

THE ART OF MAKING
FIREWORKS.



TURNER & FISHER:

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THE
**ART OF MAKING
FIREWORKS**

WITH SAFETY AND EASE.

CONTAINING INSTRUCTIONS FOR THE FOLLOWING :

Artificial Fireworks,
Artificial Thunder,
Blue Flame,
Blue Candle,
Balloons,
Crackers,
Fancy Devices,
Fires, (various sorts)
Fountains,
Gerbes,
Lights,
Mines,
Mortars,

Marroons,
Roman Candles,
Rockets,
Rains, Gold and Silver,
Stars,
Serpents,
Sparks,
Tourbillons,
Wheels, Catherine,
Wheels.
Wildfires,
Water Fireworks,
&c., &c., &c.



WITH FULL INFORMATION RELATIVE TO THE PROPERTIES, AS WELL
AS MIXING AND PREPARING

GUNPOWDER, SALTPETRE, CHARCOAL, STEEL AND IRON
FILINGS, &c., &c.

TURNER & FISHER:
NEW YORK AND PHILADELPHIA,
PUBLISHERS.

A TREATISE
ON THE
ART OF MAKING FIREWORKS,
DETONATING BALLS, &c.

OF THE SEVERAL INGREDIENTS FOR MAKING
FIREWORKS.

GUNPOWDER.

GUNPOWDER being a principle ingredient in Fireworks, 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 powder, consisting of a certain proportion of sulphur, nitre, and coal, the coal presently takes fire, upon contact with 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, propagate the same effect almost instantaneously, whence the whole mass of powder comes to be fired: and as nitre contains both a large portion 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 aerial parts, to act as bellows to the other inflammable bodies, (sulphur and coal,) to blow them into a flame, and carry off the whole substance in smoke and vapour.

SALTPETRE.

Saltpetre is another principal ingredient in fireworks, and a volatile body: by reason of its aqueous and aerial parts, it is easily rarefied by fire: but not so soon when foul and gross, as when purified from its crude and earthy parts,

which greatly retard its velocity; therefore it is necessary first to examine the saltpetre, and to see that it be well cleansed from all impurities, and of a good sort, or your works will not have the proper effect.

OF SULPHUR, OR BRIMSTONE.

Sulphur is by nature the food of fire, and one of the principle ingredients in gunpowder, and almost in all compositions of fireworks: 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 the sulphur is 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 proper for use. It is better to buy the flour ready made, as it is done in large quantities, and in a great perfection.

CHARCOAL.

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 pieces of about 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 then set it on fire; when thoroughly lighted and in a flame, cover the hole 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 them in a dry place for use. It is to be observed, that charcoal for fireworks must always be soft and well burnt, which may be bought ready done.

METHOD OF PREPARING GUNPOWDER, CHARCOAL AND BRIMSTONE, OR SULPHUR,

FOR MAKING FIREWORKS.

Mealed gunpowder being so essential an article in the manufacture of fireworks, it is necessary to give proper directions for it. It should be reduced to such a degree of

fineness, that not one grain shall be larger than another; or the fire can never be regular, nor can your work burn near so long; for if large grains are put into a case, it explodes two or three times the quantity that would burn otherwise in a fair manner. Having laid your powder on a hard table, take a wooden muller (one made of lignum vitæ is the best,) and proceed to rub your powder till the grains are broken; then put it into a lawn seive, and what will not pass through the seive, return it to the table, and rub it till the whole passes through. Your powder will then be proper for mixing: Sulphur and charcoal must be done in the same manner.

METHOD OF MAKING TOUCH PAPER.

Dissolve, in spirits of wine or vinegar, a little saltpetre; then take some purple or blue paper, and wet it with this 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 a 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, and twist the paper to a point.

TO MEAL GUNPOWDER, BRIMSTONE, AND CHARCOAL.

To meal these articles, a wooden mallet or a stone should be used, for were they to be done with an iron hammer, there would be danger of your powder exploding. You should spread your powder on a stone, and with your mallet you will soon reduce it to powder. Brimstone should be bought ready powdered; and charcoal may be pounded the same way as gunpowder: but for this an iron hammer may be safely used.

STEEL OR IRON FILINGS.

Being used in fireworks to give a brilliancy to them, some observations on them may not be amiss. If your fireworks are to be used directly, you must use the filings

without preparation ; but if they are to be kept by you a few months, or longer, the filings should be prepared.

TO PRESERVE STEEL OR IRON FILINGS.

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 weakened ; but, 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 quickly 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 before moistened with linseed oil.

If the brimstone should take fire, you may put it out by covering the pan close at top. It is not of much significance what quantity of brimstone you use, so that there be enough to give each grain of iron a coat ; but as much as will cover the bottom will do.

OF MIXING THE SEVERAL INGREDIENTS.

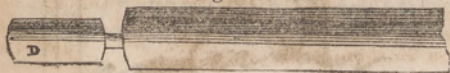
The performance of the principal part of fireworks, depends much on the composition being well mixed ; therefore great care ought to be taken in this part of the work, particularly in the composition for sky-rockets. First put the different ingredients together, then work them about with your hands, till you think they are pretty well incorporated ; after which put them in a fine sieve, and after it is sifted, any remains that will not pass through the sieve, grind again till fine enough. Common works are not so material, nor need they 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 steel or iron filings in their charge, keep long in damp weather, without being properly prepared according to the directions before given.

HOW TO MAKE ALL SORTS OF MOULDS.

In the first place, you must get the best dried box-wood you can, or if that cannot be procured, some other tough wood, such as crab-tree, holly, or such like wood. Having decided on the height of your bore: say, for example, to have one bored of an inch high, which you can get bored by some turner: and to know of what length it must be, take for the said length, six diameters of the bore, which make six inches; and for the thickness, it must be half a diameter on each side, so that being turned round, it contains two inches in diameter. You must then provide a bottom, or foot, for the mould, which must be two diameters, or two inches in height, and one diameter and a quarter in breadth, whether the bottom be round or square. When you have made your mould, then you must fit your roller, which must be two third parts of the diameter of the bore of the said mould, and the length thereof to be six inches longer than your mould; this roller, which is for the rolling of your paper, must have a hole bored in the bottom to receive a wire, which wire must be fastened in another piece of wood somewhat shorter, which wire may be taken out at pleasure; this piece of wood may be as long as a person can hold conveniently in his hand; and which will be more plainly described in treating of rolling cases, in the next chapter. When you have fitted your rockets according to this direction, proceed to the making of your rammers, of which there must be always two, at the least, to each mould, made thus: which rammer must be somewhat less than the roller (Fig. a.) because otherwise, in putting it in, it will put down the paper, which is very prejudicial to your rocket.

Fig. a.



THE METHOD OF ROLLING CASES FOR ROCKETS.

Having explained the manner and form of the mould and its dependants, we come now to treat of their use. 1st. *the use of the roller (Fig. a.)* The cases must be made of good strong catridge paper: cut this paper, so that it be one inch longer than the mould. Take your roller and one length of paper, and begin to roll; when you have rolled one sheet, you must in order to make your case as hard as possible, place it on some smooth table or board; hold the roller in your left hand, and the board in your right; roll it very hard one way, proceed so with every sheet, till it is of bigness enough to fill the mould very straight: when you have so done, draw forth your roller one inch, and then take the other part of the roller, which is short, and marked (D.) and put it in as you see described; and thus you have a place left for the choaking of your rocket.

HOW TO CHOAK A ROCKET.



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You must have a ring to screw into some post, to which ring you must tie your cord, which cord must be bigger or less, according to the size of your rocket; for a small cord will not choak a great rocket, and, *vice versa*, a great cord will not do for a small rocket; for it will make too great a choak; so you must have small cord and large cord. When you have provided yourself with these cords, tie one end of your cord to the ring; and about a yard off tie the other end of the cord to a strong stick. Having twisted the cord, put the stick between your legs, and wind the cord about the rocket case, in the place appointed, which is between the long roller and the short (See Fig. *a*;) when you have so done, girt it by degrees, continually turning your roller, in order that it may come close and neat: when you have choaked it sufficiently, draw forth your short roller, and where your choaking is, tie it about with strong pack-thread, and then drawing forth your long roller, you have a case ready to be filled when occasion requires.

FOR ROCKETS FROM ONE OUNCE TO THREE.

Take only powder dust, well sifted, and fine, which rises swiftly, but it carries no tail. The ordinary quantity for small rockets, under four ounces, is, of

Powder, mealed, 1 lb. Saltpetre 2 oz. Coal-dust, or charcoal 2 oz.

ROCKETS OF FOUR OUNCES.

Meal-Powder 1 lb. Saltpetre 4 oz. Charcoal 3 oz.

ROCKETS OF EIGHT OUNCES.

I. Mealed-powder 1 lb. Saltpetre 4 oz. Brimstone 3 oz. Charcoal 1½ oz.

II. Meal-powder 1½ lb. Charcoal 4½ oz.

ROCKET OF ONE POUND.

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

SKY ROCKETS IN GENERAL.

I. Saltpetre 4 lb. Brimstone 1 lb. Charcoal 1½ lb.

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

CRACKERS.

Cut some stout catridge-paper into pieces three inches and a half broad, and one foot long; one edge of each of these pieces fold down lengthwise rather less than an inch broad, fold the double edge down a quarter of an inch, and turn the single edge back half over the double fold; then 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 done, bend it backwards and forwards, two inches and a half, or thereabouts, at a time, as often as the paper will allow; then 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; then 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 greater 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.

WATERLOO CRACKERS.

Take a slip of catridge-paper, about three quarters of an inch wide, paste and double it; when it is quite dry, cut it into two equal lengths, as A and B in the pattern:

A	S G	B
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When you have proceeded thus far, glue or gum the paper slips in the parts marked G in the pattern, and on it strew a little powdered glass, or coarse (No. 1) emery; then put a grain of the silver on the part marked S, and while the glass composition is moist, put the paper marked A over the furthest 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.

WATER CRACKERS WHICH TURN IN THE WATER.

The case is made nine or ten diameters long; the neck is drawn quite close, and charged with meal-powder almost half full; upon this a partition is made with a hole in it; then put corn-powder for a report; upon that is placed another partition; and the paper cut short at both ends. When these crackers are to be fired, make a touch-hole at the end of both, reversed. Having filled them up with meal-powder, and covered them well with brandy-dough, you may fire and fling them into the water, having previously dipped them in melted wax or pitch.

A SLOW FIRE,

Must be composed of saltpetre four ounces, brimstone two ounces, and meal-powder one ounce and a half.

DEAD FIRE.

Saltpetre one ounce and a quarter, brimstone a quarter of an ounce, lapis calaminaris a quarter of an ounce, and antimony two drachms. *

BRILLIANT FIRE.

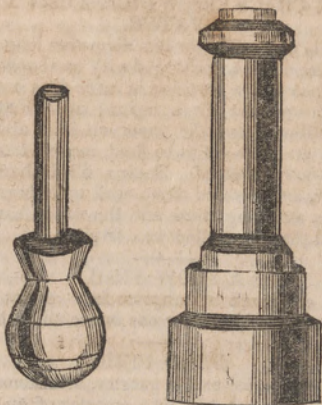
Meal-powder one pound, saltpetre one ounce and a half, brimstone half an ounce, and steel-dust one ounce and a half.

FOR A BLUE FLAME.

Meal-powder, saltpetre, and sulphur-vivum; the sulphur must be the chief part. Or, meal-powder, saltpetre, brimstone, spirits of wine, and oil of spike; but let the powder be the principal part.

INGREDIENTS THAT MAKE SPARKS WHEN RAMMED IN CASES.

The set colours of fire produced by sparks are divided in 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, saltpetre, sulphur, and charcoal; the grey of three, meal-powder charcoal, and saw dust; and the red of four, meal-powder sulphur, file-dust, and a small portion of charcoal.



PORT, OR WILD FIRES.

Saltpetre four ounces, meal-powder six ounces, and brimstone two ounces. This composition must be moistened with one gill of linseed oil.

WILDFIRE WHICH BURNS UNDER WATER.

This is composed of equal quantities of sulphur, naptha, bitumen, pitch, and gum; and can only be extinguished by vinegar mixed with sand and urine, or by covering it with raw hides.

TO PRODUCE AN EXPLOSION IMITATING GUN-POWDER.

Take a phial, which hold reserved the space of a minute over a bottle of dissolution of iron. Take away the phial, and afterwards put a lighted candle to its mouth, and you will see the effects.

TO MAKE A CATHERINE WHEEL.

Take a piece of cartridge-paper, of what length you please, and roll it twice round a pretty thick wire, pasting

as you roll it; when the cases are dry, take the wire out, and fill it with a composition of slow fire such as follows:—one part of champhor, one part of saltpetre, one part of sulphur, and two parts of mealed powder: after your cases are thus filled, you must twist it round a small wooden wheel, or a bone button mould; and to fasten it at the end, you may either use sealing wax, or what is much better, paste a piece of cartridge-paper across the catherine wheel; when this is done, put a bit more of your composition to the mouth of your case, and fasten a bit of touch-paper to the end. When this is done, it is ready for use.

They may be made with half the above directed quantity of champhor.

ARTIFICIAL FIREWORKS.

PRELIMINARY OBSERVATIONS.

Previously to giving our young readers the necessary instructions for making Artificial Fireworks, we must solicit their attention to a few preliminary observations on the different colours of the fire, &c.

To construct Artificial Fireworks, so as to produce a proper and striking effect, three circumstances are to be carefully observed: the first is, the different colours of the fire; the second, the manner of cutting out the several figures; and the third, the direction of the motion of each piece, whether it be swift or slow, straight or circular.

Artificial Fireworks may be reduced to four principle colours: the first is that of jets of fire, which is of a clear white; the second is that of such jets as are of a yellow or gold colour; the third is that of serpents or rockets, which is very bright, and of a light blue cast; and the fourth is that of a colour inclining to red, commonly used in cascades of fire. There is another sort of fire of a stronger blue, of which ciphers and emblems are formed, and which is placed on the centres of suns, and may be made to produce a very brilliant effect.

The vivacity of fire being imitated, by the rays of light that fall upon transparent paper, as we shall show hereafter

the paper is to be stained with different colours, and should be quite thin : after it is coloured, it may be made more transparent, by being dipped in, or rubbed over with clear oil. For the first sort of fire, it is left to its own natural colour ; for the second, an infusion of saffron may be used, made more or less strong ; for the third, a light tincture of Prussian blue ; and for the fourth, a small quantity of lake may be put in the saffron water just mentioned.

If, among these fireworks, you would have some parts that are transparent, and through which other parts are to be seen, you must use, for the transparent parts of a paper that is thicker than the other, that the latter may appear with a due degree of superior lustre : for in these exhibitions, it is from a just mixture of light and shade that the most pleasing effects are produced.

Having disposed of these preliminary observations, we proceed to state the various devices or imitations of which this ingenious recreation is susceptible.

TO IMITATE A JET DE FRU, COLUMN, GLOBE, OR PYARMID OF FIRE.

Fig. 1.



Fig. 2.



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 Artificial Fireworks as are to be seen through transparent papers. Let it be of a proper size for the figure you intend to exhibit.

Now refer to Figures 1 and 2.) In this paper, cut out with a penknife, several spaces, B, B, B, B, beginning at the point A; and with a piercer, make a great number of holes, rather long than round, and at no regular distance from each other; observing, however, that they must form right lines from the point, A, as expressed in the figures; the parts engraved being those that are to be cut out. Punches, fit for this purpose, which have the superior advantage of completely cutting out the part, instead of merely piercing through the paper, may be purchased at the ironmongers' shops.

Fig. 3.

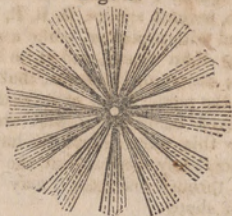


Fig. 4.



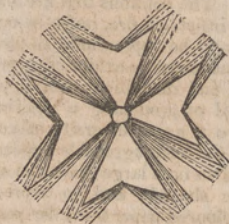
To represent revolving pyramids and globes, such as Figures 3 and 4, the paper must be cut through with a penknife; and the space, cut out between each spiral, should be three or four times as wide as the spirals themselves. You must observe to cut them in the form represented in the figures, that the pyramid or globe may appear to turn on its axis. The columns that are shown 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 a pleasing effect; but there should not be a great diversity of colours, as that 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.

Fig. 5.



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, as Fig 5, or of a star, as Fig 6, you must construct a wire wheel, of the same diameter with those pieces : this wheel has a rim and five or more spokes, or radii, branching from the centre to the rim ; it is made of wire, that its radii, by being small, may not intercept the light that is to be placed behind it ; over it, you paste a very thin paper, on which is drawn, with thick black ink, the spiral figure represented by Fig 7. The wheel thus prepared, is to be placed behind the sun or star, in such manner, that its axis may be exactly opposite the centre of either of those figures. This wheel may be turned, by any means you think proper.

Fig 6.



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 space 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 between them, that form the 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.

Fig. 7.



It will be proper to place these 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 the hinder part of the box, where the lamps are placed, lined with tin, with an opening behind.

The several figures cut out, should be placed in frames, (See Fig. 8.) that they may be put alternately, in a groove

Fig. 8.



in the fore part 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.

When there is an opportunity of representing these artificial fires by a hole made in a partition, they will, doubtless, have a much more striking effect, as the spectator cannot then imagine by what means they are produced. In fact, all Artificial Fireworks, if the apparatus be neatly constructed, and they are cleverly managed, are calculated to produce, not only a great deal of pleasure, but extreme astonishment, in the beholders; as they will, unless acquainted with the art of making them, be at a loss to account for the production of such singular effects.

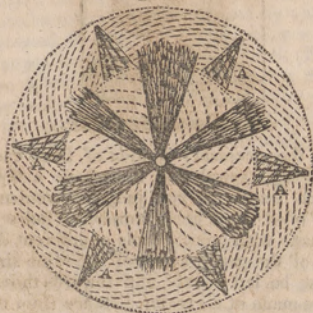
Fig. 9.



To represent fires that flow from the circumference to the centre, as B, &c. (Fig. 9.) and, at the same time, others that flow from the centre to the circumference, as A, &c. you must construct the double spiral, as represented, Fig. 9.

When this wheel is placed behind Fig. 8, the concentric spiral, A, (Fig. 9,) being opposite the parts, A, (Fig. 8,) the fire will appear to issue from the centre, as before; but the parts against the eccentric spiral of the wheel, B, (Fig. 9,) which are those marked B, in Fig. 8, will appear to move from the circumference to the centre.

Fig. 10.



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, as in Fig. 10, where are drawn on the transparent piece, the spirals that are proper to produce, not only jets de feu, but also small pyramids, as A, A, &c, which will appear to turn on their centres. It is manifest, also, that on the same principal, a great variety of transparent figures may be contrived, which may be placed before the same spiral lines.

TO REPRESENT CASCADES OF FIRE.

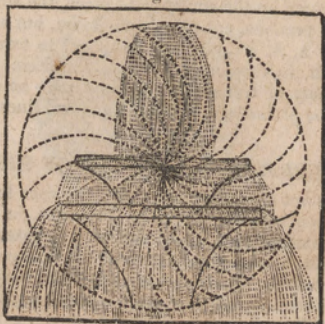
In cutting out cascades, you must take care to preserve a natural inequality in the parts cut out; for if, to save time, you would make all the holes with the same pointed tool, the uniformity of the parts will not fail to produce a disagreeable effect. As these cascades are very pleasing when well executed,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

Fig. 11.



To produce the necessary 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 great number of holes near each other, and made with pointed tools of different dimensions. 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. This paper is to be fixed, by its two extremities, to the two rollers, A and B, (Fig. 11.) When the cascade that is cut out, is placed before the scroll of paper just mentioned, and

Fig. 12.



it is entirely wound upon the roller, A, the ends of the paper being quite opaque, no part of the cascade will be visible; but as the winch, D, is turned gently and regularly round, the transparent part of the paper proceeding from A to B, 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. A cascade may also be tolerably well executed by a spiral, in the manner expressed in Fig. 12, but the roller is more eligible. The paper being totally rolled on B, (Fig. 11,) the part between A and B, will be quite opaque; therefore, the cascade may be then taken away, and another piece, which represents fire that ascends as a jet, may be placed in its room; and thus the pieces may be alternately and continually changed.

IMITATIVE ILLUMINATIONS.

On a very strong double paper, the back of which is blacked with lamp-black, dissolved in brandy, or any spirit, and diluted with gum-water, you must first paint the draught of the illumination you intend to represent in miniature, and mark the exact place of the several lamps, and other parts that compose it. Then take punches of different sizes, which may be purchased at the ironmongers, and with which make holes in the papers, in such forms as shall represent the flame of a lamp, or any other body. If the lamps are supposed to be all in a line, you must use the finest punches for the smallest lamps, and the larger for the greatest; but if the parts of the illumination be supposed at different distances, then the fine punches are to be used for those parts that are most distant, and the holes must be nearer together, in proportion to the distance. If there be objects in front, perpendicular to the point of view, you must use punches whose diameters decrease insensibly, and make the holes continually closer, in proportion as the extremities of the front are more distant. When the piece is completely cut out, place behind this double paper, one that is very thin; colour the parts that are to appear the most distant, with a little lake; it is then to be placed in a box, and strongly illuminated behind

by several candles or lamps. The candles should be placed at five or six inches distance from the paper, and equidistant from each other, and if they do not produce a light sufficiently strong, you may place more. It will be proper to line the box with tin, as that will reflect the light on the piece. The front of the paper should also be illuminated with a faint light, such as is just sufficient to show the pieces of architecture that may be painted on it.

AQUATIC FIREWORKS.

HOW TO MAKE A WATER BALL, WHICH SHALL BURN IN THE WATER.

Having determined on the size of your ball, take the circumference and halve it, and of that make a circle, which cutting out in strong canvas shall be half a case, so that sewing two of them together they shall make a case. Having made your case, proceed to the filling it, which must be done thus:—First, put in three or four good spoonsful of your mixture, and then with a stick, made round at one end, force it close together and so continue filling it, and between every filling put in your stick and press it together, rounding it continually in your hand till such time as you have finished it; which having done, sew it up close, and then arm it with a small cord, which is called marling; after you have done that, you must coat it with a quantity of rosin, pitch, and tallow dissolved, and dip your ball all over in the same, providing always that you leave two vents to fire it, which shall be pierced a third part into your ball, and must be stopped with small sticks, till such time as you come to use them; then pulling forth the stick, fill the two vents with fine powder dust, and firing it, cast it into the water, and you will have your desire. You must always let your ball be thoroughly fired before you cast it from you.

A WATER BALL TO THROW UP NUMEROUS ROCKETS IN THE AIR.

Prepare a ball of wood of eight inches diameter, and bore a hole in the middle, of about an inch and a half, and let it come within an inch from the bottom; and about the great hole you must bore eight smaller holes, of the size of an inch, so that they be big enough to receive a rocket. These small holes should be an inch distant from the great hole, but they must all meet in one at the bottom; therefore you must cut off the bottom of the ball, and fit another to it, which may be so hollowed that your mixture may be conveyed to all the rockets; then fasten on the bottom (having filled it with your mixture,) and put it into your two rockets, with the mouths downwards, passing paper round about them, which must be coated with rosin and tallow; and over each place where the rockets are placed, let the tallow be soaped over, in order that when it be fired the sparks may not easily take fire of the paper, which would make some confusion. Having done this, fit in a piece of wood to the greater bore of your ball, leaving only a smaller vent of half an inch, and by this means the fire will come out with more violence, and having spent itself within one inch of the bottom, it shall fire the eight rockets placed about, which by their force shall break the paper of each, and ascend into the air a small height, and after lie tumbling in the water.

WATER ROCKETS.

Cases for these are made in the same manner as sky-rockets, only a little thicker of paper. When you fill those which are drove solid, put in one ladleful of slow fire, and then two of the proper charge, and on that two or three ladles of sinking charge, then the proper charge, then the sinking charge again, and so on till you have nearly filled the case; then drive on the composition a thin cake of clay, through which make a small hole to the charge; then fill the case 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 your rockets (according to the above directions,) dip their ends in melted rosin or sealing-wax, or else secure them well with grease. When you fill these rockets throw in six or eight at one time.

THE FOLLOWING ARE THE PROPER CHARGES.

	lb.	oz.
Brimstone - - - - -	0	4½
Saltpetre - - - - -	1	0
Charcoal - - - - -	0	6

OR THE FOLLOWING :

Meal-powder - - - - -	1	0
Saltpetre - - - - -	4	0
Sea coal - - - - -	0	1
Charcoal - - - - -	0	8½
Sulphur - - - - -	0	1
Saw-dust - - - - -	0	0¾
Steel-dust - - - - -	0	9½

THE PROPER CHARGE FOR SINKING ROCKETS.

Meal-powder - - - - -	0	8
Charcoal - - - - -	0	0

Water Rockets may be made from four ounces to five pounds.

OTHER CURIOUS DEVICES FOR THE WATER.

Those places near or where water is situated are suitable for the display of these devices; therefore when you wish to give your friends a specimen of your ingenuity, you can make figures of beasts, fishes or the like, spitting out fire as they run through the water. Among other designs which an inventive fancy can easily accomplish, is the representing a castle, out of a door of which a dragon or any other animal may issue, by pulling a string, at the same time by means of other strings, a horseman, or Neptune on a sea horse may advance to encounter the dragon. The castle, or house, or tent, or what device may best please your fancy, should be made of light wire-work covered with oil-skin, and placed on a light wooden frame which serves to support it in the water. This frame should be so balanced as to sink it sufficiently deep, that it may not overset. When you construct the facing of your castle, which indeed is all that is necessary, you should contrive such a door at the water's edge as will, by pulling a string open; and by pulling another the dragon must come out. Your horseman, or Neptune, must be supported in the like

manner, and when it advances, by your pulling the string affixed to it, you should light one of the serpents which are put either on the turrets of the castle, or in one of its windows; upon this Neptune should seem to retreat, but presently afterwards again advance, and then several other of your serpents should be fired, and the dragon be made to advance, his nostrils and mouth also issuing forth fire. You may by these few hints construct many other ingenious devices, and that too at a very trifling expense; one pennyworth of tin wire being more than sufficient for your castle, dragon, Neptune and all; and if oil-skin cannot easily be procured, stout oil-paper will make a substitute; or pasteboard oiled over will do for your Neptune and dragon. To light your squibs or serpents placed about the castle, you can use a long thin stick, with a bit of touch-paper at the end, which will easily communicate with the touch-paper of the fireworks. One remark, however, must be made; you must confine your device by a string, so that when you fire it, it may not run so far into the water as to be beyond your reach.

TO MAKE A ROMAN CANDLE.

The cases for Roman Candles may be made for any size but those of half an inch across the mouth, and in length about six inches, are as good as any. When you have made your cases and choked them tight at one end, proceed to fill them. The charge for filling may be composed of three parts of saltpetre, two parts of brimstone, one part of meal powder, and one fourth of finely powdered glass; or four parts of saltpetre, two parts of brimstone, one part and a half of meal powder, and one part of finely powdered glass.

When you have finely powdered and well mixed either of those compositions, you can charge your cases; but in doing this, observe the following directions; first put in a little mealed powder, and then a star, (directions for making the different stars are hereafter given; but they may be varied by any of the more brilliant fires before described,) on which ram lightly a ladleful of composition, then a little mealed powder, and on that a star; then again composition, and so on till you have filled the cases. Stars for Roman candles should not be round, but must be either

square or flat and oval, 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 Roman candles 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 Roman candles, 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 too many stars at once.

COMMON PORT FIRES.

Port Fires are made of any length, but seldom more than twelve inches long. They are meant only to fire the works, their fire being very slow, and the heat of the flames so intense, that when applied to leaders, rockets, &c., it will fire them immediately. The cases for the common port fires must be rolled wet with paste, and one end pinched or folded down.

PROPER COMPOSITION FOR A COMMON PORT FIRE WHICH
MUST BE MOISTENED WITH ONE GILL OF LINSEED OIL.

	lb.	oz.
Saltpetre, - - - - -	0	12
Sulphur, - - - - -	0	4
Meal powder, - - - - -	0	2

OR THE FOLLOWING.

Saltpetre - - - - -	1	2
Meal-powder - - - - -	1	8
Sulphur - - - - -	0	10

PIN WHEEL.

First roll some paper pipes, about 14 inches long each; these pipes must not be made thick of paper, two or three rounds of elephant paper being sufficient. When your

pipes are dried, you must have a thin tube 12 inches long, to fit easy into the pipes; at the end of this tube fix a small funnel; then bend one end of one of the pipes, and put the funnel in at the other as far as it will reach, and fill the cup with composition. Having filled some pipes, get some small blocks made about one inch diameter, and half an inch thick; round one of these blocks wind and paste a pipe, and to the end of this pipe join another; which must be done by twisting the end of one pipe to a point, and putting it into the end of the other with a little paste: in this manner join four or five pipes, winding them one upon the other, so as to form a spiral line. Having wound on four pipes, paste two slips of paper across them to hold them together; besides these slips of paper, the pipes must be pasted together.

There is another method of making these wheels; viz. by winding on the pipes without paste, and sticking them together with sealing-wax at every half turn; so that when they are fired, the end will fall loose every time the fire passes the wax, by which means the circle of fire will be considerably increased.

CHARGE.

	lb	oz.
Meal-powder	0	4
Saltpetre	0	2
Sulphur	0	0
Steel-dust	0	1½

The appearance of these wheels may be heightened and varied, by occasionally putting in a spoonful of various coloured fires with the dead fire. The composition should be very dry, and not made too fine: they may be fired on a large pin, and held in the hand with perfect safety.

MORTARS,

Must be made of pasteboard, with a small bottom made of copper, 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; then putting a quick match, or touch-string of touch-paper into the hole, the mortar will be ready for firing.

FIERY RAIN, OR PEACOCK'S TAIL.

To represent a fiery rain falling from the rockets, mix among your charge a little composition of powered glass, filings of iron, and saw-dust. This shower is commonly called the peacock's tail, on account of the various colours that appear in it.

You may also exhibit a variety of colours issuing forth from a rocket, by mixing among the charge a little camphor, which produces a white or pale fire; rosin or strotium, a red and copper colour: bloodstone, which has been meal-ed and beats to an impalpable powder, will yield a blood red; sulphur a blue; sal ammoniac, a green; raw antimony, a reddish of honey colour; ivory shavings, shining silver; filed agate stone, an orange; and pitch, a dark and deep coloured fire. This must be discreetly managed; and practice will be the best teacher, as lessons perplex a young beginner.

The necks of your rockets must be drawn or choked firm, to prevent the cord giving way.

Prepare the composition for your rockets just before you want it.

Let it be neither too damp nor too dry, but sprinkle it over with a little oily substance, or a little brandy.

And always avoid, if possible, a damp, foggy, rainy, or windy night, to display your rockets.

A COMPOSITION FOR STARS OF A BEAUTIFUL COLOUR.

TO PUT IN ROCKETS, SERPENTS, BLUE-CANDLES, WATER-ROCKETS, OR OTHER FIREWORKS.

Saltpetre, 1 ounce; sulphur vivum, 1 ounce; camphor, a quarter of an ounce; beat these very fine, and mix them: afterwards make them up into paste with oil of turpentine, and form these into small balls about the size of peas, roll these in powder dust, and let them dry. Of this sort, you may put one, two, or three dozen, into a rocket, and other fireworks of a similar sort or size; and they will have a very pretty effect. To fireworks of a smaller sort, a less quantity must of course be used.

SQUIBS, OR SERPENTS.

Squibs or serpents for common use are made from 2½ inches to 7 inches long, they are rolled and choaked like the cases for port fires, and well pinched at both ends, sealing the bottom with wax. Put in about half a thimble-full or more according to the size of your squib, of corn-powder, and ram it well down, then fill it up with the following:—Charge, Meal-powder 1 lb.; Charcoal 1 oz; Steel-filings 1 oz.

Ram it down two or three times in filling. When full, paste touch-paper round the top, and pinch it up after priming it.

DO. LARGER.

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 1 ounce; brimstone 1 ounce; and steel-filings half an ounce, (or in like proportion) grind them with a mullur, or pound them in a mortar. Your cases being dry and ready, first put a thimble-full of your powder, and ram it hard down with the 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 it with touch paper, which should be pasted on that part which touches the case, otherwise they are liable to drop off.

WATER SQUIBS.

Water squibs are generally made of one ounce serpent cases, seven or eight inches long, filled two-thirds with charge, and the remainder bounced; the common method of firing them is thus;—Take a water-wheel, with a tin mortar in its centre, which load with squibs after the usual method, but the powder in the mortar must be no more than will just throw the squibs out easily into the water; you may place the cases on the wheel, either obliquely or horizontally; and on the top of the wheel round the mortar,

~~fix~~ six cases of brilliant fire, perpendicular to the wheel; these cases must be fired at the beginning of the last case of the wheel, and the mortar at the conclusion of the same.

TO MAKE THUNDER POWDER.

This is done with three ingredients, namely, three parts saltpetre, two parts salt of tartar, and one part of sulphur; these are pounded and mixed together. If you take about six grains in a spoon, and warm it over a candle or fire, it will give a report like a cannon.

BALLOONS.

Having made some thin paper shells, of what diameter you please, fill some with the composition for water balloons, and some after this manner; having made the vent of the shells pretty large, fill them almost full with water-rockets, marroons, squibs, &c. Then put in some blowing-powder, sufficient to burst the shells; and afterwards fix in the water rocket, long enough to reach the bottom of the shell, which will burst the shell, and disperse the small rockets, &c, in the water. When you have secured the large rocket in the vent of the shell, take a cork float with a hole in its middle, which fit over the head of the rocket, and fasten it to the shell; this float must be large enough to keep the balloon above water.

ODORIFEROUS BALLOONS.

These balloons are made in the same manner as the former, but very thin of paper, and in diameter 1 inch, with a vent with $\frac{1}{4}$ inch diameter. The shells being made, and quite dry, fill them with either the following compositions, which must be rammed in tight: these balloons must be fired at the vent, and put into a bowl of water. Oderiferous works are generally fired in rooms.

Compositions—Saltpetre 3lb. 2oz; Flour of Sulphur 1 oz. Camphor $\frac{1}{2}$ oz; Yellow Amber $\frac{1}{2}$ oz; Charcoal dust $\frac{3}{4}$ oz; Flour of Benjamin, or Assa Odorata $\frac{1}{2}$ oz., all powdered very fine and well mixed, and moistened with Oil of Spike; or, Saltpetre 12 oz; Meal powder 3oz; Frankincense 1 oz; Myrrh $\frac{1}{2}$ oz; Charcoal 3 oz; all moistened with the Oil of Spike or Rose.

FIRE FOUNTAINS.

To make a fire fountain you must 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 2 feet 2 inches diameter, and fixed at two feet distance from the first. The third wheel must be 1 foot 4 inches diameter, and fixed within 6 inches of the top of the post; the wheels being fixed, take eighteen 4 or 8 oz. cases of brilliant fire, and place them round the first wheel with their mouths outwards, and inclining downwards; on the second wheel place thirteen 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 cloathe all the cases with leaders, so that both they and the gerbe may take fire at the same time.

A MERMAID &c., TO PLAY AND SWIM UPON THE WATER.

You may make figures of what shape your fancy best pleases; the body must be made of light wicker rods, and in the midst of the body let there be placed an axle-tree, having two wheels coming into the water, yet so as they may not be seen: these wheels must be hollow, to contain a quantity of sand or water; the use of it is to keep the body of your figure upright, and able to sink it so far into water as is needful, and likewise to make it swim more steadily; note that these wheels must be loose, and the axle-tree fast; in the midst of this axle-tree place three or four great serpents one by another, with their mouths all one way; yet so order it that there may be such a distance between each serpent, as there may come a vent from the tail of the first to the mouth of the second, and from the second to the third. And to the end that it may continue the longer in motion, you may place divers lights about the body, to make it more beautiful; every one of these lights

extinguishing should give a report and so conclude. There are divers other fireworks to be performed on the water, which any ingenious person may invent.

HORIZONTAL WHEELS.

First get a large wooden bowl without a handle; then have an octagon wheel made of flat board 18 inches diameter, so that the length of each side will be near 7 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 eight oz. cases filled with a proper charge, each about 6 inches in length. Now, to cloathe the wheel with cases, get some whitish brown paper, cut into it slips 4 or 5 inches broad, and 7 or 8 long; these slips being pasted all over on one side, take one of the cases, and roll one of the slips of paper about $1\frac{1}{2}$ inches on its end, so that there will remain about 2 inches of the paper hollow from the end of the case: this case must be on one of the sides of the wheel, near the corners of which must be holes bored, through which you 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; the second case tie on as you did the first, and so on with the rest, except the last, which must be closed at the end, unless it be to communicate to any 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 fancy directs; six, eight, or any number may be placed on the top of the wheel, provided they be not too heavy for the bowl.

Before you tie 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 drove 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.

TAILED STARS.

These are called tailed stars because there are a great number of sparks issue from them, which represents a tail like that of a comet. Of these there are two sorts; rolled and drove; when rolled, they must be moistened with a liquor made of half a pint of spirit of wine, and half a gill of thin size, of this use as much as will wet the composition enough to make it roll easy; when they are rolled, sift meal powder over them, and set them to dry.

When tailed stars are drove, the composition must be moistened with spirits of wine only, and not made so wet as for rolling; 1 and 2 oz. cases rolled dry, are best for this purpose, and when they are filled unroll the case within three or four rounds of the charge, and all that you unroll cut off; then paste down the loose edge, two or three days after the cases are filled, cut them in pieces 5 or 6-8ths of an inch in length; then melt some wax and dip one end of each piece into it, so as to cover the composition; the other end must be rubbed with meal-powder wetted with spirits of wine.

STRUNG STARS.

First take some thin paper, and cut it into pieces of 1½ inch square or thereabouts; then on each piece lay as much dry-star composition as you think the paper will easily contain: then twist up the paper as tight as you can; when done, rub some paste on your hands, and roll the stars between them; then set them to dry; your stars being thus made, get some flax or fine tow, and roll a little of it over each star; then paste your hands and roll the stars as before, and set them again to dry; when they are quite dry, with a piercer make a hole through the middle of each, into which run a cotton quick-match, long enough to hold ten or twelve stars, at 3 or 4 inches distance; but any number of stars may be strung together by joining the match.

DROVE STARS.

Cases for drove stars are rolled with paste, but are made very thin of paper. Before you begin to fill them, damp the composition with spirit of wine that has had some

champhor dissolved in it : you may ram them indifferently hard, so that you do not break or sack the case ; to prevent which they should fit tight in the mould. They are drove in cases of several sizes, from 8 drachms to 4 oz. When they are filled in $\frac{1}{2}$ oz. cases, cut them in pieces of $\frac{3}{4}$ of an inch long : if 1 oz. cases, cut them in pieces of 1 inch ; if 2 oz. cases, cut them in pieces of 1 inch long ; and if 4 oz. cases, cut them in pieces of $1\frac{1}{2}$ inch long ; having cut your stars of a proper size, prime both ends with wet meal-powder. These stars are seldom put in rockets, being chiefly intended for balloons, and drove in cases, to prevent the composition from being broken by the force of the blowing-powder in the shell.

TO MAKE A FIRE BALLOON.

Take eight sheets of paper, either India, bank-post, or stout tissue ; cut each sheet in an oblong round form, and with good paste, join the broad parts together ; then paste the edges of the whole together, leaving the bottom part open, to serve as a neck or mouth ; when you have done this, if you can perceive any little hole in any of the seams, or other part of your balloon, cover it neatly over, and let it hang over a line to dry in the air ; or if in a room, not too near to the fire. When it is quite dry, paste a bit of thin wire round the bottom of the neck or mouth to keep it open, and put four cross wires, on the middle of which place your piece of sponge ; then get half a gill of spirits of wine, dip your sponge into it, and set fire to what remains in your cup, hold the mouth of the balloon over the spirits of wine, dip your sponge into it and set fire to what remains in the cup ; hold the mouth of the balloon over the spirits of wine, taking care not to hold it so close as to set fire to it ; when you think it is filled enough, place your sponge in your wires, and set fire to that, and you will see your balloon ascend in a regular and pleasing manner. While the sponge in the mouth of the balloon continues to burn, it will, by preventing the air from mixing with the gas, continue to ascend, but as soon as it becomes weakened, or expires, it will descend. To prevent its descending too soon, you should place your sponge some little way into the mouth or neck of your balloon ; by which means, it will keep up so long as the spirits of wine continue to have the least strength.

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