it may be moved or carried anywhere without receiving damage. The large single mortars are called *pots des aigrettes*.

FIRE-PUMPS, OR ROMAN CANDLES.

Cases for fire-pumps are made like those for tourbillons; only they are pasted instead of being rolled dry. Having rolled and dried your cases fill them: first put in a little meal-powder and then a star, on which ram, lightly, a ladle or two of composition, then a little meal-powder, and on that a star; then again composition, and so on till you have filled the case. Stars for fire-pumps should not be round, but must be made either square, or flat and circular with a hole through the middle: the quantity of powder for throwing the stars must increase as you come near the top of the case; for, if much powder be put at the bottom, it will burst the case. The stars must differ in size in this manner: let the star which you put in first be a little less than the bore of the case; but let the next star be a little larger, and the third star a little larger than the second, and so on: let them increase in diameter till within two of the top of the case, which two must fit in tight. As the loading of fire-pumps is somewhat difficult, it will be necessary to make two or three trials before you depend on their performance. When you fill a number of pumps, take care not to put in each an equal quantity of charge between the stars, so that when they are fired they may not throw up [Pg 187] too many stars together. Cases for fire-pumps should be made very strong, and rolled on 4 or 8-ounce formers, 10 or 12 inches long each.

CHARGE.

	lb.	oz.		lb.	oz.
Saltpetre	5	0	Saltpetre	5	0
Brimstone	1	0	Brimstone	2	0

Meal-powder	1½	0	Meal-powder	1	8
Glass-dust	1	0	Glass-dust	1	8

AN ARTIFICIAL EARTHQUAKE.

Mix the following ingredients to a paste, with water; bury it in the ground, and in a few hours the earth will break open in several places:

	lb.	oz.
Sulphur	4	0
Steel-dust	4	0

Chinese Fountains.

To make a Chinese fountain, you must have a perpendicular piece of wood, seven feet long, and two inches and a half square. Sixteen inches from the top, fix on the front a cross piece one inch thick, and two and a half broad, with the broad side upwards; below this, fix three more pieces of the same width and thickness, at sixteen inches from each other; let the bottom rail be five feet long, and the others of such a length as to allow the fire-pumps to stand in the middle of the intervals of each other. The pyramid being thus made, fix in the holes made in the bottom rail five fire-pumps, at equal distances; on the second rail, place four pumps; on the third, three; on the fourth, two; and on the top of the post, one; but place them all to incline a little forward, that, when they throw out the stars, they may not strike against the cross-rails. Having fixed your fire-pumps, clothe them with leaders, so that they may all be fired together.

The Dodecahedron,

So called because it nearly represents a twelve-sided figure, is made thus: First have a ball turned out of some hard wood, 14 inches diameter; divide its surface into 14 equal parts, from which bore holes one inch and a half diameter, perpendicular to the centre, so that they may all [Pg 188] meet in the middle: then let there be turned in the inside of each hole a female screw; and to all the holes but one must be made a round spoke five feet long, with four inches of the screw at one end to fit the holes; then in the screw-end of all the spokes bore a hole five inches long, which must be bored slanting, so as to come out at one side, a little above the screw; from which cut a small groove along the spoke within six inches of the other end, where make another hole through to the other side of the spoke. In this end fix a spindle, on which put a small wheel of three or four sides, each side six or seven inches long; these sides must have grooves cut in them large enough to receive a two or four-ounce case. When these wheels are clothed, put them on the spindles, and at the end of each spindle put a nut, to keep the wheel from falling off. The wheels being thus fixed, carry a pipe from the mouth of the first case on each wheel, through the hole in the side of the spoke, and from thence along the groove, and through the other hole, so as to hang out at the screw-end about an inch. The spokes being all prepared in this manner, you must have a post, on which you intend to fire the work, with an iron screw in the top of it, to fit one of the holes in the ball: on the screw fix the ball; then in the top hole of the ball put a little meal-powder and some loose quick-match: then screw in all the spokes; and in one side of the ball bore a hole, in which put a leader, and secure it at the end, and the work will be ready to be fired. By the leader the powder and match in the centre is fired, which will light the match at the ends of the spokes all at once, whereby all the wheels will be lighted at once. There may be an addition to this piece, by fixing a small globe on each wheel, or one on the top wheel only. A grey charge will be proper for the wheel-cases.

Stars with Points.

These stars are made of different sizes, according to the work for which they are intended; they are made with cases from one ounce to one pound, but in general with four-ounce cases, four or five inches long: the case must be rolled with paste, and twice as thick as that of a rocket of the same bore. Having rolled a case, pinch one end of it quite close; then drive in half a diameter of clay; and when the case is dry, fill it with composition two or three inches to the length of the [Pg 189] cases with which it is to burn: at top of the charge drive some clay; as the ends of these cases are seldom pinched, they would be liable to take fire. Having filled a case, divide the circumference of it at the pinched end close to the clay, into five equal parts; then bore five holes with a gimblet about the size of the neck of a common four-ounce case, into the composition; from one hole to the other carry a quick-match, and secure it with paper: this paper must be put on in the manner of that on the end of wheel-cases, so that the hollow part, which projects from the end of the case, may serve to receive a leader from any other work, to give fire to the points of the stars. These stars may be made with any number of points.

Fixed Sun with a transparent Face.

To make a sun of the best kind, there should be two rows of cases, which should show a double glory, and make the rays strong and full. The frame or sun-wheel must be made thus: have a circular flat nave made very strong, 12 inches diameter; to this fix six strong flat spokes; on the

front of these fix a circular fell, five feet diameter; within which, fix another fell, the length of one of the sun-cases less in diameter; within this fix a third fell, whose diameter must be less than the second by the length of one case and one-third. The wheel being made, divide the fells into so many equal parts as there are to be cases, (which may be done from 24 to 44:) at each division fix a flat iron staple: these staples must be made to fit the cases, to hold them fast on the wheel; let the staples be so placed, that one row of cases may lie in the middle of the intervals of the other.

In the centre of the block of the sun drive a spindle, on which put a small hexagonal wheel, whose cases must be filled with the same charge as the cases of the sun; two cases of this wheel must burn at a time, and begin with those on the fells. Having fixed on all the cases, carry pipes of communication from one to the other, and from one side of the sun to the wheel in the middle, and from thence to the other side of the sun. These leaders will hold the wheel steady while the sun is fixing up, and will also be a sure method of lighting both cases of the wheel together. A sun thus made is called a *brilliant sun*, because the wood-work is entirely covered with fire from the wheel in the middle, so that there appears nothing but sparks of brilliant fire; but if you would [Pg 190] have a transparent face in the centre, you must have one made of pasteboard of any size. The method of making a face is, by cutting out the eyes, nose, and mouth, for the sparks of the wheel to appear through; but instead of this face, you may have one painted on oil paper, or Persian silk, strained tight on a hoop; which hoop must be supported by three or four pieces of wire at six inches distance from the wheel in the centre, so that the light of it may illuminate the face. By this method may be shown, in the front of the sun, VIVAT REGINA, cut in pasteboard, or Apollo, painted in silk; but, for a small collection, a sun with a single glory and a wheel in front will be most suitable. Half-pound cases, filled ten inches with composition, will be a good size for a sun of five feet diameter; but, if larger, the cases must be greater in proportion.

DETONATING WORKS.

WATERLOO CRACKERS.

Take a slip of cartridge-paper, about three-quarters of an inch in width, paste and double it; let it remain till dry, and cut it into two equal parts in length, (No. 1 and 2,) according to the following pattern:

No. 1. Glass. S Glass. No. 2.

Take some of the glass composition, and lay it across the paper as in the pattern, and put about a quarter of a grain of fulminating silver in the place marked S, and while the glass composition is moist, put the paper marked No. 2, over the farthest row of glass. Over all, paste twice over the part that covers the silver a piece of paper; let it dry, and when you wish to explode it, take hold of the two ends and pull them sharply from each other, and it will produce a loud report.

DETONATING GIRDLE.

Procure a piece of girth from 12 to 18 inches in length. Double it, and fold it down about 1½ inch, similar to the fold of a letter, and then turn back one end of the girth, and it will form two compartments. Then take some gum and dissolve it in water; boil it till it is quite melted, and [Pg 191] very thick; add coarse powdered glass, sufficient to make it into a very thick paste; place two upright rows of the glass composition in the inside of one of the folds, about as wide as the thickness of a lath, and as high as a half-crown laid flat; and when they are dry, sew the first fold together on the edge, and then the second at the opposite end, so that one end may be open. Then, in the centre of the two rows, put about a grain of fulminating silver, and paste a piece of cotton or silk over it. Make a hole at each end of the girdle, and hang it to a hook in the door-post, and the other hook on the door, observing to place the silk part so that it may come against the edge of the door when opened, which will cause a report as loud as a small cannon. The fulminating silver may be purchased at any of the operating chemists.

DETONATING BALLS.

Procure some glass globes, between the size of a pea and a small marble, in which there must be a small hole; put into it half a grain of fulminating silver. Paste a piece of paper carefully over the ball to prevent the silver from escaping. When you wish to explode one put it on the ground, and tread hard upon it, and it will go off with a loud noise. These balls may be made productive of much amusement in company, by placing a chair lightly on them; for whoever sits down upon them will cause them to explode. These globes may be procured at the barometer-makers.

THE DETONATING TAPE.

Is made of binding, about three-eighths of an inch in width. Observe the same directions as given for the girdle; you may either explode it yourself, by taking hold of each end, and rolling the ends from each other sharply, or give one end to another, and pull together.

DETONATING CARDS.

Take a piece of card about three-fourths of an inch in breadth and 12 in length; slit it at one end,

and place in the opening a quarter of a grain of fulminating silver; close the edges down with a little paste, and when dry you may use it by lighting the end in a candle.

Having given the method by which these loud reports are produced, we shall mention some other effects to be produced by the silver, capable of affording much amusement. For instance, by placing about a quarter of a grain of the silver in the midst of some tobacco in a pipe, or between [Pg 192] the leaves of a cigar, and closing the end again, to prevent the powder from falling out; when lighted, it causes a loud explosion; for heat, as well as friction, will equally do.

Or, take one-third of the grain of fulminating silver; fold it up in a small piece of paper, and wrap it up in another piece, and paste it round a pin. These pins stuck in the wick of a candle make a very loud noise.

Fulminating silver may be also used in the following manner:—Put half a grain in a piece of glass-paper, and enclose it in a piece of foil; put it then at the bottom or side of a drawer, and on opening or shutting it, it will immediately go off.

Put a quarter of a grain of fulminating silver into a piece of paper, and place in the snuffers when quite cold; when the candle is snuffed, it will go off.

AQUATIC FIRE-WORKS.

Works that sport in the water are much esteemed by most admirers of fire-works, particularly water-rockets; and as they seem of a very extraordinary nature to those who are unacquainted with this art, they merit a particular explanation.

Water-Rockets.

They may be made from four ounces to two pounds. If larger, they are too heavy; so that it will be difficult to make them keep above water without a cork float, which must be tied to the neck of the case; but the rockets will not dive so well with as without floats.

Cases for these are made in the same manner and proportion as sky-rockets, only a little thicker of paper. When you fill those which are driven solid, put in first one ladleful of slow fire, then two of the proper charge, and on that one or two ladles of sinking charge, then the proper charge, then the sinking charge again, and so on, till you have filled the case within three diameters; then drive on the composition one ladleful of clay; through which make a small hole to the charge; then fill the case, within half a diameter, with corn-powder, on which turn down two or three rounds of the case in the inside; then pinch and tie the end very tight; having filled the rockets, [Pg 193] (according to the above directions,) dip their ends in melted resin or sealing-wax, or else secure them well with grease. When you fire those rockets, throw in six or eight at a time; but, if you would have them all sink, or swim, at the same time, you must fill them with an equal quantity of composition, and fire them together.

Pipes of Communication for Water.

They may be used under water, but must be a little thicker in the paper than those for land. Having rolled a sufficient number of pipes, and kept them till dry, wash them over with drying oil, and set them to dry; but when you oil them, leave about an inch and a half at each end dry, for joints; as, if they were oiled all over, when you come to join them, the paste will not stick where the paper is greasy: after the leaders are joined, and the paste dry, oil the joints. These pipes will lie many hours under water, without receiving any damage.

Horizontal Water-Wheels.

To make horizontal wheels for the water, first get a large wooden bowl without a handle; then have an eight-sided wheel, made of a flat board 18 inches diameter, so that the length of each side may nearly be seven inches: in all the sides cut a groove for the cases to lie in. This wheel being made, nail it on the top of the bowl; then take four eight-ounce cases, filled with a proper charge, each about six inches in length. Now, to clothe the wheel with these cases, get some whitish-brown paper, and cut it into slips; being pasted all over on one side, take one of the cases, and roll one of the slips of paper about an inch and a half on its end, so that there will remain about two inches and a half of the paper hollow from the end of the case: tie this case on one of the sides of the wheel, near the corners of which must be holes bored, through which put the packthread to tie the cases: having tied on the first case at the neck and end, put a little meal-powder in the hollow paper; then paste a slip of paper on the end of another case, the head of which put into the hollow paper on the first, allowing a sufficient distance from the tail of one to the head of the other, for the pasted paper to bend without tearing: tie on the second case as you did the first, and so on with the rest, except the last, which must be closed at the end, unless [Pg 194] it is to communicate to any thing on the top of the wheel, such as fire-pumps or brilliant fires, fixed in holes cut in the wheel, and fired by the last or second case, as the fancy directs: six, eight, or any number, may be placed on the top of the wheel, provided they are not too heavy for the bowl.

Before trying on the cases, cut the upper part of all their ends, except the last, a little shelving, that the fire from one may play over the other, without being obstructed by the case. Wheel-cases

have no clay driven in their ends, nor pinched, but are always left open, only the last, or those which are not to lead fire, which must be well secured.

Water-Mines.

For water-mines you must have a bowl with a wheel on it, made in the same manner as the water-wheel; only in its middle there must be a hole, of the same diameter as that of the intended mine. These mines are tin pots, with strong bottoms, and a little more than two diameters in length: the mine must be fixed in the hole in the wheel, with its bottom resting on the bowl; then loaded with serpents, crackers, stars, small water-rockets, &c., in the same manner as pots of aigrettes; but in their centre fix a case of Chinese fire, or a small gerbe, which must be lighted at the beginning of the last case on the wheel. These wheels are to be clothed as usual.

Fire Globes for the Water.

Bowls for water-globes must be very large, and the wheels on them of ten sides: on each side nail a piece of wood four inches long; and on the outside of each piece cut a groove, wide enough to receive about one-fourth of the thickness of a four-ounce case: these pieces of wood must be nailed in the middle of each face of the wheel, and fixed in an oblique direction, so that the fire from the cases may incline upwards: the wheel being thus prepared, tie in each groove a four-ounce case filled with a grey charge; then carry a leader from the tail of one case to the mouth of the other.

Globes for these wheels are made of two in hoops, with their edges outwards, fixed one within the other, at right angles. The diameter of these hoops must be rather less than that of the wheel. [Pg 195] Having made the globe, drive in the centre of the wheel an iron spindle which must stand perpendicular, and its length be four or six inches more than the diameter of the globe.

The spindle serves for an axis, on which is fixed the globe, which must stand four or six inches from the wheel; round one side of each hoop must be soldered little bits of tin, two inches and a half distance from each other; which pieces must be two inches in length each, and only fastened at one end, the other ends being left loose, to turn round the small port-fires, and hold them on: these port-fires must be made of such a length as will last out the cases on the wheel. There need not be any port-fires at the bottom of the globe within four inches of the spindle, as they would have no effect but to burn the wheel: all the port-fires must be placed perpendicularly from the centre of the globe, with their mouths outwards, and must be clothed with leaders, so as all to take fire with the second case of the wheel; and the cases must burn two at a time, one opposite the other. When two cases of a wheel begin together, two will end together; therefore the two opposite end cases must have their ends pinched and secured from fire. The method of firing such wheels is, by carrying a leader from the mouth of one of the first cases to that of the other; and the leader being burnt through the middle, will give fire to both at the same time.

Odoriferous Water-Balloons.

They are made in the same manner as air-balloons, but very thin of paper, and in diameter one inch and three-fourths, with a vent of half an inch diameter. The shells being made, and quite dry, fill them with any of the following compositions, which must be rammed in tight: these balloons must be fired at the vent, and put into a bowl of water. Odoriferous works are generally fired in rooms.

Composition I. Saltpetre two ounces, flour of sulphur one ounce, camphor half an ounce, yellow amber half an ounce, charcoal-dust three-fourths of an ounce, salt of Benzoin half an ounce, all powdered very fine and well mixed.

II. Saltpetre twelve ounces, meal-powder three ounces, frankincense one ounce, myrrh half an ounce, camphor half an ounce, charcoal three ounces, all moistened with the oil of spike.

III. Saltpetre two ounces, sulphur half an ounce, antimony half an ounce, amber half an ounce, [Pg 196] cedar raspings one-fourth of an ounce, all mixed with the oil of roses and a few drops of bergamot.

IV. Saltpetre four ounces, sulphur one ounce, saw-dust of juniper half an ounce, saw-dust of cypress one ounce, camphor one-fourth of an ounce, myrrh two drachms, dried rosemary one-fourth of an ounce, all moistened a little with the oil of roses.

N.B. Water-rockets may be made with any of the above compositions, with a little alteration, to make them weaker or stronger, according to the size of the cases.

A Sea-fight with small Ships and a Fire-ship.

Having procured four or five small ships, of two or three feet in length, make a number of small reports, which are to serve for guns. Of these range as many as you please on each side of the upper decks; then at the head and stern of each ship fix a two-ounce case, eight inches long, filled with a slow port-fire composition; but take care to place it in such a manner that the fire may fall in the water, and not burn the rigging; in these cases bore holes at unequal distances from one another, but make as many in each case as half the number of reports, so that one case

may fire the guns on one side, and the other those on the opposite. The method of firing the guns is, by carrying a leader from the holes in the cases to the reports on the decks; you must make these leaders very small, and be careful in calculating the burning of the slow fire in the regulating cases, that more than two guns be not fired at a time. When you would have a broadside given, let a leader be carried to a cracker placed on the outside of the ship; which cracker must be tied loose, or the reports will be too slow: in all the ships put artificial guns at the port-holes. Reports for these and similar occasions are made by filling small cartridges with grained powder, pinching them close at each end, and, when used, boring a hole in the side, to which is placed a match or leader for firing them.

Having filled and bored holes in two port-fires, for regulating the guns in one ship, make all the rest exactly the same; then, when you begin the engagement, light one ship first, and set it a sailing, and so on with the rest, sending them out singly, which will make them fire regularly, at different times, without confusion; for the time between the firing of each gun will be equal to that of lighting the slow fires. [Pg 197]

The fire-ship may be of any size, and need not be very good, for it is always lost in the action. To prepare a ship for this purpose, make a port-fire equal in size with those in the other ships, and place it at the stern; in every port place a larger port-fire, filled with a very strong composition, and painted in imitation of a gun, and let them all be fired at once by a leader from the slow fire, within two or three diameters of its bottom; all along both sides, on the top of the upper deck, lay star-composition about half an inch thick and one broad, which must be wetted with thin size, then primed with meal-powder, and secured from fire by pasting paper over it; in the place where you lay this composition, drive some little tacks with flat heads, to hold it fast to the deck; this must be fired just after the sham guns, and when burning will show a flame all round the ship: at the head take up the decks, and put in a tin mortar loaded with crackers, which mortar must be fired by a pipe from the end of the slow fire: the firing of this mortar will sink the ship, and make a pretty conclusion. The regulating port-fire of this ship must be lighted at the same time with the first fighting ship.

Having prepared all the ships for fighting, we shall next proceed with the management of them when on the water. At one end of the pond, just under the surface of the water, fit two running blocks, at what distance you choose the ships should fight; and at the other end of the pond, opposite to each of these blocks, under the water, fix a double block; then on the land, by each of the double blocks, place two small windlasses; round one of them turn one end of a small cord, and put the other end through one of the blocks; then carry it through the single one at the opposite end of the pond, and bring it back through the double block again, and round the other windlass: to this cord, near the double block, tie as many small strings as half the number of the ships, at any distance; but these strings must not be more than two feet long each: make fast the loose end of each to a ship, just under her bowsprit; for if tied to the keel, or too near the water, it will overset the ship. Half the ships being thus prepared, near the other double block fix two more windlasses, to which fasten a cord, and to it tie the other half of the ships as before: when you fire the ships, pull in the cord with one of the windlasses, to get all the ships together; and when you have set fire to the first, turn that windlass which draws them out, and so on with the rest, till they are all out in the middle of the pond; then, by turning the other windlass, you will [Pg 198] draw them back again; by which method you may make them change sides, and tack about backwards and forwards at pleasure. For the fire-ship fix the blocks and windlasses between the others, so that when she sails out she will be between the other ships: you must not let this ship advance till the guns at her ports take fire.

To fire Sky-Rockets under Water.

You must have stands made as usual, only the rails must be placed flat instead of edgewise, and have holes in them for the rocket-sticks to go through; for if they were hung upon hooks, the motion of the water would throw them off: the stands being made, if the pond be deep enough, sink them at the sides so deep, that, when the rockets are in, their heads may just appear above the surface of the water; to the mouth of each rocket fix a leader, which put through the hole with a stick; then a little above the water must be a board, supported by the stand, and placed along one side of the rockets; then the ends of the leaders are turned up through holes made in this board, exactly opposite the rockets. By this means you may fire them singly or all at once. Rockets may be fired by this method in the middle of a pond, by a Neptune, a swan, a water-wheel, or any thing else you choose.

Neptune in his Chariot.

To represent Neptune in his chariot, you must have a Neptune (made of wood, or basket-work) as big as life, fixed on a float large enough to bear his weight; on which must be two horses' heads and necks, so as to seem swimming. For the wheels of the chariot, there must be two vertical wheels of black fire, and on Neptune's head a horizontal wheel of brilliant fire, with all its cases, to play upwards. When this wheel is made, cover it with paper or pasteboard, cut and painted like Neptune's coronet; then let the trident be made without prongs, but instead of them, fix three cases of a weak grey charge, and on each horse's head put an eight-ounce case of brilliant fire, and on the mouth of each fix a short case, of the same diameter, filled with the white flame composition enough to last out all the cases on the wheels: these short cases must be open at bottom, that they may light the brilliant fires; for the horses' eyes put small port-fires, and in [Pg 199]

each nostril put a small case half filled with grey charge, and the rest with port-fire composition.

If Neptune is to give fire to any building on the water, at his first setting out, the wheels of the chariot, and that on his head, with the white flame on the horses' heads, and the port-fires in their eyes and nostrils, must all be lighted at once; then from the bottom of the white flames carry a leader to the trident. As Neptune is to advance by the help of a block and cord, you must manage it so as not to let him turn about, till the brilliant fires on the horses and the trident begin; for it is by the fire from the horses (which plays almost upright,) that the building, or work, is lighted, which must be thus prepared. From the mouth of the case which is to be first fired, hang some loose quick-match to receive the fire from the horses. When Neptune is only to be shown by himself, without setting fire to any other works, let the white flames on the horses be very short, and not to last longer than one case of each wheel, and let two cases of each wheel burn at a time.

Swans and Ducks in Water.

If you would have swans or ducks discharge rockets into the water, they must be made hollow, and of paper, and filled with small water-rockets, with some blowing powder to throw them out; but if this is not done, they may be made of wood, which will last many times. Having made and painted some swans, fix them on floats; then in the places where their eyes should be, bore holes two inches deep, inclining downwards, and wide enough to receive a small port-fire; the port-fire cases for this purpose must be made of brass, two inches long, and filled with a slow bright charge. In the middle of one of these cases make a little hole; then put the port-fire in the eye-hole of the swan, leaving about half an inch to project out; and in the other eye put another port-fire, with a hole made in it: then in the neck of the swan, within two inches of one of the eyes, bore a hole slantwise, to meet that in the port-fire; in this hole put a leader, and carry it to a water-rocket, that must be fixed under the tail with its mouth upwards. On the top of the head place two one-ounce cases, four inches long each, driven with brilliant fire; one of these cases must incline forwards, and the other backwards: these must be lighted at the same time as the water-rocket; to do which, bore a hole between them in the top of the swan's head, down to the [Pg 200] hole in the port-fire, to which carry a leader: if the swan is filled with rockets, they must be fired by a pipe from the end of the water-rocket under the tail. When you set the swan a swimming, light the two eyes.

Water Fire-Fountains.

To make a fire-fountain for the water, first have a float made of wood, three feet diameter; then in the middle fix a round perpendicular post, four feet high, and two inches diameter; round this post fix three circular wheels made of thin wood, without any spokes. The largest of these wheels must be placed within two or three inches of the float, and must be nearly of the same diameter. The second wheel must be two feet two inches diameter, and fixed at two feet distance from the first. The third wheel must be one foot four inches diameter, and fixed within six inches of the top of the post: the wheels being fixed, take 18 four or eight-ounce cases of brilliant fire, and place them round the first wheel with their mouths outwards, and inclining downwards; on the second wheel place 13 cases of the same, and in the same manner as those on the first; on the third, place eight more of these cases, in the same manner as before, and on the top of the post fix a gerbe; then clothe all the cases with leaders, so that both they and the gerbe may take fire at the same time. Before firing this work, try it in the water, to see whether the float is properly made, so as to keep the fountain upright.

THE END.

ARNOTT'S ELEMENTS OF PHYSICS, 1 vol. 8vo, sheep, with many wood-cuts.

BOZ'S COMPLETE WORKS, in 8 vols. 8vo, extra cloth, with numerous plates.
Same work, common edition, in paper, 9 parts, price $3 50.
Same work in 3 large vols., good paper, fancy cloth, price $3 75.

BENTHAMIANA: Extracts from Bentham, in 1 vol. 12mo.

BROWNE'S RELIGIO MEDICI, 1 vol. 12mo, extra cloth.

BOLMAR'S FRENCH SERIES, consisting of—
A Selection of One Hundred Perrin's Fables, with a Key to the Pronunciation.
A Series of Colloquial Phrases.
The First Eight Books of Fenelon's Telemachus.
Key to the same.
A Treatise on all the French Verbs, Regular and Irregular.
The whole forming five small volumes, half bound to match.

BUTLER'S ATLAS OF ANCIENT GEOGRAPHY, 8vo, half bound.

BUTLER'S GEOGRAPHIA CLASSICA, 1 vol. 8vo.

BIRD'S NATURAL PHILOSOPHY, 1 vol. with many cuts.

BRIGHAM ON MENTAL CULTIVATION, &c., 12mo, cloth.

BRIDGEWATER TREATISES. The whole complete in 7 vols. 8vo, various bindings: containing—
Roget's Animal and Vegetable Physiology, in 2 vols, with many cuts.
Kirby on the History, Habits, and Instinct of Animals, 1 vol. with plates.
Prout on Chemistry.
Chalmers on the Moral Condition of Man.
Whewell on Astronomy.
Bell on the Hand.
Kidd on the Physical Condition of Man.
Buckland's Geology, 2 vols. with numerous plates and maps.
Roget, Buckland, and Kirby are sold separate.

BROUGHAM ON THE FRENCH REVOLUTION, 1 vol. paper.

BOY'S TREASURY OF SPORTS AND PASTIMES, 1 vol. 18mo, crimson cloth, 400 illustrations.

BARNABY RUDGE, by "Boz," paper or cloth.

BROWNING'S HISTORY OF THE HUGUENOTS, 1 vol. 8vo.

BREWSTER'S TREATISE ON OPTICS, 1 vol. 12mo, cuts.

BABBAGE'S "FRAGMENT," 1 vol. 8vo.

CAMPBELL'S LIVES OF THE LORD CHANCELLORS, 7 vols. crown 8vo, extra cloth.

CHIMES, by Dickens, plates, 18mo, fancy cloth.

CHRISTMAS STORIES—The Chimes, Carol, Cricket on the Hearth, and Battle of Life, together with Pictures from Italy, by Dickens, 1 vol 8vo, paper, price 37½ cents.

COMPLETE COOK, paper, price only 25 cents.

COMPLETE CONFECTIONER, paper, 25 cents.

COMPLETE FLORIST, paper, 25 cents.

COMPLETE GARDENER, paper, 25 cents.

CURIOSITY SHOP, by "Boz," paper or doth.

CÆSAR'S COMMENTARIES, 1 vol. 18mo, neat cloth; being vol. I. of Schmitz and Zumpf's Classical Series for Schools.

CAMPBELL'S COMPLETE POETICAL WORKS, in 1 vol. crown 8vo, cloth gilt or white calf, plates.

COOPER'S NAVAL HISTORY OF THE UNITED STATES, complete in 1 vol. 8vo, cloth, with plates and maps.

COOPER'S NOVELS AND TALES, in 23 vols, sheep gilt, 12mo, or 47 vols. paper.

COOPER'S SEA TALES, 6 vols. 12mo, cloth.

COOPER'S LEATHER STOCKING TALES, 5 vols. 12mo, cloth.

CARPENTER'S COMPARATIVE ANATOMY AND PHYSIOLOGY, with numerous wood-cuts, (preparing).

CARPENTER'S ANIMAL PHYSIOLOGY, with 300 wood-cuts, (preparing).

CROLY'S HISTORY OF THE CHRISTIAN RELIGION, to be complete in 3 vols., (at press).

CLATER ON THE DISEASES OF HORSES, by Skinner, 1 vol. 12mo.

CLATER'S CATTLE AND SHEEP DOCTOR, 1 vol. 12mo, cuts.

CAMPBELL'S FREDERIC THE GREAT, 2 vols. 12mo, extra cloth.

DON QUIXOTE, with numerous illustrations by Johannot; 2 vols., 8vo, cloth, or half morocco.

DAVIDSON, MARGARET, Memoirs of and Poems, in 1 vol. 12mo, paper 50 cents, or extra cloth.

DAVIDSON, LUCRETIA, Poetical Remains, 1 vol. 12mo, paper 50 cents, or extra cloth.

DAVIDSON, Mrs., Poetry and Life, in 1 vol. 12mo, paper 50 cents, or extra cloth.

DANA ON CORALS, 1 vol. royal 4to, with Atlas of Plates, (at press).

DOMBEY AND SON, by Dickens, 1 vol. 8vo, with 16 plates, price 50 cents.
Same work, fine edition, 40 plates, extra cloth.

DOG AND SPORTSMAN, by Skinner, plates, 1 vol. 12mo, cloth.

DUNGLISON ON HUMAN HEALTH, 1 vol. 8vo, cloth or sheep.

ENCYCLOPÆDIA OF GEOGRAPHY, in 3 octavo vols. many cuts and maps, various bindings.

ENCYCLOPÆDIA AMERICANA, 14 vols. 8vo, various bindings. Vol. 14, bringing the work up to 1846, sold separate.

EAST'S KING'S BENCH REPORTS, edited by G. M. Wharton, 16 vols. in 8, large 8vo, law sheep.

EDUCATION OF MOTHERS, 1 vol. 12mo, cloth or paper.

ENDLESS AMUSEMENT, neat 18mo, crimson cloth, with cuts.

FIELDING'S SELECT WORKS, in 1 vol. 8vo, cloth, or 4 parts, paper.

FRANCATELLI'S MODERN FRENCH COOK, in 1 vol. 8vo, with many cuts.

FOWNES' RECENT WORK ON CHEMISTRY, second edition, by Bridges, 1 vol. 12mo, many cuts, sheep or extra cloth.

GRAHAME'S COLONIAL HISTORY OF THE UNITED STATES, 2 vols. 8vo, a new edition.

GRAHAM'S ELEMENTS OF CHEMISTRY, 1 vol. large 8vo, many cuts, (new edition, in press).

GIESELER'S ECCLESIASTICAL HISTORY, 3 vols. 8vo.

GRIFFITHS' CHEMISTRY OF THE FOUR SEASONS, 1 vol. 12mo, many cuts.

GRIFFITH'S MEDICAL BOTANY, 1 vol. large 8vo, extra cloth, nearly 400 cuts.

GROTE'S HISTORY OF GREECE, to form a neat 12mo series.

HAWKER ON SHOOTING, Edited by Porter, with plates and cuts, 1 vol. 8vo, beautiful extra cloth.

HERSCHELL'S TREATISE ON ASTRONOMY, 1 vol. 12mo, cuts and plates.

HALE'S ETHNOLOGY AND PHILOSOPHY OF THE U. S. EXPLORING EXPEDITION, 1 vol. royal 4to, extra cloth.

HEMANS' COMPLETE POETICAL WORKS, in 7 vols. 12mo.

HEMANS' MEMOIRS, by her Sister, 1 vol. 12mo.

HOLTHOUSE'S LAW DICTIONARY, by Penington, 1 vol. large 12mo, law sheep.

HILLIARD ON REAL ESTATE, new and much Improved Edition, 2 large vols. 8vo, law sheep.

HILL ON TRUSTEES, by Troubat, 1 large vol. 8vo, law sheep.

INGERSOLL'S HISTORY OF THE LATE WAR, 1 vol. 8vo. [Pg 205]

IRVING'S ROCKY MOUNTAINS, 2 vols. 12mo, cloth.

JOHNSON'S DICTIONARY OF GARDENING, by Landreth, 1 vol. large royal 12mo, 650 pages, many cuts.

KNAPP'S TECHNOLOGY, OR CHEMISTRY APPLIED TO THE ARTS AND TO MANUFACTURES. Translated by Ronalds, Edited by Johnson. Vol. I., with numerous illustrations.

KEBLE'S CHRISTIAN YEAR, in 32mo, extra cloth. Illuminated title.

KIRBY AND SPENCE'S ENTOMOLOGY, 1 large 8vo vol. with plates, plain or colored.

LOVER'S IRISH STORIES, 1 vol. royal 12mo, with cuts, extra cloth.
Same work, paper, price 50 cents.

LOVER'S RORY O'MORE, 1 vol. royal 12mo, with cuts, extra cloth.
Same work, paper, price 50 cents.

Same work, 8vo, price 25 cents.

LOVER'S SONGS AND BALLADS, 12mo, paper, 25 cents.

LIGHTS, SHADOWS, &c., of Whigs and Tories, 1 vol. 12mo.

LANGUAGE OF FLOWERS, eighth edition, 1 vol. 18mo, colored plates, crimson cloth, gilt.

LANDRETH'S RURAL REGISTER, for 1848, royal 12mo, many cuts, price 15 cents. Copies for 1847 still on sale.

LOVES OF THE POETS, by Mrs. Jamieson, 12mo.

MARSTON, OR THE SOLDIER AND STATESMAN, by Croly, 8vo, sewed, 50 cents.

MACKINTOSH'S DISSERTATION ON ETHICAL PHILOSOPHY, 1 vol. 8vo, cloth.

MOORE'S HISTORY OF IRELAND, in 2 vols. 8vo, cloth. Second volume sold separate.

MARTIN CHUZZLEWIT, by "Boz," cloth or paper.

MULLER'S PHYSICS AND METEOROLOGY, 1 vol. large 8vo, 2 colored plates, and 550 wood-cuts.

MILLWRIGHT'S AND MILLER'S GUIDE, by Oliver Evans, in 1 vol. 8vo, sheep, many plates.

METCALF ON CALORIC, 1 vol. 8vo, (at press).

MILL'S HISTORY OF THE CRUSADES, AND CHIVALRY, in one octavo volume.

MILL'S SPORTSMAN'S LIBRARY, 1 vol. 12mo, extra cloth.

NARRATIVE OF THE UNITED STATES' EXPLORING EXPEDITION, by Captain Charles Wilkes, U. S. N., in 6 vols. 4to, $60; or 6 vols. imperial 8vo, $25, with very Numerous and Beautiful Illustrations, on wood, copper, and steel; or 5 vols. 8vo, $10, with over three hundred wood-cuts and maps.

NIEBUHR'S HISTORY OF ROME, complete, 2 large vols. 8vo.

NICHOLAS NICKLEBY, by "Boz," cloth or paper.

OLIVER TWIST, by "Boz," cloth or paper.

PICCIOLA,—The Prisoner of Fenestrella, illustrated edition, with cuts, royal 12mo, beautiful crimson cloth.
Same work, fancy paper, price 50 cents.

PHILOSOPHY IN SPORT MADE SCIENCE IN EARNEST, 1 vol. 18mo, neat crimson cloth, with cuts.

POPULAR VEGETABLE PHYSIOLOGY, by Carpenter, 1 vol. 12mo, many cuts.

PICKWICK CLUB, by "Boz," cloth or paper.

RUSH'S COURT OF LONDON, 1 vol. 8vo.

RANKE'S HISTORY OF THE POPES OF ROME, 1 vol. 8vo, cloth.

RANKE'S HISTORY OF THE REFORMATION IN GERMANY, to be complete in 1 vol. 8vo.

RANKE'S HISTORY OF THE OTTOMAN AND SPANISH EMPIRES, 8vo, price 50 cents.

ROGERS' POEMS, a splendid edition, Illustrated, imperial 8vo.

ROGET'S OUTLINES OF PHYSIOLOGY, 1 vol. 8vo.

ROSCOE'S LIVES OF THE KINGS OF ENGLAND, a 12mo Series to match Miss Strickland's Queens.

STRICKLAND'S LIVES OF THE QUEENS OF ENGLAND, 12 vols. 12mo, cloth or paper. (This work is now complete.)
Same work, crown 8vo, extra cloth, two vols. in one; large type, and fine paper, beautiful crimson cloth.

SELECT WORKS OF TOBIAS SMOLLETT, cloth or paper.

SIMPSON'S OVERLAND JOURNEY AROUND THE WORLD, crown 8vo, extra cloth.
Same work, 2 parts, paper, price $1 50.

SIBORNE'S WATERLOO CAMPAIGN, with maps, 1 vol. large 8vo.

SCHMITZ AND ZUMPT'S CLASSICAL SERIES FOR SCHOOLS, in neat 18mo volumes, in cloth.

STABLE TALK AND TABLE TALK, FOR SPORTSMEN, 1 volume, 12mo.

SPENCE ON THE JURISDICTION OF THE COURT OF CHANCERY, vol. I., large 8vo, law sheep.
Vol. II., embracing the Practice, (nearly ready).

SMALL BOOKS ON GREAT SUBJECTS; a neat 18mo series, price 25 cents each:—

No. 1. "Philosophical Theories and Philosophical Experience."
No. 2. "On the Connection between Physiology and Intellectual Science."
No. 3. "On Man's Power over himself to Prevent or Control Insanity."
No. 4. "An Introduction to Practical Organic Chemistry."
No. 5. "A Brief View of Greek Philosophy up to the Age of Pericles."
No. 6. "A Brief View of Greek Philosophy from the Age of Socrates to the Coming of Christ."
No. 7. "Christian Doctrine and Practice in the Second Century."
No. 8. "An Exposition of Vulgar and Common Errors, adapted to the Year of Grace 1845."
No. 9. "An Introduction to Vegetable Physiology, with References to the Works of De Candolle, Lindley, &c."
No. 10. "On the Principles of Criminal Law."
No. 11. "Christian Sects in the Nineteenth Century."
No. 12. "Principles of Grammar," &c.

Or the whole done up in three volumes, extra cloth.

TAYLOR'S MEDICAL JURISPRUDENCE, Edited with respect to American Practice, by Griffith, 1 vol. 8vo.

TAYLOR'S TOXICOLOGY, by Griffith, 1 vol. 8vo, (nearly ready).

TRAILL'S OUTLINES OF MEDICAL JURISPRUDENCE, 1 small vol. 8vo, cloth.

TRIMMER'S GEOLOGY AND MINERALOGY, 1 vol. 8vo, cloth, many cuts.

THOMSON'S DOMESTIC MANAGEMENT OF THE SICK ROOM, 1 vol. 12mo, extra cloth.

TOKEAH, by Sealsfield, price 25 cents.

VIRGILII CARMINA, 1 neat 18mo vol., extra cloth, being vol. II. of Schmitz and Zumpt's Classical Series.

WALPOLE'S LETTERS, in 4 large vols. 8vo, extra cloth.

WALPOLE'S NEW LETTERS TO SIR HORACE MANN, 2 vols. 8vo.

WALPOLE'S MEMOIRS OF GEORGE THE THIRD, 2 vols. 8vo.

WHITE'S UNIVERSAL HISTORY, a new and Improved work for Schools, Colleges, &c., with Questions by Professor Hart, in 1 vol. large 12mo, extra cloth, or half bound.

WEISBACH'S PRINCIPLES OF THE MECHANICS OF MACHINERY AND ENGINEERING, vol. I, with five hundred cuts.

WILLIAM THE CONQUEROR, Life of, by Roscoe, 1 vol. 12mo, extra cloth or fancy paper.

WHEATON'S INTERNATIONAL LAW, 1 vol. large 8vo, law sheep, or extra cloth, third edition, much improved.

WRAXALL'S POSTHUMOUS MEMOIRS, 1 vol. 8vo, extra cloth.

WRAXALL'S HISTORICAL MEMOIRS, 1 vol. 8vo, do. do.

YOUATT ON THE HORSE, &c., by Skinner, 1 vol. 8vo, many cuts.

YOUATT ON THE DOG, with plates, 1 vol. crown 8vo, beautiful crimson cloth.

YOUATT ON THE PIG, 1 vol. 12mo, extra cloth, with cuts.
Same work in paper, price 50 cents.

Together with numerous works in all departments of Medical Science, Catalogues of which can be had on application.

THE AMERICAN ENCYCLOPÆDIA.
BROUGHT UP TO 1847.

THE ENCYCLOPÆDIA AMERICANA:
A POPULAR DICTIONARY
OF ARTS, SCIENCES, LITERATURE, HISTORY, POLITICS, AND BIOGRAPHY,

IN FOURTEEN LARGE OCTAVO VOLUMES OF OVER SIX HUNDRED DOUBLE COLUMNED PAGES EACH.

For sale very low, in various styles of binding.

Some years having elapsed since the original thirteen volumes of the

ENCYCLOPÆDIA AMERICANA were published, to bring it up to the present day, with the history of that period, at the request of numerous subscribers, the publishers have just issued a

SUPPLEMENTARY VOLUME (THE FOURTEENTH),

BRINGING THE WORK UP TO THE YEAR 1847.

EDITED BY HENRY VETHAKE, LL.D.

Vice-Provost and Professor of Mathematics in the University of Pennsylvania, Author of "A Treatise on Political Economy."

In one large octavo volume of over 650 double columned pages.

The numerous subscribers who have been waiting the completion of this volume can now perfect their sets, and all who want

A REGISTER OF THE EVENTS OF THE LAST FIFTEEN YEARS, FOR THE WHOLE WORLD,

can obtain this volume separately: price Two Dollars uncut in cloth, or Two Dollars and Fifty cents in leather, to match the styles in which the publishers have been selling sets.

Subscribers in the large cities can be supplied on application at any of the principal bookstores; and persons residing in the country can have their sets matched by sending a volume in charge of friends visiting the city.

"This volume is worth owning by itself, as a most convenient and reliable compend of recent History, Biography, Statistics, &c., &c. The entire work forms the cheapest and probably now the most desirable Encyclopædia published for popular use."—*New York Tribune.*

"The Conversations Lexicon (Encyclopædia Americana) has become a household book in all the intelligent families in America, and is undoubtedly the best depository of biographical, historical, geographical, and political information of that kind which discriminating readers require."—*Silliman's Journal.*

"This volume of the Encyclopædia is a Westminster Abbey of American reputation. What names are on the roll since 1833!"—*N. Y. Literary World.*

"The work to which this volume forms a supplement, is one of the most important contributions that has ever been made to the literature of our country. Besides condensing into a comparatively narrow compass, the substance of larger works of the same kind which had preceded it, it contains a vast amount of information that is not elsewhere to be found, and is distinguished, not less for its admirable arrangement, than for the variety of subjects of which it treats. The present volume, which is edited by one of the most distinguished scholars of our country, is worthy to follow in the train of those which have preceded it. It is a remarkably felicitous condensation of the more recent improvements in science and the arts, besides forming a very important addition to the department of Biography, the general progress of society, &c., &c."—*Albany Argus.*

CAMPBELL'S LORD CHANCELLORS.

NOW COMPLETE.

LIVES OF THE LORD CHANCELLORS AND KEEPERS OF THE GREAT SEAL OF ENGLAND.

FROM THE EARLIEST TIMES TO THE REIGN OF KING GEORGE IV.,

BY JOHN LORD CAMPBELL, A.M., F.R.S.E.

Now complete in seven handsome crown octavo volumes.
Bringing the work to the death of Lord Eldon, 1838.

"The volumes teem with exciting incidents, abound in portraits, sketches, and anecdotes, and are at once interesting and instructive. The work is not only historical and biographical, but it is anecdotical and philosophical. Many of the chapters embody thrilling incidents, while as a whole, the publication may be regarded as of a high intellectual order."—*Inquirer.*

MURRAY'S ENCYCLOPÆDIA OF GEOGRAPHY.

THE ENCYCLOPÆDIA OF GEOGRAPHY,

COMPRISING

A COMPLETE DESCRIPTION OF THE EARTH, PHYSICAL, STATISTICAL, CIVIL, AND

POLITICAL.
EXHIBITING
ITS RELATION TO THE HEAVENLY BODIES, ITS PHYSICAL STRUCTURE, THE NATURAL HISTORY OF EACH COUNTRY, AND THE INDUSTRY, COMMERCE, POLITICAL INSTITUTIONS, AND CIVIL AND SOCIAL STATE OF ALL NATIONS.

BY HUGH MURRAY, F.R.S.E., &c.
Assisted in Botany by Professor HOOKER—Zoology, &c., by W. W. SWAINSON—Astronomy &c., by Professor WALLACE—Geology, &c., by Professor JAMESON.

REVISED, WITH ADDITIONS,
BY THOMAS G. BRADFORD.
THE WHOLE BROUGHT UP, BY A SUPPLEMENT, TO 1843.

In three large octavo volumes,
VARIOUS STYLES OF BINDING.

This great work, furnished at a remarkably cheap rate, contains about NINETEEN HUNDRED large imperial PAGES, and is illustrated by EIGHTY-TWO small MAPS, and a colored MAP OF THE UNITED STATES, after Tanner's, together with about ELEVEN HUNDRED WOOD-CUTS, executed in the best style.

SCHOOL BOOKS.

BIRD'S NATURAL PHILOSOPHY.

NOW READY.

ELEMENTS OF NATURAL PHILOSOPHY,

BEING AN EXPERIMENTAL INTRODUCTION TO THE PHYSICAL SCIENCES.
ILLUSTRATED WITH OVER THREE HUNDRED WOOD-CUTS.

BY GOLDING BIRD, M.D.,
Assistant Physician to Guy's Hospital.
FROM THE THIRD LONDON EDITION.

In one neat volume.

"By the appearance of Dr. Bird's work, the student has now all that he can desire in one neat, concise, and well-digested volume. The elements of natural philosophy are explained in very simple language, and illustrated by numerous wood-cuts."—*Medical Gazette.*

"A volume of useful and beautiful instruction for the young."—*Literary Gazette.*

"We should like to know that Dr. Bird's book was associated with every boys' and girls' school throughout the kingdom."—*Medical Gazette.*

"This work marks an advance which has long been wanting in our system of instruction. Mr. Bird has succeeded in producing an elementary work of great merit."—*Athenæum.*

HERSCHELL'S ASTRONOMY.

A TREATISE ON ASTRONOMY,

BY SIR JOHN F. W. HERSCHELL, F. R. S., &c.
WITH NUMEROUS PLATES AND WOOD-CUTS.
A NEW EDITION, WITH A PREFACE AND A SERIES OF QUESTIONS,
BY S. C. WALKER.

In one volume, 12mo.

BREWSTER'S OPTICS.

ELEMENTS OF OPTICS,

BY SIR DAVID BREWSTER.
WITH NOTES AND ADDITIONS, BY A. D. BACHE, LL.D.
Superintendent of the Coast Survey, &c.

In one volume, 12mo., with numerous wood-cuts.

MULLER'S PHYSICS AND METEOROLOGY.

NOW READY.

PRINCIPLES OF PHYSICS AND METEOROLOGY,

BY J. MULLER,
Professor of Physics at the University of Freiburg.
ILLUSTRATED WITH NEARLY FIVE HUNDRED AND FIFTY ENGRAVINGS ON WOOD, AND TWO COLORED PLATES.

In one octavo volume.

TRANSLATOR'S PREFACE.

In laying the following pages before the public, it seems necessary to state that the design of them is to render more easily accessible a greater portion of the general principles of Physics and Meteorology than is usually to be obtained, without the sacrifice of a greater amount of time and labour than most persons can afford, or are willing to make. The subjects of which this volume treats are very numerous—more numerous, in fact, than at first sight it would seem possible to embrace in so small a compass. The Author has, however, by a system of the most judicious selection and condensation, been enabled to introduce all the most important facts and theories relating to Statics, Hydrostatics, Dynamics, Hydrodynamics, Pneumatics, the Laws of the Motions of Waves in general, Sound, the Theory of Musical Notes, the Voice and Hearing, Geometrical and Physical Optics, Magnetism, Electricity and Galvanism, in all their subdivisions, Heat and Meteorology, within the space of an ordinary middle-sized volume. Of the manner in which the translator has executed his task, it behoves him to say nothing; he has attempted nothing more than a plain, and nearly literal version of the original. He cannot, however, conclude this brief introductory note without directing the attention of his Readers to the splendid manner in which the Publishers have illustrated this volume.

August, 1847.

"The Physics of Muller is a work, superb, complete, unique: the greatest want known to English Science could not have been better supplied. The work is of surpassing interest. The value of this contribution to the scientific records of this country may be duly estimated by the fact, that the cost of the original drawings and engravings alone has exceeded the sum of 2000£."—*Lancet*, March, 1847.

"The plan adopted by Muller is simple; it reminds us of the excellent and popular treatise published many years since by Dr. Arnott, but it takes a much wider range of subjects. Like it, all the necessary explanations are given in clear and concise language, without more than an occasional reference to mathematics; and the treatise is most abundantly illustrated with well-executed wood engravings.

"The author has actually contrived to comprise in about five hundred pages, including the space occupied by illustrations, Mechanics, the Laws of Motion, Acoustics, Light, Magnetism, Electricity, Galvanism, Electro-Magnetism, Heat, and Meteorology.

"Medical practitioners and students, even if they have the means to procure, have certainly not the time to study an elaborate treatise in every branch of science: and the question therefore is, simply, whether they are to remain wholly ignorant of such subjects, or to make a profitable use of the labours of those who have the happy art of saying or suggesting much in a small space.

"From our examination of this volume, we do not hesitate to recommend it to our readers as a useful book on a most interesting branch of science. We may remark, that the translation is so well executed, that we think the translator is doing himself injustice by concealing his name."—*London Medical Gazette*, August, 1847.

GRAHAM'S CHEMISTRY.

NEARLY READY.

ELEMENTS OF CHEMISTRY,

INCLUDING

THE APPLICATIONS OF THE SCIENCE IN THE ARTS.

BY T. GRAHAM, F. R. S., &c.

SECOND AMERICAN, FROM THE SECOND LONDON EDITION.

EDITED AND REVISED BY ROBERT BRIDGES, M.D.,

Professor of Chemistry in the Franklin Medical College, Philadelphia.

In one large octavo volume, with numerous wood-engravings.

This edition will be found enlarged and improved, so as to be fully brought up to a level with the science of the day.

ARNOTT'S PHYSICS.

ELEMENTS OF PHYSICS; OR, NATURAL PHILOSOPHY,

GENERAL AND MEDICAL.

WRITTEN FOR UNIVERSAL USE, IN PLAIN, OR NON-TECHNICAL LANGUAGE.

BY NIELL ARNOTT, M.D.

A NEW EDITION, BY ISAAC HAYS, M.D.

Complete in one octavo volume, with nearly two hundred wood-cuts.

This standard work has been long and favourably known as one of the best popular expositions of the interesting science it treats of. It is extensively used in many of the first seminaries.

ELEMENTARY CHEMISTRY, THEORETICAL AND PRACTICAL,

BY GEORGE FOWNES, PH.D.,

Chemical Lecturer in the Middlesex Hospital Medical School, &c., &c.

WITH NUMEROUS ILLUSTRATIONS.

EDITED, WITH ADDITIONS,

BY ROBERT BRIDGES, M.D.,

Professor of General and Pharmaceutical Chemistry in the Philadelphia College of Pharmacy, &c., &c.

SECOND AMERICAN EDITION.

In one large duodecimo volume, sheep, or extra cloth, with nearly two hundred wood-cuts.

The character of this work is such as to recommend it to all colleges and academies in want of a text-book. It is fully brought up to the day, containing all the late views and discoveries that have so entirely changed the face of the science, and it is completely illustrated with very numerous wood engravings, explanatory of all the different processes and forms of apparatus. Though strictly scientific, it is written with great clearness and simplicity of style, rendering it easy to be comprehended by those who are commencing the study.

It may be had well bound in leather, or neatly done up in strong cloth. Its low price places it within the reach of all.

Extract of a letter from Professor Millington, of William and Mary College, Va.

> "I have perused the book with much pleasure, and find it a most admirable work; and, to my mind, such a one as is just now much needed in schools and colleges. * * * All the books I have met with on chemistry are either too puerile or too erudite, and I confess Dr. Fownes' book seems to be the happiest medium I have seen, and admirably suited to fill up the hiatus."

Though this work has been so recently published, it has already been adopted as a text-book by a large number of the higher schools and colleges throughout the country, and many of the Medical Institutions. As a work for the upper classes in academies and the junior students of colleges, there has been but one opinion expressed concerning it, and it may now be considered as THE TEXT-BOOK for the Chemical Student.

POPULAR SCIENCE.

KIRBY AND SPENCE'S ENTOMOLOGY, FOR POPULAR USE.

AN INTRODUCTION TO ENTOMOLOGY,

OR, ELEMENTS OF THE NATURAL HISTORY OF INSECTS; COMPRISING AN ACCOUNT OF NOXIOUS AND USEFUL INSECTS, OF THEIR METAMORPHOSES, FOOD, STRATAGEMS, HABITATIONS, SOCIETIES, MOTIONS, NOISES, HYBERNATION, INSTINCT, &c., &c.

With Plates, Plain or Colored.

BY W. KIRBY, M.A., F.R.S., AND W. SPENCE, ESQ., F.R.S.

FROM THE SIXTH LONDON EDITION, WHICH WAS CORRECTED AND MUCH ENLARGED.

In one large octavo volume, extra cloth.

"We have been greatly interested in running over the pages of this treatise. There is scarcely, in the wide range of natural science, a more interesting or instructive study than that of insects, or one that is calculated to excite more curiosity or wonder.

"The popular form of letters is adopted by the authors in imparting a knowledge of the subject, which renders the work peculiarly fitted for our district school libraries, which are open to all ages and classes."—*Hunt's Merchants' Magazine.*

JOHNSON AND LANDRETH ON FRUIT, KITCHEN, AND FLOWER GARDENING.

A DICTIONARY OF MODERN GARDENING,

BY GEORGE WILLIAM JOHNSON, ESQ.

Author of the "Principles of Practical Gardening," "The Gardener's Almanac," &c.

WITH ONE HUNDRED AND EIGHTY WOOD-CUTS.

EDITED, WITH NUMEROUS ADDITIONS, BY DAVID LANDRETH, OF PHILADELPHIA.

In one large royal duodecimo volume, extra cloth, of nearly Six Hundred and Fifty double columned Pages.

This edition has been greatly altered from the original. Many articles of little interest to Americans have been curtailed or wholly omitted, and much new matter, with numerous illustrations, added, especially with respect to the varieties of fruit which experience has shown to be peculiarly adapted to our climate. Still, the editor admits that he has only followed in the path so admirably marked out by Mr. Johnson, to whom the chief merit of the work belongs. It has been an object with the editor and publishers to increase its popular character, thereby adapting it to the larger class of horticultural readers in this country, and they trust it will prove what they have desired it to be, an Encyclopædia of Gardening, if not of Rural Affairs, so condensed and at such a price as to be within reach of nearly all whom those subjects interest.

GRAHAME'S COLONIAL HISTORY.

HISTORY OF THE UNITED STATES.

FROM THE PLANTATION OF THE BRITISH COLONIES TILL THEIR ASSUMPTION OF INDEPENDENCE.

SECOND AMERICAN EDITION, ENLARGED AND AMENDED,

WITH A MEMOIR BY PRESIDENT QUINCY.

IN TWO LARGE OCTAVO VOLUMES, EXTRA CLOTH, WITH A PORTRAIT.

This work having assumed the position of a standard history of this country, the publishers have been induced to issue an edition in smaller size and at a less cost, that its circulation may be commensurate with its merits. It is now considered as the most impartial and trustworthy history that has yet appeared.

A few copies of the edition in four volumes, on extra fine thick paper, price eight dollars, may still be had by gentlemen desirous of procuring a beautiful work for their libraries.

ANSTED'S ANCIENT WORLD.

JUST ISSUED.

THE ANCIENT WORLD, OR, PICTURESQUE SKETCHES OF CREATION,

BY D. T. ANSTED, M. A., F.R.S, F.G.S., &c.

PROFESSOR OF GEOLOGY, IN KING'S COLLEGE, LONDON.

In one very neat volume, fine extra cloth, with about One Hundred and Fifty Illustrations.

The object of this work is to present to the general reader the chief results of Geological investigation in a simple and comprehensive manner. The author has avoided all minute details of geological formations and particular observations, and has endeavoured as far as possible to present striking views of the wonderful results of the science, divested of its mere technicalities. The work is printed in a handsome manner, with numerous illustrations, and forms a neat volume for the centre table.

"As a resume of what is at present known on the subject of fossil remains, it is worthy to be a companion to the author's 'Descriptive Geology,' a work of which we have spoken in the highest terms. This volume is illustrated in the style of all Van Voorst's Natural History works, and that is sufficient recommendation. Our extracts will convey a notion of the style of the work, which is, like all that Professor Ansted has written, clear and pointed.—*Athenæum.*

CHEMISTRY OF THE FOUR SEASONS,

SPRING, SUMMER, AUTUMN, AND WINTER.

AN ESSAY, PRINCIPALLY CONCERNING NATURAL PHENOMENA, ADMITTING OF INTERPRETATION BY CHEMICAL SCIENCE, AND ILLUSTRATING PASSAGES OF SCRIPTURE.

BY THOMAS GRIFFITHS,

Professor of Chemistry in the Medical College of St. Bartholomew's Hospital, &c.

In one large royal 12mo. volume, with many Wood-Cuts, extra cloth.

"Chemistry is assuredly one of the most useful and interesting of the natural sciences. Chemical changes meet us at every step, and during every season, the winds and the rain, the heat and the frosts, each have their peculiar and appropriate phenomena. And those who have hitherto remained insensible to these changes and unmoved amid such remarkable, and often startling results, will lose their apathy upon reading the Chemistry of the 'Four Seasons,' and be prepared to enjoy the highest intellectual pleasures. Conceived in a happy spirit, and written with taste and elegance, the essay of Mr. Griffiths cannot fail to receive the admiration of cultivated minds; and those who have looked less carefully into nature's beauties, will find themselves led on step by step, until they realize a new intellectual being. Such works, we believe, exert a happy influence over society, and hence we hope that the present one may be extensively read."—*The Western Lancet.*

PHILOSOPHY IN SPORT, MADE SCIENCE IN EARNEST;

BEING AN ATTEMPT TO ILLUSTRATE THE FIRST PRINCIPLES OF NATURAL PHILOSOPHY, BY THE AID OF THE POPULAR TOYS AND SPORTS OF YOUTH.

FROM THE SIXTH AND GREATLY IMPROVED LONDON EDITION.

In one very neat royal 18mo. volume, with nearly one hundred illustrations on wood. Fine extra crimson cloth.

"Messrs. Lea & Blanchard have issued, in a beautiful manner, a handsome book, called 'Philosophy in Sport, made Science in Earnest.' This is an admirable attempt to illustrate the first principles of Natural Philosophy, by the aid of the popular toys and sports of youth. Useful information is conveyed in an easy, graceful, yet dignified manner, and rendered easy to the simplest understanding. The book is an admirable one, and must meet with universal favour."—*N. Y. Evening Mirror.*

ENDLESS AMUSEMENT.

JUST ISSUED.

ENDLESS AMUSEMENT,

A COLLECTION OF

NEARLY FOUR HUNDRED ENTERTAINING EXPERIMENTS IN VARIOUS BRANCHES OF SCIENCE,

INCLUDING

ACOUSTICS, ARITHMETIC, CHEMISTRY, ELECTRICITY, HYDRAULICS, HYDROSTATICS, MAGNETISM, MECHANICS, OPTICS, WONDERS OF THE AIR PUMP, ALL THE POPULAR TRICKS AND CHANGES OF THE CARDS, &c., &c.

TO WHICH IS ADDED,

A COMPLETE SYSTEM OF PYROTECHNY,

OR THE ART OF MAKING FIRE-WORKS:

THE WHOLE SO CLEARLY EXPLAINED AS TO BE WITHIN REACH OF THE MOST LIMITED CAPACITY.

WITH ILLUSTRATIONS.

FROM THE SEVENTH LONDON EDITION.

In one neat royal 18mo. volume, fine extra crimson cloth.

"It contains everything that can please the grave or the gay. It is 'endless amusement,' and the publishers might have added, instruction. What a help to a dull gathering, or what an able adjunct to a children's party! It may be introduced to the scientific or to the family circle, and to each it will give instruction and pleasure. It is filled with illustrations. We shall give extracts from it occasionally."—*Lady's Book.*

SOMERVILLE'S PHYSICAL GEOGRAPHY.

PHYSICAL GEOGRAPHY.

BY MARY SOMERVILLE.

AUTHOR OF "CONNECTION OF THE PHYSICAL SCIENCES," ETC.

In one neat royal 12mo. volume, extra cloth.

CONTENTS.—Geology—Form of the Great Continent—Highlands of the Great Continent—Mountain Systems of the Great Continent—Africa—American Continent—Low Lands of South America—Central America—North America—Greenland—Australia—The Ocean—Springs—European Rivers—African Rivers—Asiatic Rivers—River Systems of North America—Rivers of South America—Lakes—The Atmosphere—Vegetation—Vegetation of the Great Continent—Flora of Tropical Asia—African Flora—Australian Flora—American Vegetation—Distribution of Insects—Distribution of Fishes—Distribution of Reptiles—Distribution of Birds—Distribution of Mammalia—Distribution, Conditions and Future Prospects of the Human Race.

While reading this work we could not help thinking how interesting, as well as useful, geography as a branch of education might be made in our schools. In many of them, however, this is not accomplished. It is to be hoped that this defect will be remedied; and that in all our educational institutions Geography will soon be taught in the proper way. Mrs. Somerville's work may, in this respect, be pointed to as a model.—*Tait's Edinburgh Magazine*, September, 1848.

READINGS FOR THE YOUNG.

FROM THE WORKS OF SIR WALTER SCOTT.

In two very handsome 18mo. volumes, with beautiful plates, done up in crimson extra cloth.

Messrs. Lea & Blanchard deserve the thanks of all the little people in the land for these delightful volumes, which are as agreeable to read as they are attractive in appearance.—*N. Y. Literary World.*

TALES AND STORIES FROM HISTORY.

BY AGNES STRICKLAND,

AUTHOR OF "LIVES OF THE QUEENS OF ENGLAND," ETC.

In one handsome royal 18mo. volume, crimson extra cloth, with illustrations.

In these pretty tales from the legendary and authentic history of England and Continental Europe, Miss Strickland has hit a happy mean in presenting to the mind of youth, fact in its most fascinating, and fiction in its least objectionable garb. It is a little work which will be dog's eared, and pored over with absorbing interest by the school-boy.—*Balt. Patriot.*

The above works will be found admirable reading books for schools.—Lea & Blanchard also publish the following, which are suitable to advanced classes.

A POPULAR TREATISE ON VEGETABLE PHYSIOLOGY. By W. B. Carpenter, M. D. In one royal 12mo. volume, with wood-cuts.

THE ANCIENT WORLD; OR, PICTURESQUE SKETCHES OF CREATION. By D. T. Ansted, M. A., F. R. S., F. G. S. In one royal 12mo. volume, with 150 wood-cuts.

THE CHEMISTRY OF THE FOUR SEASONS, SPRING, SUMMER, AUTUMN AND WINTER; an Essay principally concerning Natural Phenomena admitting of interpretation by Chemical Science, and illustrating passages of Scripture. By Thomas Griffiths. In one large royal 12mo. volume, with 60 wood-cuts.

BOY'S TREASURY OF SPORTS.

THE BOY'S TREASURY OF SPORTS, PASTIMES AND RECREATIONS.

WITH FOUR HUNDRED ILLUSTRATIONS.

BY SAMUEL WILLIAMS.

IS NOW READY.

In one very neat volume, bound in extra crimson cloth; handsomely printed and illustrated with engravings in the first style of art, and containing about six hundred and fifty articles.
A present for all seasons.

PREFACE.

This Illustrated Manual of "Sports, Pastimes, and Recreations," has been prepared with especial regard to the Health, Exercise, and Rational Enjoyment of the young readers to whom it is addressed.

Every variety of commendable Recreation will be found in the following pages. First, you have the little Toys of the Nursery; the Tops and Marbles of the Play-ground; and the Balls of the Play-room, or the smooth Lawn.

Then, you have a number of Pastimes that serve to gladden the fireside; to light up many faces right joyfully, and make the parlour re-echo with mirth.

Next, come the Exercising Sports of the Field, the Green, and the Play-ground; followed by the noble and truly English game of Cricket.

Gymnastics are next admitted; then, the delightful recreation of Swimming; and the healthful sport of Skating.

Archery, once the pride of England, is then detailed; and very properly followed by Instructions in the graceful accomplishment of Fencing, and the manly and enlivening exercise of Riding.

Angling, the pastime of childhood, boyhood, manhood, and old age, is next described; and by attention to the instructions here laid down, the lad with a stick and a string may soon become an expert Angler.

Keeping Animals is a favourite pursuit of boyhood. Accordingly, we have described how to rear the Rabbit, the Squirrel, the Dormouse, the Guinea Pig, the Pigeon, and the Silkworm. A long chapter is adapted to the rearing of Song Birds; the several varieties of which, and their respective cages, are next described. And here we may hint, that kindness to Animals invariably

denotes an excellent disposition: for, to pet a little creature one hour, and to treat it harshly the next, marks a capricious if not a cruel temper. Humanity is a jewel, which every boy should be proud to wear in his breast.

We now approach the more sedate amusements—as Draughts and Chess: two of the noblest exercises of the ingenuity of the human mind. Dominoes and Bagatelle follow. With a knowledge of these four games, who would pass a dull hour in the dreariest day of winter; or who would sit idly by the fire?

Amusements in Arithmetic, harmless Legerdemain, or sleight-of-hand, and Tricks with Cards, will delight many a family circle, when the business of the day is over, and the book is laid aside.

Although the present volume is a book of amusements, Science has not been excluded from its pages. And why should it be? when Science is as entertaining as a fairy tale. The changes we read of in little nursery-books are not more amusing than the changes in Chemistry, Optics, Electricity, Magnetism, &c. By understanding these, you may almost become a little Magician.

Toy Balloons and Paper Fireworks, (or Fireworks *without* Fire,) come next. Then follow Instructions for Modelling in Card-Board; so that you may build for yourself a palace or a carriage, and, in short, make for yourself a little paper world.

Puzzles and Paradoxes, Enigmas and Riddles, and Talking with the Fingers, next make up plenty of exercise for "Guess," and "Guess again." And as you have the "Keys" in your own hand, you may keep your friends in suspense, and make yourself as mysterious as the Sphynx.

A chapter of Miscellanies—useful and amusing secrets—winds up the volume.

The "Treasury" contains upwards of four hundred Engravings; so that it is not only a collection of "secrets worth knowing," but it is a book of pictures, as full of prints as a Christmas pudding is of plums.

It may be as well to mention that the "Treasury" holds many new games that have never before been printed in a book of this kind. The old games have been described afresh. Thus it is, altogether, a new book.

And now we take leave, wishing you many hours, and days, and weeks of enjoyment over these pages; and we hope that you may be as happy as this book is brimful of amusement.

TRANSCRIBER'S NOTES

1. Images have been moved from the middle of a paragraph to the closest paragraph break.

2. The following misprints have been corrected:
   "umlimited" corrected to "unlimited" (page 67)
   "immerged" corrected to "immersed" (page 124)
   "shil ing" corrected to "shilling" (page 133)
   "where-ever" corrected to "wherever" (page 148)
   "sttll" corrected to "still" (page 149)
   "mattrasses" corrected to "mattresses" (page 156)

3. Other than the corrections listed above, printer's inconsistencies in spelling, punctuation, and hyphenation, have been retained.

Gutenberg™.

1.E.5. Do not copy, display, perform, distribute or redistribute this electronic work, or any part of this electronic work, without prominently displaying the sentence set forth in paragraph 1.E.1 with active links or immediate access to the full terms of the Project Gutenberg™ License.

1.E.6. You may convert to and distribute this work in any binary, compressed, marked up, nonproprietary or proprietary form, including any word processing or hypertext form. However, if you provide access to or distribute copies of a Project Gutenberg™ work in a format other than “Plain Vanilla ASCII” or other format used in the official version posted on the official Project Gutenberg™ website (www.gutenberg.org), you must, at no additional cost, fee or expense to the user, provide a copy, a means of exporting a copy, or a means of obtaining a copy upon request, of the work in its original “Plain Vanilla ASCII” or other form. Any alternate format must include the full Project Gutenberg™ License as specified in paragraph 1.E.1.

1.E.7. Do not charge a fee for access to, viewing, displaying, performing, copying or distributing any Project Gutenberg™ works unless you comply with paragraph 1.E.8 or 1.E.9.

1.E.8. You may charge a reasonable fee for copies of or providing access to or distributing Project Gutenberg™ electronic works provided that:

- You pay a royalty fee of 20% of the gross profits you derive from the use of Project Gutenberg™ works calculated using the method you already use to calculate your applicable taxes. The fee is owed to the owner of the Project Gutenberg™ trademark, but he has agreed to donate royalties under this paragraph to the Project Gutenberg Literary Archive Foundation. Royalty payments must be paid within 60 days following each date on which you prepare (or are legally required to prepare) your periodic tax returns. Royalty payments should be clearly marked as such and sent to the Project Gutenberg Literary Archive Foundation at the address specified in Section 4, “Information about donations to the Project Gutenberg Literary Archive Foundation.”
- You provide a full refund of any money paid by a user who notifies you in writing (or by e-mail) within 30 days of receipt that s/he does not agree to the terms of the full Project Gutenberg™ License. You must require such a user to return or destroy all copies of the works possessed in a physical medium and discontinue all use of and all access to other copies of Project Gutenberg™ works.
- You provide, in accordance with paragraph 1.F.3, a full refund of any money paid for a work or a replacement copy, if a defect in the electronic work is discovered and reported to you within 90 days of receipt of the work.
- You comply with all other terms of this agreement for free distribution of Project Gutenberg™ works.

1.E.9. If you wish to charge a fee or distribute a Project Gutenberg™ electronic work or group of works on different terms than are set forth in this agreement, you must obtain permission in writing from the Project Gutenberg Literary Archive Foundation, the manager of the Project Gutenberg™ trademark. Contact the Foundation as set forth in Section 3 below.

1.F.

1.F.1. Project Gutenberg volunteers and employees expend considerable effort to identify, do copyright research on, transcribe and proofread works not protected by U.S. copyright law in creating the Project Gutenberg™ collection. Despite these efforts, Project Gutenberg™ electronic works, and the medium on which they may be stored, may contain “Defects,” such as, but not limited to, incomplete, inaccurate or corrupt data, transcription errors, a copyright or other intellectual property infringement, a defective or damaged disk or other medium, a computer virus, or computer codes that damage or cannot be read by your equipment.

1.F.2. LIMITED WARRANTY, DISCLAIMER OF DAMAGES - Except for the “Right of Replacement or Refund” described in paragraph 1.F.3, the Project Gutenberg Literary Archive Foundation, the owner of the Project Gutenberg™ trademark, and any other party distributing a Project Gutenberg™ electronic work under this agreement, disclaim all liability to you for damages, costs and expenses, including legal fees. YOU AGREE THAT YOU HAVE NO REMEDIES FOR NEGLIGENCE, STRICT LIABILITY, BREACH OF WARRANTY OR BREACH OF CONTRACT EXCEPT THOSE PROVIDED IN PARAGRAPH 1.F.3. YOU AGREE THAT THE FOUNDATION, THE TRADEMARK OWNER, AND ANY DISTRIBUTOR UNDER THIS AGREEMENT WILL NOT BE LIABLE TO YOU FOR ACTUAL, DIRECT, INDIRECT, CONSEQUENTIAL, PUNITIVE OR INCIDENTAL DAMAGES EVEN IF YOU GIVE NOTICE OF THE POSSIBILITY OF SUCH DAMAGE.

1.F.3. LIMITED RIGHT OF REPLACEMENT OR REFUND - If you discover a defect in this electronic work within 90 days of receiving it, you can receive a refund of the money (if any) you paid for it by sending a written explanation to the person you received the work from. If you received the work on a physical medium, you must return the medium with your written explanation. The person or entity that provided you with the defective work may elect to provide a replacement copy in lieu of a refund. If you received the work electronically, the person or entity providing it to you may choose to give you a second opportunity to receive the work electronically in lieu of a refund. If the second copy is also defective, you may demand a refund in writing without further opportunities to fix the problem.

1.F.4. Except for the limited right of replacement or refund set forth in paragraph 1.F.3, this work is provided to you 'AS-IS', WITH NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PURPOSE.

1.F.5. Some states do not allow disclaimers of certain implied warranties or the exclusion or limitation of certain types of damages. If any disclaimer or limitation set forth in this agreement violates the law of the state applicable to this agreement, the agreement shall be interpreted to make the maximum disclaimer or limitation permitted by the applicable state law. The invalidity or unenforceability of any provision of this agreement shall not void the remaining provisions.

1.F.6. INDEMNITY - You agree to indemnify and hold the Foundation, the trademark owner, any agent or employee of the Foundation, anyone providing copies of Project Gutenberg™ electronic works in accordance with this agreement, and any volunteers associated with the production, promotion and distribution of Project Gutenberg™ electronic works, harmless from all liability, costs and expenses, including legal fees, that arise directly or indirectly from any of the following which you do or cause to occur: (a) distribution of this or any Project Gutenberg™ work, (b) alteration, modification, or additions or deletions to any Project Gutenberg™ work, and (c) any Defect you cause.

Section 2. Information about the Mission of Project Gutenberg™

Project Gutenberg™ is synonymous with the free distribution of electronic works in formats readable by the widest variety of computers including obsolete, old, middle-aged and new computers. It exists because of the efforts of hundreds of volunteers and donations from people in all walks of life.

Volunteers and financial support to provide volunteers with the assistance they need are critical to reaching Project Gutenberg™'s goals and ensuring that the Project Gutenberg™ collection will remain freely available for generations to come. In 2001, the Project Gutenberg Literary Archive Foundation was created to provide a secure and permanent future for Project Gutenberg™ and future generations. To learn more about the Project Gutenberg Literary Archive Foundation and how your efforts and donations can help, see Sections 3 and 4 and the Foundation information page at www.gutenberg.org.

Section 3. Information about the Project Gutenberg Literary Archive Foundation

The Project Gutenberg Literary Archive Foundation is a non-profit 501(c)(3) educational corporation organized under the laws of the state of Mississippi and granted tax exempt status by the Internal Revenue Service. The Foundation's EIN or federal tax identification number is 64-6221541. Contributions to the Project Gutenberg Literary Archive Foundation are tax deductible to the full extent permitted by U.S. federal laws and your state's laws.

The Foundation's business office is located at 809 North 1500 West, Salt Lake City, UT 84116, (801) 596-1887. Email contact links and up to date contact information can be found at the Foundation's website and official page at www.gutenberg.org/contact

Section 4. Information about Donations to the Project Gutenberg Literary Archive Foundation

Project Gutenberg™ depends upon and cannot survive without widespread public support and donations to carry out its mission of increasing the number of public domain and licensed works that can be freely distributed in machine-readable form accessible by the widest array of equipment including outdated equipment. Many small donations ($1 to $5,000) are particularly important to maintaining tax exempt status with the IRS.

The Foundation is committed to complying with the laws regulating charities and charitable donations in all 50 states of the United States. Compliance requirements are not uniform and it takes a considerable effort, much paperwork and many fees to meet and keep up with these requirements. We do not solicit donations in locations where we have not received written confirmation of compliance. To SEND DONATIONS or determine the status of compliance for any particular state visit www.gutenberg.org/donate.

While we cannot and do not solicit contributions from states where we have not met the solicitation requirements, we know of no prohibition against accepting unsolicited donations from donors in such states who approach us with offers to donate.

International donations are gratefully accepted, but we cannot make any statements concerning tax treatment of donations received from outside the United States. U.S. laws alone swamp our small staff.

Please check the Project Gutenberg web pages for current donation methods and addresses. Donations are accepted in a number of other ways including checks, online payments and credit card donations. To donate, please visit: www.gutenberg.org/donate

Section 5. General Information About Project Gutenberg™ electronic works

Professor Michael S. Hart was the originator of the Project Gutenberg™ concept of a library of electronic works that could be freely shared with anyone. For forty years, he produced and distributed Project Gutenberg™ eBooks with only a loose network of volunteer support.

Project Gutenberg™ eBooks are often created from several printed editions, all of which are confirmed as not protected by copyright in the U.S. unless a copyright notice is included. Thus, we do not necessarily keep eBooks in compliance with any particular paper edition.

Most people start at our website which has the main PG search facility: www.gutenberg.org.

This website includes information about Project Gutenberg™, including how to make donations to the Project Gutenberg Literary Archive Foundation, how to help produce our new eBooks, and how to subscribe to our email newsletter to hear about new eBooks.