# A NEW
# TREATISE
## ON
# Artificial Fireworks.

CONTAINING

I. The Method of refining and pulverising of Salt-petre.
II. Of extracting Salt-petre from damaged Gun-powder.
III. Of the Ingredients used in Fireworks.
IV. To restore damaged Gun-powder to its proper strength.
V. Of the Compositions for Fireworks.
VI. Of the proportion of Moulds for Sky-rockets, Wheel-cases, Serpents, &c.
VII. Of such Works as shew themselves in the Air.
VIII. Of Works for the Water.
IX. Of fixed, moveable, projected, and transparent Pieces.

The whole illustrated with Five Copper Plates, exhibiting the Figures of several Pieces of Fireworks.

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BY ROBERT JONES,
Lieutenant in the Royal Regiment of ARTILLERY.

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MDCCLXV.

TO

SIR CHARLES FREDERICK,
KNIGHT OF THE MOST NOBLE
ORDER OF THE BATH,
SURVEYOR GENERAL OF HIS
MAJESTY'S ORDNANCE,
AND FELLOW OF THE ROYAL
SOCIETY, AT LONDON.
THIS TREATISE
ON ARTIFICIAL FIREWORKS
IS HUMBLY INSCRIBED

BY

HIS MOST OBEDIENT
AND MUCH OBLIGED
HUMBLE SERVANT,

ROBERT JONES.

# PREFACE.

I SHALL not pretend to ſay any thing here concerning the origin of Fireworks; thoſe who are willing to be better informed of that point, may have recourſe to the treatiſe of M. F***, on that ſubject; who has handled this point in a moſt elaborate manner; and perhaps it may be no diſpleaſing ſurprize to the reader, to find that, while he imagines himſelf only concerned about an invention which he could not have thought to have ſubſiſted above 422 years, he is carried gradually back to the age of Auguſtus, and from thence to the time of the Trojan war.

It is ſufficient for me that Fireworks have ſubſiſted a long time, and ſtill continue to do ſo among the politeſt nations of both Europe and Aſia. I am very well aware that it may here be objected, there are already treatiſes publiſhed on this ſubject, and ſome of thoſe voluminous ones; but then thoſe are either tranſlations from the French and Italian authors, &c. which in themſelves are both imperfect and erroneous; or elſe they are very ſmall abridgments, and thoſe little, not of the art itſelf, only on ſome particular branches of it.

I have endeavoured, in the following treatiſe, to avoid prolixity as much as poſſible without being obſcure; the rules I have laid down, are as plain as was in my power to make them, and I have endeavoured to carry the reader in by the moſt gradual manner, from the minuteſt circumſtances to the higheſt, and have been careful to keep

keep to the ſubject I firſt propoſed, only as an Eſſay on Artificial Fire-works. I own I cannot help re-flecting with ſome kind of chagrin, that, whenever we have had occa-ſion for any of theſe ſort of diver-ſions to be exhibited in England, we have almoſt always had re-courſe to foreigners to execute them; if this has been owing to the ignorance of our own people on this ſubject, I ſhall be very happy if it is in my power to cor-rect it; if it is only owing to that prevailing fondneſs we entertain for every thing that is foreign, I know no remedy for that evil but time and experience.

June 20, 1765.

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47. 15. *for* ballóóns, *read* ballóón
86. 26. *inſert* : to a rocket of eight ounces twenty-one ſtrokes.
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243. 18. *for* ſcrole, *read* ſcroll,

# A TREATISE ON Artificial Fireworks.

## SECT. I.

### Of Saltpetre.

SALTPETRE being the principal ingredient in fireworks, and a volatile body, by reaſon of its aqueous and aërial parts, is eaſily rarified 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, when any quantity of Fireworks are 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, neither will it agree with the ſtanding proportions of compoſitions: but to prevent accidents I ſhall proceed with the method of refining it.

## How to refine SALTPETRE.

Put into a copper, or any other veſſel, one hundred weight of rough nitre with about fourteen gallons of clean water, and let it boil gently for half an hour, and as it boils take off the ſcum; then ſtir it about in the copper, and before it ſettles put it into your filtring bags, which muſt be hung on a rack, with glazed earthen pans under them in which muſt be ſticks laid acroſs for the cryſtals to adhere to; it muſt ſtand in the pans for two or three days to ſhoot, then take out the cryſtals and let them dry: the water that remains in the pans boil again for an hour, and ſtrain it into the pans as before, and the ſaltpetre will be quite clear and tranſparent; if not, it wants more refining, to do which proceed as uſual, till it is well cleanſed of all it's earthy parts.

N. B.

N. B. Thoſe who do not chuſe to procure their ſaltpetre by the above method, may buy it ready done, which for fireworks in general will do equally as well.

## How to pulveriſe SALTPETRE.

Take a copper kettle whoſe bottom muſt be ſpherical, and put into it fourteen pound 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 pulveriſed a quantity of ſaltpetre, be careful to keep it in a dry place.

## How to extract SALTPETRE from damaged GUN-POWDER.

Firſt you muſt have ſome filtring bags, hung on a rack, with glazed earthen pans under them, in the ſame manner as thoſe for refining ſaltpetre: then take any quantity of damaged powder, and put it into a copper, with as much clean water as will juſt cover it; and when it begins to boil take off the ſcum, and after it has boiled a few minutes, ſtir it up; then take it out of the copper with a ſmall hand kettle for that purpoſe, and put ſome into each bag, beginning at one end of the rack, ſo that by the time you have got to the laſt bag, the firſt will be ready for more; continue thus, till all the bags are full; then take the liquor out of the pans, which boil and filter, as before, two or three times, till the water runs quite clear, which you muſt let ſtand in the pans for ſome time, and the ſaltpetre will appear at top. Now to get all the ſaltpetre entirely out of the powder, take the water from the ſaltpetre already extracted, to which add ſome freſh water and the dregs of the powder that remain in the bags, and put them together in a veſſel, to ſtand as long as you pleaſe, and when you want to extract the nitre, you muſt proceed with this mixture as with the powder at firſt, by which means you will draw out all the

the ſaltpetre; but this proceſs muſt be boiled longer than the firſt.

## Of SULPHUR, or BRIMSTONE.

Sulphur is by nature the food of fire, and one of the principal 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 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 to do, it is better to buy the flower ready made, which is done in large quantities, and in great perfection: but when a grand collection of fireworks are to be made, the ſtrongeſt and beſt ſulphur to uſe, is the lump brimſtone ground in the ſame manner as gun powder, which we ſhall treat of in the following part of the treatiſe.

## How to prepare CHARCOAL for Fireworks.

Charcoal being a preſervative by which the ſaltpetre and the brimſtone is made into gun-powder, 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 hazle, others willow and alder; but there being ſo little difference, you may make uſe of either which is moſt convenient to be got. And the method of burning the wood is this: Cut it in pieces about one or two feet long, then ſplit 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 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

charcoal for fireworks muſt always be ſoft and well burnt, which may be bought ready done.

## To make Artificial CAMPHOR.

Camphor, in the Materia medica, "is a body of a particular nature, being "neither a reſin, nor a volatile ſalt, nor "an oil, nor a juice, nor a bitumen, "nor a gum, but a mixed ſubſtance, "dry, white, tranſparent and brittle, "of a ſtrong and penetrating ſmell. "The Indians diſtinguiſh two kinds of "it, a finer and a coarſer; the finer is "the produce of Borneo and Sumatra, "is very rare, and is hardly ever ſent "into Europe; the coarſer is the Japo-"neſe kind, which is the common ſort, "both in the Indies and in Europe.

"The camphor, which we meet "with in the ſhops, is alſo of two "kinds, differing in regard to the degree "of their purity, and diſtinguiſhed by "the name of rough and refined cam-"phor. The tree, which produces "camphor, is a ſpecies of bay tree, "every part of which abounds with "camphor; but is not collected from

Now there is alſo an artificial camphor for fireworks, which I ſhall here give you the method of making; take of gum ſandarach pulveriſed two pound, and of diſtilled vinegar enough to cover it; put them together in a glaſs phial, and ſet it for twenty days in warm horſe dung. Then take it out again, and pour it into another phial, with a large mouth to it; and expoſe it to the ſun for a month, and you will have a concreted camphor in form of the cruſt of bread, and ſomething like the natural camphor: which when you uſe muſt be ground to a powder with a little ſpirits of wine in a mortar. Though we have here taught the method of making artificial camphor, I would not recommend it to thoſe who chuſe to make their works to perfection, the natural camphor, being by far the beſt.

## To make the OIL of CAMPHOR.

The oil of camphor, which is ſometime uſed to moiſten compoſitions, is produced by adding to ſome camphor a little oil of ſweet almonds, and working them together in a braſs mortar, till it turns to a green oil.

N. B.

N. B. Thoſe works that have any camphor in their compoſitions, ſhould be kept as much from air as poſſible, or the camphor will evaporate.

## Of Benjamin.

Benjamin is a reſin (much uſed by perfumers, and ſometimes in medicine); it is brought from the Indies, where it is found of different ſorts; and diſtinguiſhed by the following colours, viz. yellow, grey, and brown, but the beſt is that which is eaſy to break and full of white ſpots.

Benjamin is alſo one of the ingredients in odoriferous fireworks, when reduced to a fine flour; which may be done by obſerving the following directions. Put into a deep, and narrow earthen pot, three or four ounces of benjamin groſsly pounded, cover the pot with paper, which tie very cloſe round the edge; then ſet the pot on a ſlow fire, and once in an hour take off the paper, and you will find ſome flower ſticking to it, which return again in the pot; this you muſt continue till the flower appears white and fine. There is alſo an oil of benjamin, which is ſometimes drawn from the dregs of the flour; it affords a very good ſcent, and may be uſed in wet compoſitions.

## Of GUN-POWDER and its original.

Gun-powder being a principal 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 gun-powder, is as follows. "Each grain of powder conſiſting of "a certain proportion of ſulphur, nitre, "and coal, the coal preſently takes 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 con- "tains both a large proportion of air and "water, which are now violently rari-

"fied by the heat, a kind of fiery ex-
"plofive blaft is thus produced, wherein
"the nitre feems, by its aqueous and
"aërial parts, to act as bellows to the
"other inflammable bodies, fulphur
"and coal, to blow them into a flame,
"and carry off their whole fubftance in
"fmoke and vapour."

After having fpoke of the nature of powder, I fhall in the next place proceed to its original, though fomewhat uncertain; but it is imagined to have been invented in the time of Alexander the great, as Philoftratus fpeaks of a city near the river Hypafis in the Indies, that was faid to be impregnable and its inhabitants relations of the gods, becaufe they thew thunder and lightning on their enemies; but this perhaps might be the effect of gun-powder, which, not being known by any other people, might very well be faid to be thunder and lightning.

This conjecture has been confirmed by fome travellers, who affert that it was ufed in the Eaft Indies, particularly in the Philippine Iflands about the year 85, which is 1265 years before it was known in Europe, where they fay it it was not known till 1350, though, it is ſaid, there is mention made of gun-powder in the regiſters of the chambers of accounts in France, as early as the year 1338, and Friar Bacon mentions the compoſition of powder in expreſs terms, in his treatiſe Denullitate magiae, publiſhed at Oxford in the year 1216; but we find from moſt accounts, that the Germans have the honour of the invention, as is commonly reported.

I ſhould give a deſcription of a machine for the trying of gun powder, but they being ſo common, it would be needleſs; yet, would have all thoſe who practice this art, know, that, when they make ſky rockets with powder, that it muſt be of the beſt ſort; but as to wheels, and other common works, any powder will do, only be careful that it is quite dry.

## Of the Compoſitions for GUN-POWDER of different ſorts.

Having treated of the nature of powder, and its original, I ſhall here give the proportion of each ingredient, neceſſary for compoſing the different ſorts of of gun-powder, it being proper that every one who makes uſe of powder, ſhould know of what it is compoſed. Therefore in the firſt place; I ſhall ſet down the ſeveral compoſitions mentioned in Caſimir Siemienowicz's grand art of artillery, in which there are ſix ſorts, viz.

I. Saltpetre one hundred pound, ſulphur twenty five pound, and coal twenty five pound.
II. Saltpetre one hundred pound, ſulphur eighteen pound, and coal twenty pound.
III. Saltpetre one hundred pound, ſulphur twelve pound, and coal fifteen pound.
IV. Saltpetre one hundred pound, ſulphur twenty pound, and coal twenty four pound.
V. Saltpetre one hundred pound, ſulphur fifteen pound, and coal eighteen pound.
VI. Saltpetre one hundred pound, ſulphur ten pound, and coal eight pound.

Mr. Belidor, in his Hydraulics, ſpeaks of a compoſition for gun powder which is as as follows, to thirty pound of ſalt-petre, add five pound of ſulphur, with as much coal: but the proportion of the ſeveral ingredients for powder, are to be found beſt by experience. For tho' there has been ſo much practice in making powder, there has not yet been aſcertained a ſtanding proportion of the nitre, ſulphur, and coal; but it is hoped that in time this great and nòble invention will be much improved, and that the different, and beſt quantity of every ingredient, will be determined. At the powder mills they generally allow for waſting, in making up, one pound and a half in a hundred. And their mixture for a hundred weight of good powder is thus: To ſeventy-ſix pound and a half of ſaltpetre, well refined and dry'd, twelve pound and a half of coal, and as much ſulphur, all which added together makes one hundred one pound and a half, which when worked up will nearly weigh one hundred. As it is moſt certain that gun-powder is capable of being improved, I ſhall not omit any particular that may be of ſervice to ſuch

ingenious

ingenious gentlemen as are willing to make experiments; for which reaſon we ſhall here inſert another compoſition for powder, mentioned by an author on this ſubject, whoſe name I have forgot, but the compoſition is thus: Refined ſalt-five pounds, ſulphur one pound four ounces, and charcoal ſeven ounces and a half.

But notwithſtanding you may have a good proportion of ingredients, the powder will not always be the ſame, for there is a great deal depends on their being well incorporated, corned and dry'd, the method of which will be taught in the next article.

## To reſtore damaged GUN-POWDER to its proper ſtrength.

It is moſt certain, that, if powder be kept long in a damp place, it will become weak and moiſt, and great part of it will be formed into hard lumps, which is a certain ſign of its being damaged. When powder is thus found, you will alſo ſee at the bottom of the barrel ſome ſaltpetre, which, by being wet, will ſeparate from the ſulphur and coal, and al-

always

ways fall to the bottom of the veſſel wherein the powder is contained, and ſettle there in the form of a white downey matter; but the only method to prevent this, is to move the barrels as often as convenient, and place them on their oppoſite ſides or ends, to which they before ſtood: but although ever ſo great care be taken of powder, and it be kept as dry as poſſible, length of time will greatly leſſen its primitive ſtrength.

Therefore when any of the above mentioned accidents happen to your powder, you may recover it by applying to the directions here given; for example, if you imagine that the powder has not received much damage, proceed thus. Spread it on canvas, or dry boards, and expoſe it to the ſun, then add to it an equal quantity of good powder, and mix them well together, and, when thoroughly dry, barrel it up, and put it in a dry and proper place. But if gun-powder be quite bad, the method to reſtore it is as follows; firſt, you muſt know what it weighed when good; then, by weighing it again, you will find how much it has loſt by the ſeparation and evaporation of the ſaltpetre; then add to it as much refined ſaltpetre, as it has loſt in weight, but as a large quantity of this would be difficult to mix, it will be beſt to put a proportion of nitre, to every twenty pound of powder; when done, put one of theſe proportions into your mealing table, and grind it therein, till you have brought it to an impalpable powder, and then ſearce it with a fine ſieve; but if any remain in the ſieve that will not paſs through, return it to the table, and grind it again, till you have made it all fine enough to go through the ſieve; being thus well ground and ſifted, it muſt be made into grains in the following manner, firſt you muſt have ſome (copper wire ſieves) made according to what ſize you intend the grains ſhould be; theſe are called corning ſieves or grainers, which being provided, fill them with the powder compoſition, then ſhake them about, and the powder will paſs through the ſieve formed into grains. Having thus corned your powder, ſet it to dry in the ſun; and when quite dry, ſearce it with a fine hair ſieve in order to ſeparate the duſt from the grains. This duſt may be worked up again with another mixture; ſo that none of the

powder

powder will be waſted: but ſometimes it may ſo happen, that the weight of the powder when good cannot be known; in which caſe add to each pound an ounce or an ounce and a half of ſalt-petre, according as the powder is decayed, and then grind, ſift, and granulate it as before directed.

N. B. If you have a large quantity of powder, that is very bad, and quite ſpoiled; the only way is to extract the ſaltpetre from it, according to the uſual manner: for powder thus circumſtanced, would be very difficult to recover.

## Of SILENT POWDER, commonly called WHITE POWDER.

It would be rather abſurd for any one to imagine, that it is poſſible for gun-powder to have any effect without ſome report, when it is plain and well known, that the ſound does not proceed from the powder only, but from the air being rarified by the expanſion of the powder.

From whence it is evident, that any compoſition acting with the ſame exploſive force as gun-powder, would certainly produce the ſame effect, in every reſpect. However as for ſuch ſort of powder I never had any proof, nor ever knew any experiment made of it, but have ſo little opinion of it, that I ſhould not have given it a place in this work, had it not been treated of by ſome authors of note; and at the ſame time giving every one, who is fond of this art, an opportunity of making experiments, and of knowing every thing belong thereto.

## To make SILENT POWDER.

For the firſt ſort, mix two pound of borax, with four pound of gun-powder.

2d. Add half a pound of lapis-calaminaris, and half a pound of borax, to two pound of powder.

3d. To ſix pound of gun-powder, half a pound of calcined moles, with as much borax of Venice.

4th. To ſix pound and a half of ſalt-petre, eight pound and a half of ſulphur, and half a pound of the ſecond bark of an elder tree, burnt and ground to a powder, with two pound of common ſalt.

There

There are alſo many other methods of making powder ſilent, according to report, by uſing camphor or touchwood inſtead of charcoal, or by adding to the common powder burnt paper, hay ſeed, &c. When any of theſe ingredients are to be mixed with common powder, grind them together, and make them into grains.

## To make GUN-POWDER of different Colours.

Notwithſtanding the repeated trials and experiments made by the greateſt artiſts, to add to the ſtrength of gunpowder, all have proved without ſucceſs, and moſt of them have agreed that the preſent powder will not admit of a fourth ingredient; therefore it is evident, that any thing being mixed with the preſent compoſition of gun-powder, would rather reduce it's ſtrength than add to it; conſequently coloured powder muſt be weaker than black; ſo that the making of powder of different colours, is only a fancy that ſerves to pleaſe the curious, without any other effect.

## To make GUN-POWDER white.

To ſix pound of ſalt-petre, add one pound of the pith of an elder tree, well dryed and pulveriſed, with a ſufficient quantity of brimſtone to make it into powder, which you will find in the compoſition of gun-powder, or an ounce of the ſalt of tartar, calcined till it comes white, and then boiled in clear water, till the water is all evaporated.

## To make POWDER red.

Boil in water ſome braſil wood or vermillion and a pound of chopped paper; and, when boiled for ſome time to draw out the colour, dry and meal it with a pound of ſulphur, and eight pound of ſaltpetre.

Or, to ſix pound of ſaltpetre, put one pound of ſulphur, and half a pound of amber, and blood ſtone one pound.

cal preparation; but as the preparing of the ingredients require a tedious and expensive process, I shall omit the method of doing it, and let those who chuse to make chemical experiments refer to authors on that subject, by whom they will find the manner of making this powder fully explained. It is said one grain of fulmanans aurum, when made to perfection, and held on the point of a knife, over a candle, will make a report louder than a musket.

SECT.

## SECT. II.

### Of the SPUR-FIRE.

THIS fire is the moſt beautiful and curious of any yet known, and was invented by the Chineſe, but now is in greater perfection in England, than in China; and as it requires a great deal of trouble to make it to perfection, it will be neceſſary that young beginners ſhould have full inſtructions in every particular; therefore care ought to be taken that all the ingredients be of the beſt ſort, that the lamp-black is not damp and clodded, and that the ſaltpetre and brimſtone are thoroughly refined. This compoſition is generally rammed in one or two ounce caſes, about five or ſix inches long, but not drove very hard; and theſe caſes muſt have their concave ſtroke ſtruck very ſmooth, and the choak or vent not quite ſo large as the uſual proportion; this charge, when driven and

and kept a few months, will be much better than when juſt rammed, but will not ſpoil, if kept dry, in many years.

Now 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; for it is of ſo innocent a nature, that, though with 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 mouth of the caſe, you will feel the ſparks like drops of rain. When any of theſe ſpur-fires are fired ſingly, they are called artificial flower pots; but ſome of them placed round a tranſparent pyramid of paper, and fired in a large room, make a very pretty appearance.

The

## The Compoſition for the SPUR-FIRE.

Saltpetre four pound eight ounces, ſulphur two pound, and lamp-black one pound eight ounces.

Or, ſaltpetre one pound, ſulphur half a pound, and lamp-black four quarts.

As the ſpur-fire compoſition is very difficult to mix, and the manner of doing it quite different from any other, I ſhall here treat of it ſeparately; for example, the ſaltpetre and the 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 tryal, 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,

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.

N. B. This mixture, when rubbed too much, will be too fierce, and hardly ſhew any ſtars at all; and, on the contrary, when not mixed enough, will be too weak, and throw forth 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 it's name.

## Characters, or ſignificant Signs, for diſtinguiſhing the different Ingredients uſed in Fireworks.

| | |
|---|---|
| Meal Powder | M |
| Corned Powder | Ↄ |
| Saltpetre | ⊖ |
| Brimſtone | Z |
| Crude Sulphur | C Z |
| Charcoal | C + |
| Sea Coal | C S |
| Saw-duſt or Beech-raſpings | B R |

Steel

| | |
|---|---|
| Steel or Iron-filings ——— | S × |
| Brafs-duft ——— ——— | B × |
| Glafs-duft ——— ——— | G × |
| Tanners-duft of Bark ——— | T × |
| Caft Iron ——— ——— | C I |
| Antimony Crude ——— ——— | C A |
| Camphor ——— ——— | x |
| Yellow Amber ——— ——— | A Y |
| Lapis Calaminaris ——— | L S |
| Gum ——— ——— ——— | ⌒ |
| Lamp Black ——— ——— | B L |
| Ifing Glafs ——— ——— | G I |
| Spirit of Wine ——— | W |
| Spirits of Turpentine ——— | S T |
| Oil of Spike ——— ——— | P O |

The ufe of the above characters is, that by the help of them, the different receipts may be contracted to fo fmall a compafs, that they may all be contained in one leaf of a pocket book, which is much lefs than any table that has yet been invented. Thefe figns are alfo very convenient for thofe who travel.

How

## How to meal GUN-POWDER, BRIMSTONE, and CHARCOAL.

There have been many methods uſed to grind theſe ingredients to a powder for fireworks, ſuch as large mortars and peſtles, made of ebony, and other hard wood; likewiſe horizontal mills with braſs barrels; but none of theſe methods has proved ſo effectual and ſpeedy as the laſt invention, that of the mealing table, which is repreſented in Plate I. Fig. I. This table it made of elm, with a rim round it's edge, four or five inches high; and at the narrow end, A, 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 the copper ſhovel Fig. 2. you may ſweep all clean out at the ſlider A. When you are going to meal a quantity of powder, obſerve not to put too much in the table at once; but when you have put in a good proportion, take the muller Fig. 3. and rub it therewith till all the grains are broke, then ſearce 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 it all fine enough to go through the ſieve. Brimſtone and charcoal are ground in the ſame manner as gun-powder, only the muller muſt be made of ebony, for theſe ingredients being harder than powder, would ſtick in the grain of elm, and be very difficult to grind; and as the brimſtone is apt to ſtick and clod 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.

## To prepare CAST-IRON for Gerbes, White Fountains, and Chineſe Fire.

Caſt-iron being of ſo hard a nature, as not to be cut by a file, we are obliged to make uſe of the following method to reduce it into grains, though ſomewhat difficult to perform; but if we conſider what beautiful ſparks this ſort of iron yields, no pains ſhould be ſpared to granulate ſuch an eſſential material, to do which

which you muſt proceed thus: get at an iron foundry ſome thin pieces of iron, ſuch as generally runs over the moulds, at the time of caſting: then have a ſquare block made of caſt iron, and a ſquare hammer of the ſame metal, about four pound weight; then, having covered the floor with cloth, or ſomething to catch the beatings, lay the thin pieces of iron on the block, and beat them thereon with the hammer, till you have reduced them into ſmall grains, which afterwards ſearce with a very fine ſieve, in order to ſeparate from them the fine duſt, which is ſometimes uſed in ſmall caſes of brilliant fire, inſtead of ſteel duſt; and when you have got out all the duſt, ſift what remains with a ſieve a little larger, and ſo on with ſieves of different ſizes, till the iron will paſs through about the bigneſs of ſmall bird ſhot: your iron being thus beat and ſifted, put each ſort into wooden boxes or oiled paper, to keep it from getting ruſt. When you uſe any of this iron, obſerve that you make a difference in its ſize, in proportion to the caſes for which the charge is intended; for the coarſe ſort of it is only defigned for very large gerbes, of fix or eight pound weight.

## Charges for Sky-Rockets, &c.

### For Rockets of Four Ounces.

Mealed powder one pound four ounces, faltpetre four ounces, and charcoal two ounces.

### For Rockets of Eight Ounces.

I. Meal powder one pound, faltpetre four ounces, brimftone three ounces, and charcoal one ounce and a half.

II. Meal powder one pound and a half, and charcoal four ounces and a quarter.

### For Rockets of One Pound.

Meal powder two pound, faltpetre eight ounces, brimftone four ounces, charcoal two ounces, and fteel filings one ounce and a half.

For

## For Sky Rockets in general.

I. Saltpetre four pound, brimſtone one pound, and charcoal one pound and a half.

II. Saltpetre four pound, brimſtone one pound and a half, charcoal one pound twelve ounces, and meal powder two ounces.

## For large Sky Rockets.

Saltpetre four pound, meal powder one pound, and brimſtone one pound.

## The following Compoſitions may be uſed for Rockets of a midling ſize.

I. Saltpetre eight pound, ſulphur three pound, meal powder three pound.

II. Saltpetre three pound, ſulphur two pound, meal powder one pound, charcoal one pound.

## Compoſitions for Rocket Stars.

### For White Stars.

Meal powder four ounces, ſaltpetre twelve ounces, ſulphur vivum ſix ounces, oil of ſpike two ounces, and camphor five ounces.

### For Blue Stars.

Meal powder eight ounces, ſaltpetre four, ſulphur two, ſpirits of wine two, and oil of ſpike two.

### Coloured, or variegated Stars.

Meal powder eight drams, rochpetre four ounces, ſulphur vivum two ounces, and camphor two ounces.

### For Brilliant Stars.

Saltpetre three ounces and a half, ſulphur an ounce and a half, and meal powder three quarters of an ounce. This compoſition muſt be worked up with ſpirits of wine only.

For

## For Common Stars.

Saltpetre one pound, brimſtone four ounces, antimony four ounces and three quarters, iſinglaſs half an ounce, camphor half an ounce, and ſpirits of wine three quarters of an ounce.

## For Tailed Stars.

Meal powder three ounces, brimſtone two ounces, ſaltpetre one ounce, and charcoal (coarſely ground) three quarters of an ounce.

## For Drove Stars.

I. Saltpetre three pound, ſulphur one pound, braſs duſt twelve ounces, and antimony three ounces.

II. Saltpetre one pound, antimony four ounces, and ſulphur eight.

## For fix'd Pointed Stars.

Saltpetre eight ounces and an half, ſulphur two ounces, and antimony one ounce and ten drams.

## Stars of a fine Colour.

Sulphur one ounce, meal powder one ounce, ſaltpetre one ounce, camphor four drams, oil of turpentine four drams.

## Gold Rain for Sky Rockets.

I. Saltpetre one pound, meal powder four ounces, ſulphur four ounces, braſs duſt one ounce, ſaw duſt two and a quarter, and glaſs duſt ſix drams.

II. Meal powder twelve ounces, ſaltpetre two ounces, and charcoal four,

III. Saltpetre eight ounces, brimſtone two ounces, glaſs duſt one ounce, antimony three quarters of an ounce, braſs duſt a quarter of an ounce, and ſaw duſt twelve drams.

## Silver Rain.

I. Saltpetre four ounces, ſulphur, meal powder, and antimony, of each two ounces, and half an ounce of ſal prunellae.

II. Saltpetre half a pound, brimſtone two ounces, and charcoal four.

III. Salt-

III. Saltpetre one pound, brimſtone a quarter of a pound, and antimony ſix ounces.

IV. Saltpetre four ounces, brimſtone one ounce, powder two ounces, and ſteel duſt three quarters of an ounce.

## For Water Rockets.

I. Meal powder ſix pound, ſaltpetre four pound, brimſtone three pound, and charcoal five pound.

II. Saltpetre one pound, brimſtone four ounces and a half, and charcoal ſix ounces.

III. Saltpetre one pound, brimſtone four ounces, and charcoal twelve ounces.

IV. Saltpetre four pound, brimſtone one pound eight ounces, and charcoal one pound twelve ounces.

V. Brimſtone two pound, ſaltpetre four pound, and meal powder four pound.

VI. Saltpetre one pound, meal powder four ounces, brimſtone eight ounces and a half, and charcoal two ounces.

VII. Meal powder one pound, ſaltpetre three pound, brimſtone one pound, ſeacoal one ounce, charcoal eight ounces and a half, ſaw duſt three quarters of an ounce, ſteel duſt half an ounce, and coarſe charcoal a quarter of an ounce.

VIII. Meal powder one pound twelve ounces, ſaltpetre three pound, ſulphur one pound eight ounces, charcoal twelve ounces, ſaw duſt two ounces.

## A ſinking Charge for Water Rockets.

Meal powder eight ounces, charcoal three quarters of an ounce.

## For Wheel Caſes, from two Ounces to four Pound.

I. Meal powder two pound, ſaltpetre four ounces, and iron filings ſeven ounces.

II. Meal powder two pound, ſaltpetre twelve ounces, ſulphur four, and ſteel duſt three ounces.

III. Meal powder four pound, ſaltpetre one pound, brimſtone eight ounces, and charcoal four ounces and a half.

IV. Meal powder eight ounces, ſaltpetre four, ſaw duſt one ounce and a half, and ſea coal three quarters of an ounce.

V. Meal

V. Meal powder one pound four ounces, brimſtone four ounces ten drams, ſaltpetre eight ounces, glaſs duſt two ounces and a half.

VI. Meal powder twelve ounces, charcoal one ounce, ſaw duſt half an ounce.

VII. Saltpetre one pound nine ounces, brimſtone four ounces, and charcoal four ounces and a half.

VIII. Meal powder two pound, ſaltpetre one pound, brimſtone half a pound, and ſea coal two ounces.

IX. Saltpetre two pound, brimſtone one pound, meal powder four pound, and glaſs duſt four ounces.

X. Meal powder one pound, ſaltpetre two ounces, and ſteel duſt three ounces and a half.

XI. Meal powder two pound, and ſteel duſt two ounces and a half, with two ounces and a half of the fine duſt of beat iron.

XII. Saltpetre eleven pound thirteen ounces, brimſtone eight ounces, and charcoal ſix ounces.

## A ſlow Fire for Wheels.

I. Saltpetre four ounces, brimſtone two ounces, and meal powder one ounce and a half.

II. Saltpetre four ounces, brimſtone one ounce, and antimony one ounce ſix drams.

III. Saltpetre four ounces and a half, brimſtone one ounce, and mealed powder one ounce and a half.

## A dead Fire for Wheels.

Saltpetre one ounce and a quarter, brimſtone a quarter of an ounce, lapis-calaminaris a quarter of an ounce, and antimony two drams.

## For ſtanding or fixed Caſes.

I. Meal powder four pound, ſaltpetre two pound, brimſtone and charcoal one pound.

II. Meal powder two pound, ſaltpetre one pound, and ſteel duſt eight ounces.

III. Meal powder one pound four ounces, and charcoal four ounces.

IV. Meal

IV. Meal powder one pound, and ſteel duſt four ounces.

V. Meal powder two pound and a half, brimſtone four ounces, and ſea-coal ſix ounces.

VI. Meal powder three pound, charcoal five ounces, and ſaw duſt one ounce and a half.

## For Sun Caſes.

I. Meal powder eight pound and a half, ſaltpetre one pound two ounces, ſteel duſt two pound ten ounces and a half, and brimſtone four ounces.

II. Meal powder three pound, ſaltpetre ſix ounces, and ſteel duſt ſeven ounces and a half.

## For a Brilliant Fire.

Meal powder twelve pound, ſaltpetre one pound, brimſtone four ounces, and ſteel duſt one pound and a half.

## For Gerbes.

Meal powder ſix pound, and beat iron two pound one ounce and a half.

## Chineſe Fire.

Saltpetre twelve oũces, meal powder two pound, brimſtone one pound two ounces, and beat iron twelve ounces.

## Charges for Tourbillons.

### For four ounce Tourbillons.

Meal powder two pound four ounces, and charcoal four ounces and a half.

### For eight ounce Tourbillons.

Meal powder two pound, and charcoal four ounces and three quarters.

## For large Tourbillons.

Meal powder two pound, ſaltpetre one pound, brimſtone eight ounces, and beat iron eight ounces.

N. B. Tourbillons may be made very large, and of different colour'd fires, only you are to obſerve, that the larger they be, the weaker muſt be the charge; and, on the contrary, the ſmaller they be, the ſtronger muſt be their charge.

## For Water Ballóóns.

I. Saltpetre four pound, brimſtone two pound, meal powder two pound, antimony four ounces, ſaw duſt four ounces, and glaſs duſt one ounce and a quarter.

II. Saltpetre nine pound, brimſtone three pound, meal powder ſix pound, roſin twelve ounces, and antimony eight ounces.

## For Water Squibs.

I. Meal powder one pound, and charcoal one pound.

II. Meal

II. Meal powder one pound, and charcoal nine ounces.

## For Mine-ports or Serpents.

I. Meal powder one pound, and charcoal one ounce.

II. Meal powder nine ounces, and charcoal one ounce.

## Port-fires for firing Rockets, &c.

I. Saltpetre twelve ounces, brimſtone four ounces, and meal powder two ounces.

II. Saltpetre eight ounces, brimſtone four ounces, and meal powder two ounces.

III. Saltpetre one pound two ounces, meal powder one pound and a half, and brimſtone ten ounces. This compoſition muſt be moiſtened with one gill of linſeed oil.

IV. Meal powder ſix ounces, ſaltpetre two pound two ounces, and brimſtone ten ounces.

V. Saltpetre one pound four ounces, meal powder four ounces, brimſtone five ounces, and ſaw duſt eight ounces.

VI. Salt-

VI. Saltpetre eight ounces, brimſtone two ounces, and meal powder two ounces.

## Port-fires for Illuminations.

Saltpetre one pound, brimſtone eight ounces, and meal powder ſix ounces.

## For Cones or Spiral Wheels.

Saltpetre one pound and a half, brimſtone ſix ounces, meal powder fourteen ounces, and glaſs duſt fourteen ounces.

## For Crowns or Globes.

Saltpetre ſix ounces, brimſtone two pound, antimony four ounces, and camphor two ounces.

## For Air Ballóóns Fuzes.

I. Saltpetre one pound ten ounces, brimſtone eight ounces, and meal powder one pound ſix ounces.

II. Saltpetre one pound and a half, brimſtone eight ounces, and meal powder one pound eight ounces.

Serpents

## Serpents for Pots des Brins.

Meal powder one pound eight ounces, ſaltpetre twelve ounces, and charcoal two ounces.

## For Fire Pumps.

I. Saltpetre five pound, brimſtone one pound, meal powder one pound and a half, and glaſs duſt one pound.

II. Saltpetre five pound eight ounces, brimſtone one pound, meal powder one pound eight ounces, and glaſs duſt one pound eight ounces.

## For a Slow White Flame.

I. Saltpetre two pound, ſulphur three pound, antimony one pound.

II. Saltpetre three pound and a half, ſulphur two pound and a half, meal powder one pound, antimony half a pound, glaſs duſt four ounces, braſs duſt one ounce.

N. B. Theſe compoſitions, driven one inch and a quarter in a one ounce caſe, will burn one minute, which is much longer time than an equal quantity of any compoſition will laſt, that has yet been made public.

## For Amber Lights.

Meal powder nine ounces, and amber three ounces. This charge may be drove in ſmall caſes, for illuminations.

## For Lights of another Sort.

Saltpetre three pound, brimſtone one pound, meal powder one pound, antimony ten ounces and a half. All theſe ingredients muſt be mixed with the oil of ſpike.

## For a Red Fire.

Meal powder three pound, charcoal twelve ounces, and ſaw duſt eight ounces.

## For a Common Fire.

Saltpetre three pound, charcoal ten ounces, and brimſtone two ounces.

## To make an Artificial Earthquake.

Mix the following ingredients to a paſte with water, and then bury it in the ground, and in a few hours the earth will break and open in ſeveral places. The compoſition: Sulphur four pound, and ſteel duſt four pound.

Having laid down, under the preceding heads, the different compoſitions uſed in fireworks by our modern artiſts; I ſhall, in the next place, give ſome tables of charges that were formerly uſed, according to the ſeveral accounts given by thoſe authors from whom they are collected: but if the reader will conſider, he will find the charges in theſe tables to be very uncertain, by comparing their method of determining the ſize and weight of rockets, and the proportions of ingredients thereto, with the method taught in this work, which is ſo plain, eaſy, and certain, that I have never yet known it fail; and doubt not, but that it will be ſo allowed by all who chuſe to make a tryal thereof.

The

The ſubſequent table is taken from Siemienowicz, wherein is ſpecified the different charges of ſky rockets, from half an ounce to one hundred pound; the charges being calculated in proportion to the weight of a leaden ball of the ſame diameter as the bore of each mould; which bores are divided into inches and lines *, and each line into twelve equal parts, according to the French method.

* A line is the twelfth part of an inch..

# TAB. I.

| Weight of the ball. | Diameter of the mould. | pow-der. | Salt-petre | Brimstone | char-coal. |
|---|---|---|---|---|---|
| lb. oz. | in. l. pts | lb.oz. | lb.oz. | lb.oz. | lb.oz. |
| ½ | 0 6 3 | 0 15 | 0 0 | 0 0 | 0 2 |
| 1 | 0 7 8 | | | | |
| 2 | 0 9 7 | 0 12 | 0 2 | 0 ½ | 0 1½ |
| 3 | 0 11 0 | | | | |
| 4 | 1 0 1 | | | | |
| 5 | 1 1 0 | 1 3 | 0 12 | 0 4 | 0 1½ |
| 6 | 1 1 10 | | | | |
| 7 | 1 2 7 | | | | |
| 8 | 1 3 4 | | | | |
| 9 | 1 3 11 | | | | |
| 10 | 1 4 5 | | | | |
| 11 | 1 5 0 | | | | |
| 12 | 1 5 5 | | | | |
| 13 | 1 6 0 | | | | |
| 14 | 1 6 5 | | | | |
| 16 | 1 7 3 | 18 0 | 8 0 | 2 0 | 4 0 |
| 2 0 | 2 0 3 | 0 0 | 60 0 | 2 0 | 15 0 |
| 3 0 | 2 3 7 | | | | |
| 4 0 | 2 6 9 | 0 0 | 64 0 | 8 0 | 16 0 |
| 5 0 | 2 8 8 | | | | |
| 6 0 | 2 10 9 | 0 0 | 35 0 | 5 0 | 10 0 |
| 8 0 | 3 2 6 | | | | |
| 10 0 | 3 5 4 | 0 0 | 62 0 | 9 0 | 20 0 |
| 12 0 | 3 7 10 | 0 0 | 32 0 | 8 0 | 16 0 |
| 15 0 | 3 11 4 | | | | |
| 17 0 | 4 1 5 | 0 0 | 64 0 | 12 0 | 16 0 |
| 20 0 | 4 4 2 | | | | |
| 27 0 | 4 9 9 | | | | |
| 30 0 | 4 11 6 | 0 0 | 30 0 | 7 0 | 18 0 |
| 40 0 | 5 5 1 | | | | |
| 60 0 | 6 3 3 | 0 0 | 30 0 | 10 0 | 20 0 |
| 100 0 | 7 5 3 | | | | |

TAB.

## TAB. II.

The following table is taken from a late French author *, whose method of regulating the charges is according to the interior diameter of the mould, which he divides into lines.

| Interior diameter of the mould. | Weight of the rocket. | | | Saltpetre. | Brimstone. | Charcoal. |
|---|---|---|---|---|---|---|
| Lines. | lb. | oz. | dr. | ounces. | ounces. | ounces. |
| 6 | 0 | 0 | 4 | | | |
| 7 | 0 | 0 | 6 | 44 | 4 | 16 |
| 8 | 0 | 1 | 1 | | | |
| 9 | 0 | 1 | 5 | | | |
| 10 | 0 | 2 | 2 | 40 | 4 | 16 |
| 11 | 0 | 3 | 0 | | | |
| 12 | 0 | 3 | 7 | | | |
| 13 | 0 | 4 | 6 | 38 | 4 | 16 |
| 14 | 0 | 6 | 1 | | | |
| 15 | 0 | 7 | 4 | | | |
| 16 | 0 | 9 | 1 | 36 | 4 | 16 |
| 17 | 0 | 11 | 0 | | | |
| 18 | 0 | 13 | 1 | | | |
| 19 | 0 | 15 | 4 | 34 | 4 | 16 |
| $19\frac{1}{4}$ | 1 | 0 | 0 | | | |
| 21 | 1 | 7 | 1 | | | |
| 24 | 1 | 15 | 1 | 32 | 5 | 16 |
| 30 | 4 | 0 | 0 | | | |
| 36 | 6 | 9 | 0 | 30 | 6 | 18 |
| 72 | 55 | 8 | 0 | | | |

* Traité des feux d'artifice, par M. F***.

## TAB. III.

A table of charges for ſky-rockets in which the charges are adapted in proportion to the weight of compoſition contained in each rocket, after the method of Hanzelet.

| Weight of compoſition. | | Powder | | Saltpetre. | | Brimſtone. | | Charcoal. | |
|---|---|---|---|---|---|---|---|---|---|
| lb. | oz. | lb. | oz. | lb. | oz. | lb. | oz. | lb. | oz. |
| 0 | 1½ | 0 | 4 | | | | | 0 | 1 |
| or, | | 1 | 0 | 0 | 1½ | | | 0 | 1½ |
| 0 | 2 | 0 | 4 | 0 | 1 | | | | |
| or, | | 0 | 4 | | | | | 0 | ½ |
| 0<br>0 | 4<br>8 | 1 | 0 | 0 | 4 | | | 0 | 4 |
| or, | | 0 | 3 | 0 | 10 | 0 | 1 | 0 | 3 |
| | | 0 | 10 | 0 | 3½ | 0 | 1 | 0 | 3½ |
| 1 | 0 | 1 | 0 | | | 0 | 1 | 0 | 2 |
| or, | | | | 1 | 4 | 0 | 2 | 0 | 3½ |
| 3 | 0 | | | 1 | 14 | 7 | 7½ | 0 | 11 |
| 6<br>7 | 0<br>0 | | | 31 | 0 | 4 | 8 | 10 | 0 |
| 8<br>10 | 0<br>0 | | | 8 | 0 | 1 | 8 | 2 | 12 |

# TAB. IV.

A table collected from Henrion, whofe method of adjufting the charges is the fame as in the preceding table.

| Weight of compofition. | | Powder | | Saltpetre. | | Brimftone. | | Charcoal. | |
|---|---|---|---|---|---|---|---|---|---|
| lb. | oz. | lb. | oz | lb. | oz. | lb. | oz. | lb. | oz. |
| | 1<br>2 | 1 | 0 | | | | | 0 | 2 |
| or, | | 1 | 0 | 1 | 0 | | | 0 | 1 |
| | 3 | | 4½ | 0 | 1 | | | 0 | 1 |
| | 4<br>8 | 4 | 0 | 1 | 0 | 0 | ½ | 0 | 4 |
| | | 1 | 8 | 0 | 4 | | | 0 | 2 |
| or, | | 1 | 0 | 0 | 4 | | | 0 | 1 |
| | | 3 | ½ | 0 | 10 | | | 0 | 3½ |
| | 8<br>10 | 2 | 5 | 0 | 0 | 0 2<br>fteel duft<br>0 2 | | 0 | 6 |
| | 12 | 17 | 0 | 0 | 4 | 0 | 3½ | 0 | 7 |
| | 14<br>15 | 2 | 8 | 0 | 9 | 0 3<br>fteel duft<br>0 3 | | 0 | 3 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| 2 | 0 | 0 | 2 | 0 | 12 | 0 | 1 | 0 | 3 |
| 3<br>10 | 0<br>0 | 0 | 0 | 8 | 0 | 1 4<br>fteel duft<br>0 2 | | 2 | 2 |

# TAB. V.

A table of charges for ſky rockets, taken from the Memoires D'Artillerie de M. de Saint Remy, with improvements by M. F***.

| Compoſition for a rocket of two pound. | Compoſition for a rocket of one pound. | Compoſition for a rocket of half a pound. | Compoſition for a rocket of four ounces. | Compoſition for a rocket of one ounce and a half. |
|---|---|---|---|---|
| Corrected by M. F***, one pound. | Corrected, eleven ounces. | Corrected, ſeven ounces and a half. | Corrected, ſix ounces five drams. | Corrected, one ounce five drams. |
| lb. oz. | lb. oz. | lb. oz. | oz. | oz. |
| Pow. 2 0 | 1 0 | 1 4 | 5 | 8 or 9 |
| Saltp. 1 0 | 12 | 12 | 1 | $\frac{1}{5}$ |
| Brimſt. 5 | 2 | 1 | $\frac{1}{4}$ | |
| Charc. 4 | | 3 | $\frac{1}{2}$ | $\frac{1}{2}$ or 1 |
| Steel-d. 2 | | 2 | | |
| Height of the mould, nine inches and a half. | Height of the mould, eight inches and a half. | Height of the mould, ſeven inches and a half. | Height of the mould ſeven inches. | Height of the mould, four inches and a half. |
| Diameter of the mould, one in, ſeven lines. | Diameter of the mould, one inch five lines. | Diameter of the mould, one inch three lin. | Diameter of the mould, one inch two lines. | Diameter of the mould, nine lines. |

## French Names for Sky Rockets.

| Double Marquiſe. | Marquiſe. | Groſſe de partement. | De partement. | FuſiedeCaiſſe. |
|---|---|---|---|---|

Remarks

## Remarks on the foregoing Tables.

In table the firſt, we find that the compoſitions for all rockets under one pound are made chiefly of gun-powder and charcoal, which method has been long proved erroneous in many reſpects: firſt, that rockets made with ſuch charges will not keep long without ſpoiling; ſecondly, that they are very uncertain in performing their proper effect; thirdly, they will carry but a ſhort tail, with a black and ſmoaky fire.

We alſo find thoſe charges for rockets above one pound, that are compoſed of ſaltpetre, brimſtone, and charcoal, to be too ſtrong; by which we ſhould imagine that, at the time when they were uſed, the piercers did not bear the ſame proportion to the rockets, as thoſe made uſe of by our preſent artiſts; for it is on the ſize of the cavity in the compoſition, that the effect of the rocket and proportion of the charge depends: which we ſhall endeavour to ſhew hereafter.

Table the ſecond is given, by the author, as an improvement on the firſt; wherein he takes notice of the charges being

being too many in number; he has therefore reduced them to ſeven only, which, according to his opinion, are ſufficient for rockets of any ſize: he alſo obſerves, that the ingredients are expreſſed in unequal quantities; which he has likewiſe laid down in a more regular order. By the ſame author's account, rockets were made in France, not many years ſince, with the compoſitions mentioned in his table. I ſhall not here pretend to ſay, that rockets were not made with the charges given in the abovementioned table; yet can affirm, by practice and experience, that ſeveral of them will not agree with our preſent moulds.

As to the method preſcribed in the third and fourth tables, it is difficult to determine whether we ſhall praiſe or condemn it,as they were wrote when the art of making fireworks was in it's infancy; as may be ſeen by their ſtrange method of determining the proportion of ingredients, and weight of rockets, by the quantity of compoſition contained in each caſe; which muſt have required a very nice calculation, for at that time, they had not fixed upon an exact length for rockets, but made them from

from ſix to nine diameters long: all which differ ſo much from our modern practice, that I never thought it worth the trouble of making a trial: but am of opinion, that very few of the charges will anſwer.

In table the fifth, the compoſitions are in proportion to the weight of the rocket, with it's head and ſtick, all compleat; which head and ſtick together are equal to the weight of the rocket, according to the improvement made by M. F * * *, as may be ſeen by the ſecond column from the top; he alſo has added the diameters to the moulds, in proportion to their height, allowing each ſix diameters, which ſuppoſing to be right, the rockets will be nearly reduced to half their weight given in the firſt column. On the charges in this table I have made no experiment, therefore cannot recommend them as proof.

Having already given a variety of charges for ſky-rockets, in the preceding tables, which are collected from the principal authors on this ſubject, together with remarks on the ſame; I ſhall, in the next place, according to my promiſe

miſe of not omitting any thing that may be of ſervice to the reader, add ſome compoſitions for rocket-ſtars of ſeveral colours, as inſerted by former authors.

## Compoſitions for Stars of different Colours.

I. Meal powder four ounces, ſaltpetre two ounces, brimſtone two ounces, ſteel duſt one ounce and a half, and camphor, white amber, antimony, and mercury-ſublimate, of each half an ounce.

II. Rochepetre ten ounces, brimſtone, charcoal, antimony, meal powder, and camphor, of each three quarters of an ounce, moiſtened with oil of turpentine. Theſe compoſitions are made into ſtars, by being worked to a paſte with aqua vitæ, in which has been diſſolved ſome gum-tragacanth; and after you have roll'd them in powder, make a hole through the middle of each, and ſtring them on quick-match, leaving about two inches from one to the other.

III. Saltpetre eight ounces, brimſtone two ounces, yellow amber one ounce, antimony one ounce, and powder three ounces.

IV. Brim-

IV. Brimſtone two ounces and a half, ſaltpetre ſix ounces, olibanum or frankincenſe in drops four ounces; maſtick, and mercury-ſublimate, of each four ounces; meal powder five ounces; white amber, yellow amber, and camphor, of each one ounce; antimony and orpiment half an ounce each.

V. Saltpetre one pound, brimſtone half a pound, and meal powder eight ounces, moiſtened with potrolio-oil.

VI. Powder half a pound, brimſtone and ſaltpetre, of each four ounces.

VII. Saltpetre four ounces, brimſtone two ounces, and meal powder one ounce.

## For Stars that carry Tails of ſparks.

I. Brimſtone ſix ounces, antimony crude two ounces, ſaltpetre four ounces, and roſin four ounces.

II. Saltpetre, roſin, and charcoal, of each two ounces; brimſtone one ounce, and pitch one ounce.

Theſe compoſitions are ſometimes melted in an earthen pan, and mixed with chopped cotton match, before they are rolled into ſtars, but will do as well if wetted, and worked up in the uſual manner.

## Another Sort of Stars, which yield ſome Sparks.

I. Camphor two ounces, ſaltpetre one ounce, meal powder one ounce.

II. Saltpetre one ounce, ditto melted half an ounce, and camphor two ounces. When you would make ſtars of either of theſe compoſitions, you muſt wet them with gum water, or ſpirit of wine, in which has been diſſolved ſome gum-arabick, or gum-tragacanth, that the whole may have the conſiſtence of a pretty thick liquid; having thus done, take one ounce of lint, and ſtir it about in the compoſition till it becomes dry enough to roll into ſtars.

## For Stars of a yellowiſh Colour.

Take four ounces of gum-tragacanth or gum-arabick, pounded and ſifted thro' a fine ſieve, camphor diſſolved in brandy two ounces, ſaltpetre one pound, ſulphur half

half a pound, coarſe powder of glaſs four ounces, white amber one ounce and a half, and orpiment two ounces. All theſe ingredients being well incorporated, make them into ſtars after the common method.

## Stars of another Sort.

Take a pound of camphor and melt it in a pint of ſpirit of wine over a ſlow fire; then add to it a pound of gum-arabick that has been diſſolved; with this liquor, mix one pound of ſaltpetre, ſix ounces of ſulphur, and five ounces of meal powder; and after you have ſtirred them well together, roll them into ſtars proportionable to the rockets for which you intend them.

## Of the Colours produced by the different Compoſitions.

As variety of fires adds greatly to a collection of works, it is neceſſary that every artiſt ſhould know the different effect of each ingredient; for which reaſon, I ſhall here explain the colours they

they produce of themſelves; and likewiſe how to make them retain the ſame when mixed with other bodies: as for example, ſulphur gives a blue, camphor a white or pale colour, ſaltpetre a clear white, yellow amber a colour inclining to yellow, ſal-armoniac a green, antimony a reddiſh, roſin a copper colour, and greek-pitch a kind of bronze or between red and yellow. All theſe ingredients are ſuch as ſhew themſelves in a flame, viz.

## For a white Flame.

Saltpetre, ſulphur, meal powder, and camphor, the ſaltpetre muſt be the chief part.

## For a blue Flame.

Meal powder, ſaltpetre, and ſulphur vivum, the ſulphur muſt be the chief part: or, meal powder, ſaltpetre, brimſtone, ſpirit of wine, and oil of ſpike; but let the powder be the principal part.

For

## For a Flame inclining to Red.

Saltpetre, ſulphur, antimony, and greek-pitch, the ſaltpetre the chief part.

By the above method may be made various colours of fire, as the practitioner pleaſes; for, by making a few trials, he may cauſe any ingredient to be predominant in colour.

## Of ſuch Ingredients as ſhew themſelves in Sparks when rammed in choaked 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, ſeacoal, antimony, glaſs duſt, braſs duſt, ſteel filings, caſt iron, tanner's 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.

## How to make Cotton Quick-match.

Quick-match is generally made of ſuch cotton as is put in candles, of ſeveral ſizes, from one to ſix threads thick, according to the pipes it is deſigned for, which pipe muſt be large enough for the match, when made, to be puſhed in eaſily without breaking it. Having doubled the cotton into as many threads as you think proper, coil it very lightly into a flat-bottomed copper or earthen pan; then put in the ſaltpetre and the liquor, and boil them together about twenty minutes; after which, coil it again into another pan, as is ſhewn in Fig. 4. and pour

pour on it what liquor remains; then put in ſome meal powder, and preſs it down with your hands, till it is quite wet; afterwards place the pan before the wooden frame, Fig. 5, which muſt be ſuſpended by a point in the center of each end; and place yourſelf before the pan, tying the upper end of the cotton to the end of one of the ſides of the frame.

When every thing is thus got ready, you muſt have one to turn the frame round, while you let the cotton paſs through your hands, holding it very lightly, and at the ſame time keeping your hands full of the wet powder; but if the powder ſhould be too wet to ſtick to the cotton, put more in the pan, ſo as to keep a continual ſupply till the match is all wound up; you may wind it as cloſe on the frame as you pleaſe, ſo that it does not ſtick together; when the frame is full, take it off the points, and ſift dry meal powder on both ſides the match, till it appears quite dry: in winter the match will be a fortnight before it is fit for uſe; when it is thoroughly dry, cut it along the outſide of one of the ſides of the frame, and tie it up in ſkains for uſe.

N. B. The match muſt be wound tight on the frames.

## Ingredients for the Match.

Cotton one pound twelve ounces, ſalt-petre one pound, ſpirit of wine two quarts, water three quarts, iſinglaſs three gills, and meal powder ten pound. To diſſolve four ounces of iſinglaſs, take three pints of water.

SECT.

## SECT. III.

### Of Sky-rocket Moulds.

AS the performance of rockets depends much on their moulds, it is requiſite to give a definition of them and their proportions, which are as follows: They are made and proportioned by the diameter of their orifice, which is divided into ſix equal parts: as for example, Fig. 6. repreſents a mould made by its diameter A B, its height from C to D is ſix diameters and two thirds; from D to E is the height of the foot, which is one diameter and two thirds; F the choak, or cylinder, whoſe height is one diameter and one third; it muſt be made out of the ſame piece as the foot, and fit tight in the mould; G an iron pin that goes through the mould and cylinder, to keep the foot faſt; H the nipple, which is half a diameter high, and two thirds thick, and of the ſame piece of metal as the piercer I, whoſe height is three diameters and a half, and at the bottom is one third of the diameter thick, and from thence tapering to one ſixth of the diameter: the beſt way to fix the piercer in the cylinder, is to make that part below the nipple long enough to go quite through the foot, and rivet it at the bottom. Fig. 7. is a former or rowler for the caſes, whoſe length, from the handle, is ſeven diameters and a half, and its diameter two thirds of the bore A B; 8. the end of the former, which is of the ſame thickneſs and one diameter and two thirds long, the ſmall part; which fits into the hole in the end of the rowler when the caſe is pinching, is one ſixth and a half of the mould's diameter thick. Fig. 9. the firſt drift, which muſt be ſix diameters from the handle, and this as well as all other rammers muſt be a little thinner than the former, to prevent the ſacking of the paper, when you are driving in the charge: in the end of this rammer is a hole to fit over the piercer; the line K marked on this is two diameters and one third from the handle, ſo that when you are filling the

rocket,

rocket, this line appears at top of the caſe; you muſt then take the ſecond rammer, 10, which from the handle is four diameters; and the hole for the piercer is one diameter and a half long. Fig. 11. is the ſhort and ſolid drift which you uſe when you have filled the caſe as high as the top of the piercer.

It is to be obſerved, that all rammers muſt have a collar of braſs at the bottom, to keep the wood from ſpreading or ſplitting; and that the ſame proportion be given to all moulds, from one ounce to ſix pound. I mentioned nothing concerning the handles of the rammers; however, if their diameter be equal to the bore of the mould, and two diameters long, it will be a very good proportion; but the ſhorter you can uſe them the better, for the longer the drift, the leſs will be the preſſure on the compoſition, by the blow given with the mallet.

## A Table of Dimenſions for Rocket Moulds, in which the Rockets are rammed ſolid.

| Weight of rockets. | Length of the moulds without their feet. | Interior diameter of the moulds. | Height of the nipples. |
|---|---|---|---|
| lb. oz. | Inches. | Inches. | Inches. |
| 6 0 | 34,7 | 3,5 | 1,5 |
| 4 0 | 38,6 | 2,9 | 1,4 |
| 2 0 | 13,35 | 2,1 | 1,0 |
| 1 0 | 12,25 | 1,7 | 0,85 |
| 0 8 | 10,125 | 1,333 &c. | 0,6 |
| 0 4 | 7,75 | 1,125 | 0,5 |
| 0 2 | 6,2 | 0,9 | 0,45 |
| 0 1 | 4,9 | 0,7 | 0,35 |
| 0 ½ | 3,9 | 0,55 | 0,25 |
| 6 drams | 3,5 | 0,5 | 0,225 |
| 4 drams | 2,2 | 0,3 | 0,2 |

The diameter of the nipple muſt always be equal to that of the former.

I have omitted the thickneſs of the moulds, it being very immaterial, provided they are ſubſtantial and ſtrong.

of any length or diameter, according as the cafes are required, but the diameter of the rollers muft be equal to half the bore, and the rammers made quite folid.

## How to roll Rocket and other Cafes.

Sky rocket cafes are to be made fix and a half of their exterior diameter long, and all other cafes that are to be filled in moulds muft be as long as the moulds, within half its interior diameter.

Rocket cafes, from the fmalleft to four or fix pound, are generally made of the ftrongeft fort of cartridge paper, and rolled dry; but the large fort are made of pafted pafte-board. As it is very difficult to roll the ends of the cafes quite even, the beft way will be to keep a pattern of the paper for the different forts of cafes, which pattern fhould be fomewhat longer than the cafe it is defigned for, and on it marked the number of fheets required, which will prevent any paper being cut to wafte: having cut your papers of a proper fize, and the

the laſt ſheet for each caſe with a ſlope at one end, ſo that when the caſes are rolled it may form a ſpiral line round the outſide, and that this ſlope may always be the ſame, let the pattern be ſo cut for a guide: before you begin to roll, fold down one end of the firſt ſheet, ſo far that the fold will go two or three times round the former; then, on the double edge, lay the former with its handle off the table, and when you have rolled on the paper, within two or three turns, lay, on that part which is looſe, the next ſheet, and roll it all on.

Having thus done, you muſt have a ſmooth board, about twenty inches long, and equal in breadth to the length of the caſe; in the middle of this board muſt be a handle placed length-ways; under this board lay your caſe, and let one end of the board lay on the table; then preſs hard on it, and puſh it forwards, which will roll the paper very tight; do this three or four times before you roll on any more paper: this muſt be repeated every other ſheet of paper, till the caſe is thick enough; but if the rolling board be drawn backwards, it will looſen the paper: you are to obſerve, when

when you roll on the laſt ſheet, that the point of the ſlope be placed at the ſmall end of the roller. Having rolled your caſe to fit the mould, puſh in the ſmall end of the former F, about one diameter from the end of the caſe, and put in the end piece within a little diſtance of the former; then give the pinching cord one turn round the caſe, between the former and the end piece; at firſt pull eaſy, and keep moving the caſe, which will make the neck ſmooth, and without large wrinkles; when the caſes are hard to choak, let each ſheet of paper (except the firſt and laſt, in that part where the neck is formed) be a little moiſtened with water: immediately after you have ſtruck the concave ſtroke, bind the neck of the caſe round with ſmall twine, which muſt not be tied in a knot, but faſtened with two or three hitches.

Having thus pinched and tied the caſe ſo as not to give way, put it into the mould without it's foot, and, with a mallet, drive the former hard on the end piece, which will force the neck cloſe and ſmooth; this being done, cut the caſe to its proper length, allowing from the neck to the edge of the mouth half

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 the long rammer, and the vent will be of a proper ſize. Wheel caſes muſt be drove on a nipple with a point, in order to cloſe the neck, and make the vent of the ſize required; which, in moſt caſes, is generally one fourth of their interior diameter: as it is very often difficult, when the caſes are rolled, to draw the roller out, you may make a hole through the handle, and put in it a ſmall iron pin, by which you may eaſily turn the former round, and pull it out. Fig. 17. ſhews the method of pinching caſes; P a treddle, which, when preſſed hard with the foot, will draw the cord tight, and force the neck as cloſe as you pleaſe; Q a ſmall wheel or pully, with a groove round it for the cord to run in.

Caſes are commonly rolled wet, for wheels and fixed pieces; and when they are required to contain a great length of charge, the method of making thoſe ſort of caſes is as follows: Your paper muſt be cut as uſual, only the laſt ſheet muſt not be cut with a ſlope; having your

your paper ready, paſte each ſheet on one ſide, then fold down the firſt ſheet as before directed, but be careful that the paſte does not touch the upper part of the fold, for if the roller be wetted, it will tear the paper in drawing it out: in paſting the laſt ſheet, obſerve not to wet the laſt turn or two in that part where it is to be pinched, for if that part be damp, the pinching cord will ſtick to it, and tear the paper; therefore, when you choak thoſe caſes, roll a bit of dry paper once round the caſe, before you put on the pinching cord; but this bit of paper muſt be taken off after the caſe is choaked. The rolling board, and all other methods, according to the former directions for the rolling and pinching of caſes, muſt be uſed to theſe as well as all other caſes.

## To make Tourbillon Caſes.

Thoſe ſorts of caſes are generally made about eight diameters long, but if very large, ſeven diameters will be ſufficient: tourbillons will anſwer very well from four ounces to two pound, but when larger there is no certainty. The caſes are beſt rolled wet with paſte, and the laſt ſheet muſt have a ſtreight edge, ſo that the caſe may be all of a thickneſs: when you have rolled your caſes, after the manner of wheel caſes, pinch them at one end quite cloſe; then, with the rammer, drive the ends down flat, and afterwards ram in about one third of a diameter of dryed clay. The diameter of the former for theſe caſes muſt be the ſame as for ſky rockets.

N. B. Tourbillons are to be rammed in moulds without a nipple, or in a mould without its foot.

## To make Balóón Caſes, or Paper Shells.

Firſt you muſt have an oval former turned of ſmooth wood; then paſte a quantity of brown or cartridge paper, and let it lay till the paſte has quite ſoaked 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

to dry, and when dry, cut it round the middle, and the two halves will eaſily come off; but obſerve, when you cut, to leave 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 paſte a ſlip of paper round the opening to hold them together, and let that dry; then lay on paper all over as before, every where equal, excepting that end which goes downwards in the mortar, which may be a little thicker than the reſt; for that part which receives the blow from the powder in the chamber of the mortar conſequently requires the greateſt ſtrength: when the ſhell is thoroughly dry, burn a round vent at top, with ſquare iron, large enough for the fuze: this method will do for balóóns from four inches two fifths, to eight inches diameter; but if they are larger, or required to be thrown a great height, let the firſt ſhell be turn'd of elm, inſtead of being made of paper.

For a ballóón of four inches two fifths, let the former be three inches one eighth diameter, and five inches and a half long. For a ballóón of five inches and a half a half, the diameter of the former muſt be four inches, and eight inches long. For a ballóón of eight inches, let the diameter of the former be five inches and fifteen ſixteenths, and eleven inches ſeven eighths long. For a ten inch ballóón, let the former be ſeven inches three ſixteenths diameter, and fourteen inches and a quarter long. The thickneſs of a ſhell for a ballóón of four inches two fifths, muſt be half an inch. For a ballóón of five inches and a half, let the thickneſs of the paper be five eighths of an inch. For an eight inch ballóón ſeven eighths of an inch. And for a ten inch ballóón, let the ſhell be one inch and one eighth thick.

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: when you are making the ſhell, make uſe of a pair of calibers, or a round gauge, ſo that you may not lay the paper thicker in one place than another; and alſo to know when the ſheell is of a proper thickneſs; ballóóns muſt always be made to go eaſy into the mortars.

## Of the Method of mixing Compofitions.

The performance of the principal part of fireworks depends much on the compofitions being well mixed; therefore great care ought to be taken in this part of the work, particularly in the compofitions for fky rockets. When you have four or five pounds of ingredients to mix, which is a fufficient quantity at a time (for a larger proportion will not do fo well), firft 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 fieve with a receiver and top to it; and if, after it is fifted, any remains that will not pafs through the fieve, grind it again till fine enough; and if it be twice fifted it will not be amifs; but the compofitions for wheels and common works are not fo material, nor need not be fo fine. But in all fixed works, from which the fire is to play regular, the ingredients muft be very fine, and great care taken in 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 directions given in the following article.

## How to preſerve Steel or Iron Filings.

It ſometimes may happen, that fireworks 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 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 hardly be ſtrong enough to force them round: but to prevent ſuch accidents, prepare your filings after the following manner.

## The Method of Driving or Ramming Sky Rockets, &c.

Rockets which are drove over a piercer muſt not have ſo much compoſition put in them at a time, as when drove ſolid, for the piercer, taking up great part of the bore of the caſe, would cauſe the rammer to riſe too high; ſo that the preſſure of it would not be ſo great on the compoſition, nor would it be drove every where equal: to prevent which, obſerve the following rule; that for thoſe rockets, that are rammed over a piercer, let the ladle * hold as much compoſition as when drove, will raiſe the drift one half the interior diameter of the caſe, and for thoſe drove ſolid to contain as much as will raiſe it half the exterior diameter of the caſe: ladles are generally made to go eaſy in the caſe, and the length of the ſcoop about one and a half of its own diameter.

The charge of rockets muſt always be drove one diameter above the piercer,

* A copper ſcoop with a wooden handle.

and on it muſt be rammed one third of a diameter of clay, through the middle of which bore a ſmall hole to the compoſition, in order that, when the charge is burnt to the top, it may communicate its fire, through the hole, to the ſtars in the head: great care muſt always be taken, to ſtrike with the mallet, and with an equal force, the ſame number of ſtrokes to each ladle-ful of charge; otherwiſe the rockets will not riſe with an uniform motion, nor will the compoſition burn equal and regular; for which reaſon they cannot carry a proper tail, for it will break before the rocket has got half way up; inſtead of reaching from the ground to the top, where the rocket breaks and diſperſes the ſtars, rains, or whatever is contained in the head. When you are ramming, keep the drift conſtantly turning or moving; and when you uſe the hollow rammers, knock out of them the compoſition now and then, or the piercer will ſplit them: to a rocket of four ounces, give to each ladle-ful of charge ſixteen ſtrokes: to a rocket of one pound, twenty eight: to a two pounder, thirty-ſix: to a four

pounder

pounder forty-two: and to a ſix pounder fifty ſtrokes; but rockets of a larger ſort cannot be drove well by hand, but muſt be rammed with a machine made in the ſame manner as thoſe for driving piles, which are ſo very common to be ſeen, that I ſhall here omit giving a deſcription of them.

The method of ramming of wheel caſes, or any other ſort, in which the charge is drove ſolid, is much the ſame as ſky rockets; for the ſame proportion may be obſerved in the ladle, and the ſame number of ſtrokes given, according to their diameters, all caſes being diſtinguiſhed by their diameters; in this manner, a caſe whoſe bore is equal to a rocket of four ounces is called a four ounce caſe, and that which is equal to an eight ounce rocket an eight ounce caſe, and ſo on, according to the different rockets.

Having taught the method of ramming caſes in moulds; we ſhall here ſay ſomething concerning thoſe filled without moulds, which method, for ſtrong paſted caſes, will do extremely well, and ſave the expence of making ſo many moulds. The reader muſt here

 obſerve,

obſerve, when he fills any ſort of caſes, to place the mould on a perpendicular block of wood, and not on any place that is hollow, for we have found by experience, that when caſes were rammed on driving benches, which were formerly uſed, the works frequently miſcarried, on account of the hollow reſiſtance of the benches, which often jarred and looſened the charge in the caſes; but this accident has never happened ſince the driving blocks * have been uſed.

When caſes are to be filled without moulds, proceed thus; have ſome nipples made of braſs or iron, of ſeveral ſorts and ſizes, in proportion to the caſes, and to ſcrew or fix in the top of the driving block; when you have fixed in a nipple, make, at about one inch and a half from it, a ſquare hole in the block, ſix inches deep and one inch diameter; then have a piece of wood, ſix inches longer than the caſe intended to be filled and two inches ſquare; on one ſide of it cut a groove almoſt the length

* A piece of hard wood in the form of an anvil block.

of

of the caſe, whoſe breadth and depth muſt be ſufficient to cover near half the caſe; then cut the other end to fit the hole in the block, but take care to cut it ſo that the groove may be of a proper diſtance from the nipple: this half mould being made and fixed tight in the block, cut, in another piece of wood nearly of the ſame length as the caſe, a groove of the ſame dimenſions as that in the fixed piece; then put the caſe on the nipple, and with a cord tie it and the two half moulds together, and your caſe will be ready for filling.

The dimenſions of the above deſcribed half moulds, are proportionable for caſes of eight ounces; but notice muſt be taken, that they differ in ſize in proportion to the caſes.

Note, the clay, mentioned in this article, muſt be prepared after this manner; get ſome clay, in which there is no ſtones nor ſand, and bake it in an oven till quite dry; then take it out and beat it to a powder, and afterwards ſift it through a common hair ſieve, and it will be fit for uſe.

Of

## Of the Proportion of Mallets.

The beſt wood for mallets is dry beech, though ſome have preferred other ſorts of wood, and have likewiſe pretended to determine their exact weight, which is not of much ſignification; however, for the better inſtruction of thoſe who have not made a great progreſs in this art, I ſhall here give a good proportion for mallets; but at the ſame time would have every practitioner know, that if he makes uſe of a common mallet, of a moderate ſize, in proportion to the rocket, according to his judgment, and if that rocket ſucceeds, he may depend on the reſt, by uſing the ſame mallet; yet it will be neceſſary that caſes of different ſorts be drove with mallets of different ſizes.

The following proportion of the mallets for rockets of any ſize, from one ounce to ſix pound, may be obſerved; but as rockets are ſeldon made leſs than one ounce, or larger than ſix pound, I ſhall leave the management of them to the curious; but all caſes under one ounce, may be rammed with an ounce rocket

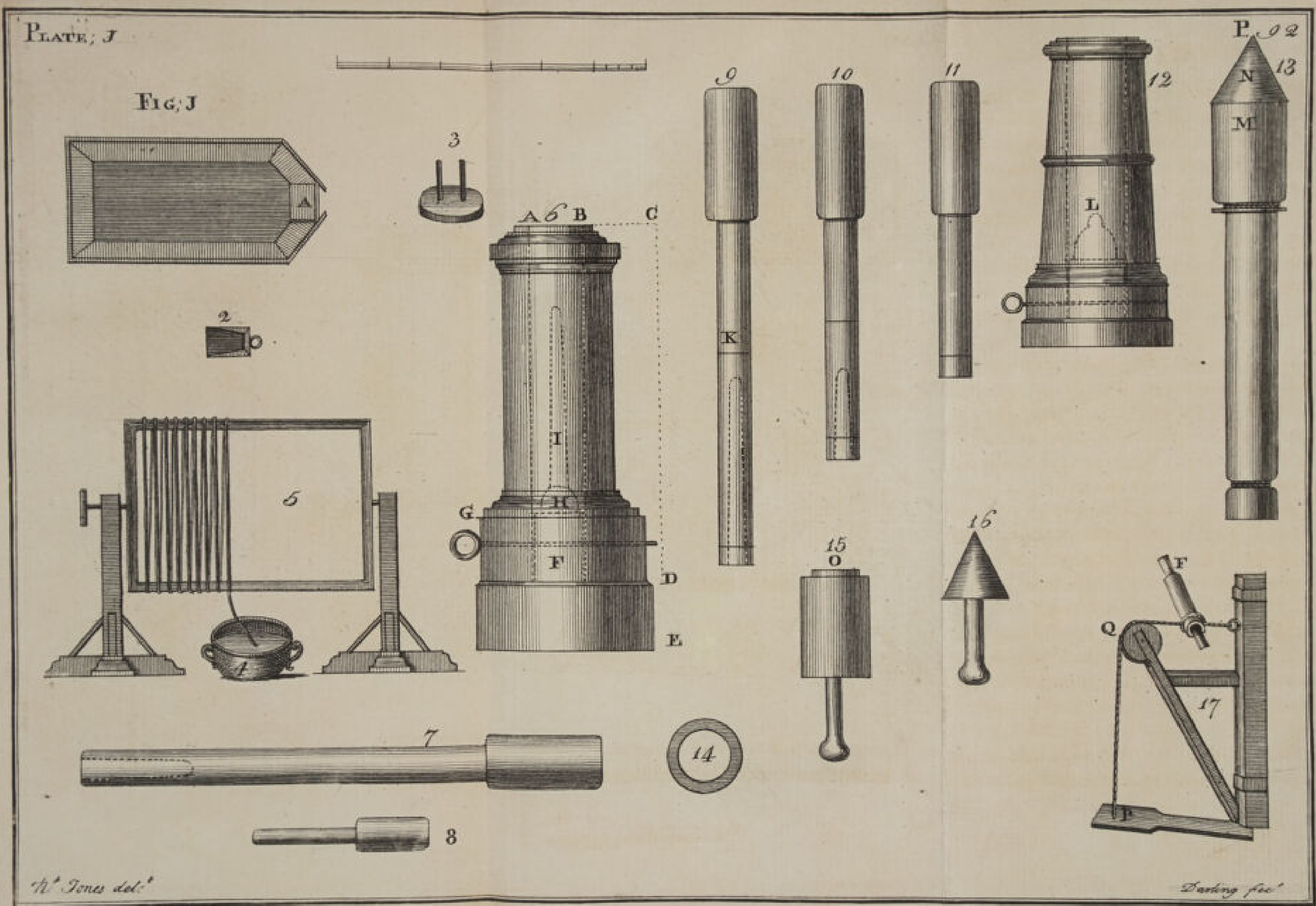
rocket mallet. Your mallets will ſtrike more ſolid, by having their handles turned out of the ſame piece as the head, and made in a cylindrical form: let their dimenſions be worked by the diameters of the rockets: for example; let the thickneſs of the head be three diameters, and its length four, and the length of the handle five diameters, whoſe thickneſs muſt be in proportion to the hand.

## Of the Proportion of Sky Rockets, with the Manner of heading them.

Fig. 13. repreſents a rocket compleat without its ſtick, whoſe length from the neck is five diameters one ſixth; the caſes ſhould always be cut to this length after they are filled: M the head, which is two diameters high, and one diameter one ſixth and a half in breadth; N the cone or cap, whoſe perpendicular height muſt be one diameter one third. Fig. 14. is the collar to which the head is fixed; this is turned out of deal or any light wood, and its exterior diame-

ter

ter muſt be equal to the interior diameter of the head; one ſixth will be ſufficient for its thickneſs, and round the outſide edge muſt be a groove; the interior diameter of the collar muſt not be quite ſo wide as the exterior diameter of the rocket; when this is to be glued on the rocket, you muſt cut two or three rounds of paper off the caſe, which will make a ſhoulder for it to reſt upon. Fig. 15, a former for the head; two or three rounds of paper well paſted will be enough for the head, which, when rolled, put the collar on that part of the former marked O, which muſt fit the inſide of it; then with the pinching cord, pinch the bottom of the head into the groove, and tie it with ſmall twine. Fig. 16, repreſents a former for the cone. To make the caps, cut your paper in round pieces, equal in diameter to twice the length of the cone you intend to make; which pieces being cut into halves, will make two caps each, without waſting any paper; having formed the caps, paſte over each of them a thin white paper, which muſt be a little longer than the cone, ſo as to project about half an inch below the bottom; this



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this projection of paper, being notch'd and pasted, serves to fasten the cap to the head.

When you load the heads of your rockets with stars, rains, serpents, crackers, scroles, or any thing else, according to your fancy; remember always to put one ladle-ful of meal powder, into each head, which will be enough to burst the head, and disperse the stars or whatever is contained therein: when the heads are loaded with any sort of cases, let their mouths be placed downwards; and after the heads are filled, paste on the top of them a piece of paper, before you put on the caps. As the size of stars often differ, it would be needless to give an exact number for each rocket, but this rule may be observed, that the heads may be nearly filled with whatever they are loaded.

## Of the Decorations for Sky Rockets.

Sky rockets bearing the pre-eminence of all fireworks, it will not be improper to treat of their various kinds of decoration, which are directed according to fancy;

fancy; ſome are headed with ſtars of different ſorts, ſuch as tailed ſtars, brilliant ſtars, white ſtars, blue and yellow ſtars, &c. ſome with gold and ſilver rain; others with ſerpents, crackers, fire-ſcroles, marrons; and ſome with ſmall rockets, and many other devices, as the maker pleaſes.

## Dimenſions and Poiſe of Rocket Sticks.

| weight of the rocket | | Length of the ſtick. | | Thickneſs at top. | Breadth at top. | Square at bottom. | Poize from the point of the cone. | |
|---|---|---|---|---|---|---|---|---|
| lb. | oz. | ft. | in. | Inches. | Inches. | Inch. | ft. | in. |
| 6 | 0 | 14 | 0 | 1,5 | 1,85 | 0,75 | 4 | 1,5 |
| 4 | 0 | 12 | 10 | 1,25 | 1,40 | 0,625 | 3 | 9, |
| 2 | 0 | 9 | 4 | 1,125 | 1, | 0,525 | 2 | 9, |
| 1 | 0 | 8 | 2 | 0,725 | 0,80 | 0,375 | 2 | 1, |
| | 8 | 6 | 6 | 0,5 | 0,70 | 0,25 | 1 | 10,5 |
| | 4 | 5 | 3 | 0,3750 | 0,55 | 0,35 | 1 | 8,5 |
| | 2 | 4 | 1 | 0,3 | 0,45 | 0,15 | 1 | 3, |
| | 1 | 3 | 6 | 0,25 | 0,35 | 0,10 | 11 | 0, |
| | $\frac{1}{2}$ | 2 | 4 | 0,125 | 0,20 | 0,16 | 8 | 0, |
| | $\frac{1}{4}$ | 1 | $10\frac{1}{2}$ | 0,1 | 0,15 | 0,5 | 5 | 0,5 |

The laſt column on the right in the above table, expreſſes the diſtance from the top of the cone, where the ſtick, when tied on, ſhould ballance the rocket, et, ſo as to ſtand in an equilibrium on one's finger or the edge of a knife. The beſt wood for the ſticks is dry deal, made after the following manner; when you have cut and planed the ſticks according to the dimenſions given in the table, cut on one of the flat ſides at 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 lay in; one of theſe notches muſt be near the top of the ſtick, and the other facing the neck of the rockets; the diſtance between theſe notches may eaſily be 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. Thoſe who, merely for curioſity, may chuſe to make rockets of different ſizes, to what I have expreſſed in the table of dimenſions, may find the length of their ſticks, by making them for rockets, from half an ounce to one pound, ſixty diameters of the rocket long; and for rockets above one pound, fifty or fifty-two diameters will be a good length; their thickneſs at top

may

may be about half a diameter, and their breadth a very little more; their ſquare at bottom is generally equal to half the thickneſs at top. But, although the dimenſions of the ſticks be very nicely obſerved, you muſt depend only on their ballance: for, without a proper counterpoiſe, your rockets, inſtead of mounting perpendicularly, will take an oblique direction, and fall to the ground before they are burnt out.

## The Method of Boring Rockets which have been drove ſolid.

Plate 2, Fig. 18, repreſents the plan of an apparatus, or lath, for boring of rockets; A the large wheel which turns the ſmall one B, that works the reammer C: theſe reammers are of different ſizes according to the rockets; they muſt be of the ſame diameter as the top of the bore intended, and continue that thickneſs a little longer than the depth of the bore required, and their points muſt be like that of an auger; the thick end of each reammer muſt be made ſquare and all of the ſame ſize, ſo as to fit into one ſocket, wherein they are faſtened by a ſcrew D: E the guide for the reammer, which is made to move backwards and forwards; ſo that after you have marked the reammer three diameters and a half of the rocket from the point, ſet the guide, allowing for the thickneſs of the fronts of the rocket boxes, and the neck and mouth of the rocket, ſo that when the front of the large box is cloſe to the guide, the reammer may not go too far up the charge. F, boxes for holding the rockets, which are made ſo as to fit one in another; their ſides muſt be equal in thickneſs to the difference of the diameters of the rockets, and their interior diameters equal to the exterior diameters of the rockets. To prevent the rockets turning round while boring, a piece of wood muſt be placed againſt the end of the box in the inſide, and preſſed againſt the tail of the rocket; this will alſo hinder the reammer from forcing the rocket backwards. G, a rocket in the box. H, a box that ſlides under the rocket boxes to receive the borings from the rockets, which falls through holes made on purpoſe in the boxes; theſe holes muſt be juſt under the mouth of the rocket, one in each box, and all to correſpond with each other.

Fig. 19, is a front view of the large rocket box. I, an iron plate, in which are holes of different ſizes, through which the reammer paſſes; this plate is faſtened with a ſcrew in the center, ſo that when you change the reammer, you turn the plate round, but always let the hole you are going to uſe be at the bottom: the fronts of the other boxes muſt have holes in them to correſpond with them in the plate. K, the lower part of the large box, which is made to fit the inſide of the lathe, in order that all the boxes may move quite ſteady.

Fig. 20, is a perſpective view of the lathe. L, the guide for the reammer, which is ſet by the ſcrew at bottom.

Fig. 21, a view of the front of the guide facing the reammer. M, an iron plate, of the ſame dimenſions as that on the front of the box, and placed in the ſame direction, and alſo to turn on a ſcrew in the center. N, the rocket box, which ſlides backwards and forwards: when you have fixed a rocket in the box, puſh it forwards againſt the reammer;

and when you think the ſcoop of the reammer is full, draw the box back, and knock out the compoſition; this you muſt do till the rocket is bored, or it will be in danger of taking fire; and if you bore in a hurry, wet the end of the reammer now and then with oil to keep it cool.

Having bored a number of rockets, you muſt have taps of different ſorts according to the rockets. Theſe taps are a little longer than the bore, but when you uſe them, mark them three diameters and a half from the point, allowing for the thickneſs of the rocket's neck; then, holding the rocket in one hand, you tap it with the other. In order to explain theſe taps, I have repreſented one by Fig. 22. They are made in the ſame proportion as the fixed piercers, and are hollowed their whole length.

## Of a Hand Machine uſed for boring of Rockets inſtead of a Lathe.

Thoſe ſort of machines anſwer very well, but not ſo expeditious as the lathe, nor are they ſo expenſive to make; they may be worked by one man; but the lathe will require three. Fig. 23, represents the machine. O, the rocket boxes, which are to be fixed and not to ſlide as thoſe in the lathe. P Q, are guides for the reammers, that are made to ſlide together, as the reammer moves forward: the reammers for theſe ſort of machines muſt be made of a proper length, allowing for the thickneſs of the front of the boxes, and the length of the mouth and neck of the caſe: on the ſquare end of theſe reammers, muſt be a round ſhoulder of iron, to turn againſt the outſide of the guide Q, by which means the guides are forced forwards. R, the ſtock which turns the reammer, and while turning muſt be preſſed towards the rocket, by the body of the man who works it; all the reammers are to be made to fit one ſtock. This machine as well as the lathe is made by the ſcale in the ſame plate.

## The Manner of making large Gerbes.

Fig. 24, repreſents a wooden former; 25, a gerbe compleat, with its foot or ſtand. The caſes for gerbes are made very ſtrong, on account of the ſtrength of the compoſition; which, when fired, comes out with great velocity; therefore, to prevent their burſting, the paper ſhould be paſted, and the caſes made as thick at the top as at the bottom; they ought alſo to have very long necks, for this reaſon; firſt, that the particles of iron will have more time to be heated, by meeting with greater reſiſtance in getting out, than with a ſhort neck, which would be burnt too wide before the charge be conſumed, and ſpoil the effect: Secondly, that with long necks the ſtars will be thrown to a great height, and will not fall before they are ſpent, or ſpread too much; but, when made to perfection, will riſe and ſpread in ſuch a manner as to form exactly a wheat-ſheaf.

In the ramming of gerbes, there will be no need of a mould, the cafes being fufficiently ftrong to fupport themfelves; but you are to be careful, before you begin to ram, to have a piece of wood made to fit in the neck; for if this be not done, the compofition will fall into the neck, and leave a vacancy in the cafe, which, as I faid before, will caufe the cafe to burft as foon as the fire arrives at the vacancy: you muft likewife obferve, that the firft ladle of charge, or two, if you think proper, be of fome weak compofition. When the cafe is filled, take out the piece of wood, and fill the neck with fome flow charge. Gerbes are generally made about fix diameters long, from the bottom to the top of the neck; their bore muft be one fifth narrower at top than at bottom. The neck S is one fixth diameter and three fourths long. T, a wooden foot or ftand, on which the gerbe is fixed. This may be made with a choak or cylinder, four or five inches long, to fit the infide of the cafe, or with a hole in it to put in the gerbe; both thefe methods will anfwer the fame. Gerbes produce a moft brilliant fire, and are very beautiful when a number of them are fixed in the front of a building, or a collection of fireworks.

N. B. Gerbes are made by their diameters, and their cafes at bottom one fourth thick. The method of finding the interior diameter of a gerbe is thus: Supposing you would have the exterior diameter of the cafe, when made, to be five inches, then, by taking two fourths for the fides of the cafe, there will remain two inches and a half for the bore, which will be a very good fize. Thefe fort of gerbes ought to be rammed very hard.

## Of fmall Gerbes or White Fountains.

Small gerbes may be made of four, eight ounces, or one pound cafes, pafted and made very ftrong, of what length you pleafe; but, before you fill them, drive in dry clay one diameter of their orifice high, and when you have filled a cafe, bore a vent through the center of the clay to the compofition; the common proportion will do for the vent, which muft be primed with a flow

 charge.

charge. Theſe ſort of caſes without the clay, may be filled with Chineſe fire.

## To make Paſte-board and Paper Mortars.

Fig. 26, a former, and 27, an elm foot for the mortar; 28, a mortar compleat; theſe mortars are beſt when made with paſte-board; your paſte-board muſt be well paſted before you begin; or, inſtead of paſte, you may uſe glue. For a coehorn mortar, which is four inches two fifths diameter, roll the paſte-board on the former one ſixth of its diameter thick; and, when dry, cut one end ſmooth and even, then nail and glue it on the upper part of the foot; when done, cut off the paſte-board at top, allowing for the length of the mortar two diameters and a half from the mouth of the powder chamber; then bind the mortar round with a ſtrong cord wetted with glue. U, the bottom part of the foot, is one diameter two thirds broad, and one diameter high; and that part which goes into the mortar is two thirds of it's diameter high. W, is a copper chamber for powder, made in a conical form, and is one third of the diameter wide, and one and a half of its own diameter long; in the center of the bottom of this chamber, make a ſmall hole a little way down the foot; this hole muſt be met by another of the ſame ſize made in the ſide of the foot, as is ſhewn in Fig. 28. If theſe holes are made true, and a copper pipe fitted into both, the mortar when loaded will prime itſelf, for the powder will naturally fall to the bottom of the firſt hole; then, by putting a bit of quick-match in the ſide hole, your mortar will be ready to be fired.

Mortars of five and a half, eight, and ten inches diameter, may be made of paper, or paſte-board, by the above method, and in the ſame proportion; but if larger, it will be beſt to have them made of braſs. N.B. The copper chamber, muſt have a ſmall rim round its edge with holes in it, for ſcrews to make it faſt in the foot.

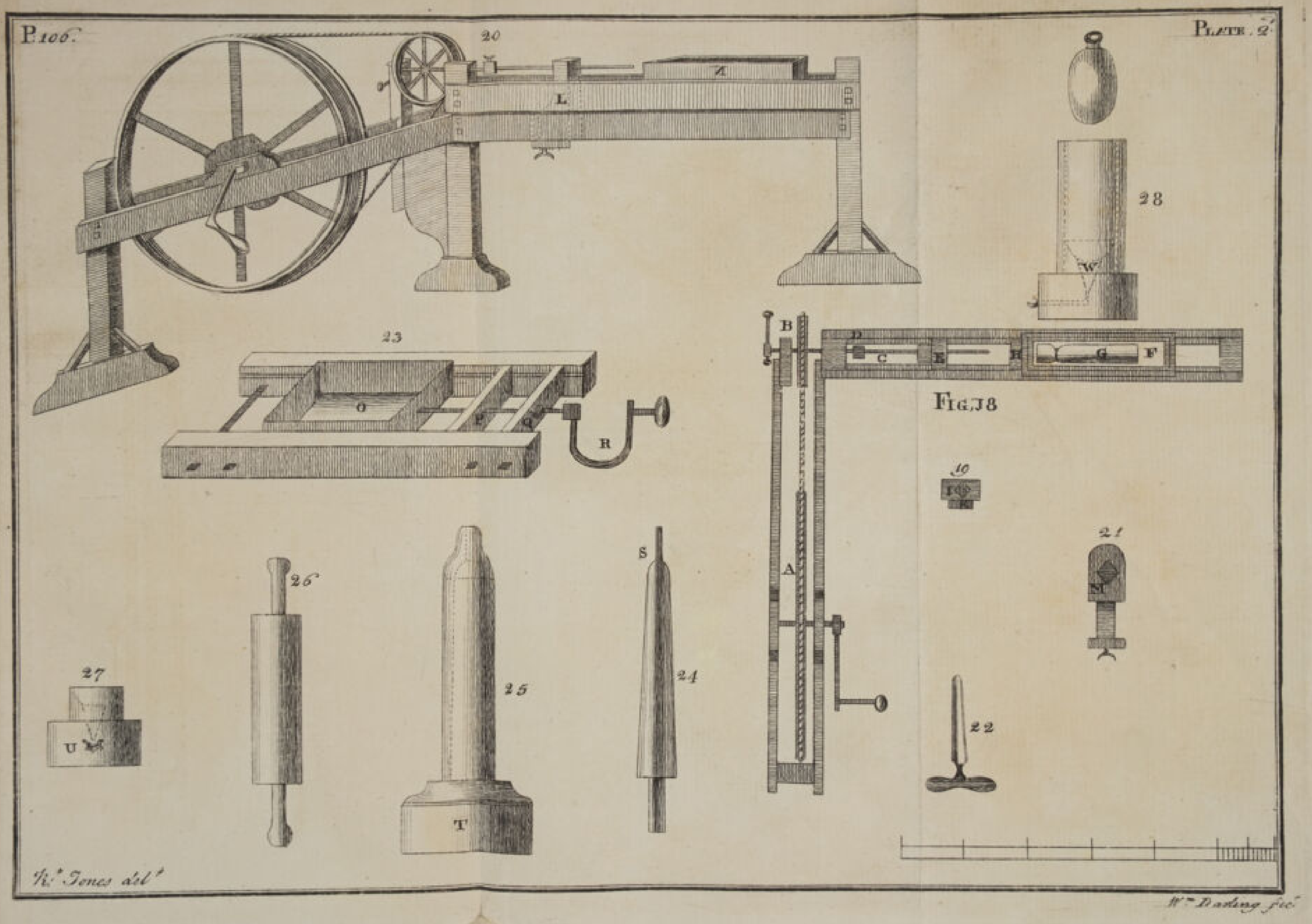
SECT.

## SECT. IV.

### The Manner of loading Air Ballóóns, with the Number of Stars, Serpents, Snakes, Rain-falls, &c. contained in Shells of each Nature.

AS ballóóns are held in great efteem, by moft admirers of fire works, I fhall here give a full defcription of them in every particular, in fo clear a manner, that a young practitioner may, by taking a little pains, be pretty certain of fucceeding the firft trial.

When you fill your fhells, you muft firft put in the ferpents, rains, ftars, &c. or whatever they are compofed of; then the blowing powder; but the fhells muft not be quite filled; all thofe things muft be put in at the fuze hole; but marrons, being


P.106.
Plate. 2.
20
L
Z
28
W
23
O
P
Q
R
B
D
C
E
H
G
F
Fig.18
19
21
M
26
25
24
S
27
U
T
A
22
Rd. Jones del.
Wm. Darling sc.

being too large to go in at the fuze hole, muſt be put in before the inſide ſhell be joined. When the ſhells are loaded, glue and drive in the fuzes very tight. Of theſe fuzes we ſhall ſay more hereafter; but ſhall here give the diameter of the fuze hole in ballóóns of each nature, which are as follows. For a coehorn ballóón, let the diameter of the fuze hole be ſeven eighths of an inch. For a royal ballóón, which is near five inches and a half diameter, make the fuze hole one inch one eighth diameter. For an eight inch ballóón, one inch three eighths: and for a ten inch ballóón, one inch five eighths.

Having proceeded thus far with the directions of loading ballóóns, I ſhall in the ſecond place give an account of the quantities and number of each article, proper for ſhells of each nature; but it is to be obſerved, that air-ballóóns are divided into four ſorts, viz. firſt, illuminated ballóóns; ſecond, ballóóns of ſerpents; third, ballóóns of reports, marrons, and crackers; and fourth, compound ballóóns.

For

## For a Coehorn Ballóón illuminated.

| | | | oz. |
|---|---|---|---|
| Meal powder | — | — | $1\frac{1}{2}$ |
| Corn powder | — | — | $0\frac{1}{4}$ |
| Powder for the mortar | | — | 2 |

Length of the fuze compoſition three quarters of an inch; one ounce drove or rolled ſtars, as many as will nearly fill the ſhell.

## For a Coehorn Ballóón of Serpents.

| | | | oz. |
|---|---|---|---|
| Meal powder | — | — | $1\frac{1}{4}$ |
| Corn powder | — | — | 1 |
| Powder for the mortar | | — | $2\frac{1}{4}$ |

Length of the fuze compoſition thirteen ſixteenths of an inch; half ounce caſes drove three diameters and bounced three diameters; and half ounce caſes drove two diameters and bounced four; of each an equal quantity, and as many of them as will fit in eaſily, placed head to tail.

For

## For a Coehorn Ballóón of Crackers and Reports.

| | | | oz. |
|---|---|---|---|
| Meal powder | — | — | $1\frac{1}{4}$ |
| Corn powder | — | — | $0\frac{3}{4}$ |
| Powder for the mortar | | — | 2 |

Length of the fuze compoſition three quarters of an inch; reports four, and crackers of ſix bounces, as many as will fill the ſhell.

## For Compound Coehorn Ballóóns.

| | | | oz. | dr. |
|---|---|---|---|---|
| Meal powder | — | — | 1 | 4 |
| Corn powder | — | — | 0 | 12 |
| Powder for the mortar | | — | 2 | 4 |

Length of the fuze compoſition thirteen ſixteenths of an inch; half ounce caſes drove three diameters and a half and bounced two, ſixteen. Half ounce caſes drove four diameters and not bounced, ten. Blue ſtrung ſtars, ten. Rolled ſtars as many as will compleat the ballóón.

For

## For Royal Ballóóns illuminated.

| | | | oz. | dr. |
|---|---|---|---|---|
| Meal powder | — | — | 1 | 8 |
| Corn powder | — | — | 0 | 12 |
| Powder for the mortar | | — | 3 | 0 |

Length of the fuze compofition fifteen fixteenths of an inch; two ounce ftrung ftars, thirty-four: Rolled ftars as many as the fhell will contain, allowing room for the fuze.

## For Royal Ballóóns of Serpents.

| | | | oz. | dr. |
|---|---|---|---|---|
| Meal powder | — | — | 1 | 0 |
| Corn powder | — | — | 1 | 8 |
| Powder for the mortar | | — | 3 | 8 |

Length of the fuze compofition one inch; one ounce cafes drove three and a half and four diameters, and bounced two, of each an equal quantity, fufficient to load the fhell.

Royal

## Royal Ballóóns of Crackers and Marrons.

| | | oz. | dr. |
|---|---|---|---|
| Meal powder | — | 1 | 8 |
| Corn powder | — | 1 | 4 |
| Powder for firing the mortar | | 3 | 0 |

Length of the fuze compoſition fourteen ſixteenths of an inch; reports twelve, and compleated with crackers of eight bounces.

## For Compound Royal Ballóóns.

| | | oz. | dr. |
|---|---|---|---|
| Meal powder | —— | 1 | 5 |
| Corn powder | —— | 1 | 6 |
| Powder for the mortar | — | 3 | 12 |

Length of the fuze compoſition one inch; half ounce caſes drove and bounced two diameters, eight. Two ounce caſes filled three eighths of an inch with ſtar compoſition, and bounced two diameters, eight. Silver rain-falls, ten. Two ounce tailed ſtars, ſixteen. Rolled brilliant ſtars,

ſtars, thirty. If this ſhould not be ſufficient to load the ſhell, you may compleat it with gold rain falls.

## For eight inch Ballóóns illuminated.

| | oz. | dr. |
|---|---|---|
| Meal powder ——— | 2 | 8 |
| Corn powder ——— | 1 | 4 |
| Powder for the mortar ——— | 9 | 0 |

Length of the fuze compoſition one inch one eighth; two ounce drove ſtars, forty-eight. Four ounce caſes drove with ſtar compoſition three eighths of an inch and bounced three diameters, twelve; and the ballóón compleated with two ounce drove brilliant ſtars.

## For eight inch Ballóóns of Serpents.

| | oz. | dr. |
|---|---|---|
| Meal powder ——— | 2 | 0 |
| Corn powder ——— | 2 | 0 |
| Powder for the mortar ——— | 9 | 8 |

Length

Length of the fuze compofition one inch three fixteenths. Two ounce cafes drove one diameter and a half, and bounced two; and one ounce cafes drove two diameters, and bounced two and a half; of each an equal quantity fufficient for the fhell.

N. B. The ftar compofition which is drove in cafes that are bounced, muft be managed thus; firft the cafes muft be pinched clofe at one end, then the corn powder put in for a report, and the cafe pinched again clofe to the powder, only leaving a fmall vent for the ftar compofition, which is drove at top, to communicate to the powder at the bounce end.

## REMARKS.

Ballóóns filled with crackers, reports, and marrons, make no great fhow of themfelves, nor are they very pleafing to the eye, for they reprefent nothing more than a number of pale white flafhes, followed by a variety of reports; which altogether make but a very indifferent appearance when fired with illuminated ballóóns, which are fo beautiful and brilliant, as to caſt forth ſuch luſtre that will dazzle the eyes of the ſpecta-tors for ſome time; on this conſiderati-on, I do not think it worth while load-ing ſhells of a large nature, with things that afford ſo little pleaſure: but they have a pretty good effect in royal ſhells, when thrown among a number of air works, ſuch as pots des brins or flights of rockets, in order to alarm the people with a thundering in the air. For they will not know from whence the reports came, if fired exactly at the ſame time with the other works, and the fuze made to carry a ſmall fire. But if any one thinks proper to make large ballóóns of this ſort, it is only obſerving a proportion of the blowing and firing powder, and the length of the fuze, for ſhells of the ſame dimenſions as thoſe you intend to make. Theſe kind of ballóóns are lighter than any other ſort, by reaſon of the crackers being light of themſelves, and not lying cloſe in the ſhells. It muſt be obſerved, when you fire light ballóóns, not to put ſo much powder in the mortar as for heavy ones.

## Compound Eight-inch Ballóóns.

| | | oz. | dr. |
|---|---|---|---|
| Meal powder | —— | 2 | 8 |
| Corn powder | —— | 1 | 12 |
| Powder for the mortar | — | 9 | 4 |

Length of the fuze compoſition one eighth; four ounce caſes drove with ſtar compoſition three eighths of an inch, and bounced three diameters, ſixteen. Two ounce tailed ſtars, ſixteen. Two ounce drove brilliant ſtars, twelve. Silver rain-falls, twenty. One ounce drove blue ſtars, twenty: and one ounce caſes drove and bounced two diameters, as many as will fill the ſhell.

## Another of Eight-inches.

| | | oz. | dr. |
|---|---|---|---|
| Meal powder | — | 2 | 8 |
| Corn powder | — | 1 | 12 |
| Powder for the mortar | — | 9 | 4 |

Length of the fuze compoſition one inch one eighth; crackers of ſix reports, ten. Gold rains, fourteen. Two ounce cafes drove with ftar compofition three eighths of an inch, and bounced two diameters, fixteen. Two ounce tailed ftars, fixteen. Two ounce drove brilliant ftars, twelve. Silver rains, ten: one ounce drove blue ftars, twenty: and one ounce cafes drove with a brilliant charge two diameters and bounced three, as many as the fhell will hold.

## Another of Eight-inches.

| | | | oz. | dr. |
|---|---|---|---|---|
| Meal powder | — | — | 2 | 12 |
| Corn powder | — | — | 2 | 0 |
| Powder for the mortar | | — | 9 | 0 |

Length of the fuze compofition one inch one fixteenth; crackers of fix reports, ten. Gold rains, twenty. Two ounce cafes drove with ftar compofition half an inch, and bounced two diameters fixteen. Two ounce drove brilliant ftars, two ounce drove blue ftars, two ounce drove coloured ftars, two ounce drove tailed ftars, large ftrung ftars, and rolled ftars, of each an equal quantity, fufficient for the ballóón.

For

## For a compound Ten-inch Ballóón.

| | | | oz. | dr. |
|---|---|---|---|---|
| Meal powder | — | — | 3 | 4 |
| Corn powder | — | — | 2 | 8 |
| Powder for the mortar | | — | 12 | 8 |

Length of the fuze compoſition fifteen ſixteenths of an inch; one ounce caſes drove and bounced three diameters, ſixteen. Crackers of eight reports, twelve. Four ounce caſes drove half an inch with ſtar compoſition, and bounced two diameters, fourteen. Two ounce caſes drove with brilliant fire one diameter and a quarter, and bounced two diameters, ſixteen. Two ounce drove brilliant ſtars, thirty. Two ounce drove blue ſtars, thirty. Gold rains, twenty. Silver rains, twenty: after all theſe are put in, fill the remainder of the caſe with tailed and rolled ſtars.

## For a Ten-inch Ballóón of three Changes.

| | oz. | dr. |
|---|---|---|
| Meal powder ——— | 3 | 0 |
| Corn powder ——— | 3 | 2 |
| Powder for the mortar ——— | 13 | 0 |

Length of the fuze compoſition one inch; the ſhell muſt be loaded with two ounce caſes, drove with ſtar compoſition a quarter of an inch, and on that one diameter of gold fire, then bounced three diameters; or with two ounce caſes firſt filled one diameter with gold-fire, then a quarter of an inch with ſtar compoſition, and on that one diameter and a quarter of brilliant fire. Theſe caſes muſt be well ſecured at top of the charge, leſt they ſhould take fire at both ends, but their necks muſt be larger than the common proportion.

## To make Ballóón Fuzes.

Fuzes for air ballóóns are ſometimes turned out of dry beech, with a cup at top,

top, to hold the quick-match, as you ſee in Plate II. Fig. 28, but if made with paſted paper, they will do as well: the diameter of the former for fuzes for coehorn ballóóns, muſt be half an inch; for a royal fuze, five eighths of an inch; for an eight inch fuze, three quarters of an inch; and for a ten inch fuze, ſeven eighths of an inch. Having rolled your caſes, pinch and tie them almoſt cloſe at one end; then drive them down, and let them dry; before you begin to fill them, mark, on the outſide of the caſe, the length of charge required, allowing for the thickneſs of the bottom; and when you have rammed in the compoſi-tion, take two pieces of quick-match, about ſix inches long, and lay one end of each on the charge, and then a little meal powder, which ram down hard; the looſe ends of the match double up into the top of the fuze, and cover it with a paper cap to keep it dry. When you put the ſhells in the mortars, uncap the fuzes, and pull out the looſe ends of the match, and let them hang on the ſides of the ballóóns; the uſe of the match is, to receive the fire from the powder in the chamber of the mortar, in order to light the fuze: the ſhell being put in the mortar with the fuze uppermoſt, and exactly in the center; ſprinkle over it a little meal-powder, and it will be ready to be fired. Fuzes made of wood muſt be longer than thoſe of paper, and not bored quite through, but left ſolid about half an inch at bottom; and when you uſe them, ſaw them off to a proper length, meaſuring the charge from the cup at top.

## Of Tourbillons.

Having filled ſome caſes within about one diameter and a half, drive in a ladle full of clay, then pinch their ends cloſe, and drive them down with a mallet; when done, find the center of gravity of each caſe, where you nail and tie a ſtick which ſhould be half an inch broad at the middle, and run a little narrower to the ends theſe ſticks muſt have their ends turned upwards, ſo that the caſes may turn horizontally on their centers: at the oppoſite ſides of the caſes at each end, bore a hole cloſe to the clay with a gimblet, a gimblet, the ſize of the neck of a common caſe of the ſame nature; from theſe holes draw a line round the caſe, and at the under part of the caſe bore a hole, with the ſame gimblet, within half a diameter of each line towards the center; then from one hole to the other draw a right line. This line divide into three equal parts, and at X and Y, Fig. 29, Plate III. bore a hole, then from theſe holes to the other two, lead a quick-match, over which paſte a thin paper. Fig. 30, repreſents a tourbillon as it ſhould lay to be fired, with a leader from one ſide hole A, to the other B. When you fire tourbillons, lay them on a ſmooth table, with their ſticks downwards, and burn the leader thro' the middle with a port fire. They ſhould ſpin three or four ſeconds on the table before they riſe, which is about the time the compoſition will be burning, from the ſide holes to thoſe at bottom.

To tourbillons may be fixed reports, in this manner; in the center of the caſe at top, make a ſmall hole, and in the middle of the report make another; then place them together, and tie on the report, and with a ſingle paper ſe-

cure

cure it from fire, this being done your tourbillon is compleated. By this method you may fix on tourbillons, ſmall cones of ſtars, rains, &c. but be careful not to load them too much. One eighth of an inch will be enough for the thickneſs of the ſticks, and their length equal to that of the caſes.

## The Manner of making Mortars, for throwing Aigrettes and loading and firing the ſame.

Mortars uſed for throwing aigrettes are generally made of paſte-board, of the ſame thickneſs as ballóón 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 proportion as thoſe for ballóón mortars; theſe ſort of mortars muſt alſo be bound round with cord as before mentioned; ſometimes eight or nine of theſe ſort of 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

the foot muſt be of the ſame diameter as the mortars; and only half a diameter high. Your 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 your ſerpents up in parcels with quick-match, and put them in the mortar with their mouths downwards; but take care that 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 center 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 paper on the tops of all the mortars.

Mortars thus prepared are called a neſt of ſerpents, as repreſented by Fig. 31. When you would fire theſe mortars, light the fire-pump C, which when conſumed will communicate to all the mortars at once, by means of the leaders. For mortars of ſix, eight, or ten 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 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 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 the ſerpents in too tight, for fear of burſting the mortars. Theſe ſort of mortars may be loaded with ſtars, crackers, &c.

If the mortars, when loaded, are to be ſent 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

well as hurt their performance; to prevent which, load your mortars after this manner; 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 any where, without receiving any damage. The large ſingle mortars are called pots des aigrettes.

## The Manner of making, loading, and firing of Pots des Brins.

Theſe pots are made of paſte-board, and muſt be rolled pretty thick; they are uſually made three or four inches diameter, and four diameters long, and pinched with a neck at one end, like common caſes; a number of theſe are placed

placed on a plank in the following manmer: having fixed on a plank, two rows of wooden pegs, cut, in the bottom of the plank, a groove the whole length under each row of pegs; then, through the centre of each peg, bore a hole down to the groove at bottom, and on every peg fix and glue a pot, whofe mouth muft fit tight on the peg; thro' all the holes run a quick-match, one end of which muft go into the pot, and the other into the groove, which muft have a match laid in it from end to end, and covered with paper, fo that when lighted at one end, it may difcharge the whole almoft inftantaneoufly: in all the pots put about one ounce of meal and corn powder; then in fome put ftars, and others rains, fnakes, ferpents, crackers, &c. when they are all loaded, pafte paper over their mouths. Two or three hundred of thefe pots being fired together, make a very pretty fhow, by affording fo great a variety of fires. Fig. 32, is a range of pots des brins, with the leader A, by which they are fired.

Of

## Of Pots des Sauciſſons.

Sauciſſons are generally fired out of large mortars without chambers, the ſame as thoſe for aigrettes, only ſomewhat ſtronger: ſauciſſons are made of one and two ounce caſes, five or ſix inches long, and choaked in the ſame manner as ſerpents; half the number which the mortar contains, muſt be drove one diameter and a half with compoſition, and the other half two diameters, ſo that when fired they may give two volleys of reports; but if the mortars be very ſtrong, and will bear a ſufficient charge, to throw the ſauciſſons very high, you may make three volleys of reports, by dividing the number of caſes into three parts, and making a difference in the height of the charge: after they are filled, pinch and tie them at top of the charge, almoſt cloſe; only leaving a ſmall vent to communicate the fire to the upper part of the caſe, which muſt be filled with corn powder very near the top; then pinch the end quite cloſe, and tie it; after this is done, bind the caſe very tight with waxed pack-

thread,

thread, from the choak at top of the compoſition, to the end of the caſe; this will make the caſe very ſtrong in that part, and cauſe the report to be very loud: ſauciſſons ſhould be rolled a little thicker of paper than the common proportion. When they are to be put in the mortar, they muſt be primed in their mouths, and fired by a caſe of brilliant fire, fixed in their center.

The charge for theſe ſort of mortars ſhould be one ſixth, or one eighth, more than for pots des aigrettes of the ſame diameter.

## To fix one Rocket on the Top of another.

When ſky rockets are thus managed, 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, when done put it in the head of the large rocket with

with its mouth downwards; but before you put it in, ſtick a bit quick-match in the hole in the clay of the pound rocket, which match ſhould be long enough to go a little way up the bore of the ſmall rocket, in order to fire it, when the large one is burnt out; the four ounce rocket being too ſmall to fill the head of the other, roll round it as much tow as will make it ſtand upright in the center 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 tu n before the ſmall one takes fire, and entirely deſtroy the intended effect; when one rocket is headed with another, there will be no occaſion for any blowing powder; for the force with which it ſets off, will be ſufficient to diſingage it from the head of the firſt fired rocket. The ſticks for theſe ſort of rockets, muſt be a little longer than for thoſe headed with ſtars, rains, &c.

## Of Caduceus Rockets.

Caduceus rockets in riſing form two ſpiral lines, or double worm, by reaſon of their being placed obliquely, one oppoſite the other; and their counterpoiſe in their center, which cauſes them to riſe in a vertical direction. Rockets for this purpoſe, muſt have their ends choaked cloſe, without either head or bounce; for a weight at top, would be a great obſtruction to their mounting; though I have known them ſometimes to be bounced, but then they did not riſe ſo high as thoſe that were not, nor do any Caduceous rockets aſcend ſo high as ſingle ones; 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.

By Fig. 33. you ſee the method of fixing theſe rockets: the ſticks for this purpoſe, muſt have all their ſides equal, which 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 to taper downwards as as uſual, long enough to ballance 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 ſixty degrees. In tying on the rockets, place their heads on the oppoſite ſides of the croſs-ſtick; and their ends on the oppoſite ſides of the long 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 one pound, are a good ſize, for this uſe.

## Of Honorary Rockets.

Honorary rockets 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, you tie 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 ſides at each end, bore a hole, in the ſame manner as in Tourbillons; 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.

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 ſort of rockets have no cones.

There is alſo a third method, by which theſe kind of rockets are managed, which is thus: In the top of the 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 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.

Fsg. 34. is a honorary rocket compleat. The beſt ſized rockets for this purpoſe are thoſe of one pound.

## To divide the Tail of a Sky Rocket, ſo as to form an Arch when aſcending.

Having ſome rockets made, and 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; ſixteen inches from the rockets 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 will play with great 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 if well managed) if there be a ſhort piece of portfire, of a ſtrong charge, tied to the end of the ſtick, it will make a great addition; but this muſt be lighted, before you fire the rocket.

## To make ſeveral Sky Rockets, riſe together, in the ſame direction, and equally diſtant from each other.

Take ſix or any number of ſky rockets, of what ſize you pleaſe; then cut ſome ſtrong pack-thread, 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 your pack-thread, round the body, of one rocket, and the other end to another; take a ſecond piece of pack-thread 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 outſide ones will be faſtened to two pieces of pack-thread; 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 you are going to fire

fire them, hang them almoſt cloſe together, 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 themſelves as far as the ſtrings will allow; which diviſion they will keep, provided they are all rammed alike, and well made. Theſe ſort of rockets, are called by ſome, chained-rockets.

## Of Signal Sky Rockets.

Signal-rockets are made of ſeveral ſorts, according to the different ſignals intended to be given: but in Artificial Fireworks, two ſorts are only made uſe of, which are one with reports, and the other without any thing, except the charge; but thoſe for the uſe of the Navy and Army, are headed with ſtars, ſerpents, &c. —— Rockets which are to' be bounced, muſt have their caſes made one and a half or two diameters longer, than the common proportion, and after they are filled, drive in a double quantity of clay, then bounce and pinch them, after the uſual manner, and fix on each a cap.

Signal ſky rockets without bounces, are nothing more than common ſky rockets, cloſed and caped: rockets of this ſort are very light, therefore do not require ſuch heavy ſticks as thoſe with loaded heads, for which reaſon, you may cut one length of the rocket, off the ſtick, or elſe make them thinner.

Signal rockets with reports, are ſometimes fired in ſmall flights, and often both theſe and thoſe without reports, are uſed, for a ſignal, to begin firing a collection of works; and occaſionally, for many other purpoſes.

## How to fix two or more Sky Rockets on one 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 ballóón; but the management of this device, requires a ſkilful hand; therefore for the encouragement of thoſe who are fond of curious performances, I ſhall give ſuch in-

ſtructions,

ſtructions, that, if 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 out of the one 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) according to the following directions: firſt ſuppoſing your 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 the thickneſs of theſe ſort of ſticks, cannot be exactly aſcertained, I ſhall give a rule which generally anſwers, for any number of rockets above two: the

the rule is this; that the ſtick at top, muſt be thick enough when the grooves are cut, for all the rockets to lay, without preſſing each other, though as near together as poſſible.

When only two rockets, are to be fixed on one ſtick, let the length of the ſtick be according to the laſt given proportion, but ſhaped after the common method, and the breadth and thickneſs, double the dimenſions, given in the table page, 94. The point of poiſe, muſt be in the uſual place, (let the number of rockets be what they 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 be taken, for caſes being placed on all ſides, there can be no notches, for the cord which ties on the rockets, to lay in; therefore inſtead of notches, drive a ſmall nail, in each ſide of the ſtick, between the necks of the caſes; and let the cord which goes round their necks, be brought

brought cloſe under the nails; by this means, the rockets will be as ſecure, as when tied on ſingly. Your 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 the rockets at once.

Notwithſtanding the directions already given, may be ſufficient, for the management of thoſe ſort of rockets; I ſhall here add an improvment, of my own, on a very eſſential part of this device, which is, that of hanging the rockets, to be fired; for before I hit upon the following method, many of my eſſays, proved unſucceſsful; but to prevent ſuch perplexities, inſtead of the old and common manner of hanging them on nails or hooks, make uſe of this 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 let this ring be 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

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

## Of Sky Rockets without ſticks.

To fire rockets without ſticks, you muſt have a ſtand made in this manner; get a block of wood, one foot diameter or there abouts, and make the bottom of it flat, ſo that it may ſtand ſteady; in the center 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 in length, and drive them into the block, one at each point made on the circle; when theſe wires, are drove in, deep enough to hold them faſt, and upright, ſo that the diſtance from one to the other, be the ſame at top, as at bottom, the ſtand is compleat.

The ſtand being thus made, prepare your rockets after the following method; take ſome common ſky rockets, of any ſize, and head them as you pleaſe, then get

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 ballance the rocket in the ſame manner as a ſtick, at the uſual point of poize. To fire theſe ſort of rockets, hang them, one at a time, between the tops of the wires, letting their heads reſt on the points of the wires, and the balls hang down between them; if 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.

## Of Rain-falls for Sky Rockets, Double and Single.

Gold and ſilver rain compoſition, are drove in caſes, that are pinched quite cloſe at one end; if you roll them dry, four

four or five rounds of paper will be ſtrong enough, but if the are paſted, three rounds will do, and the thin ſort of cartridge paper is beſt for thoſe ſmall caſes; which in rolling you muſt not turn down the inſide edge, as in other caſes, for a double edge would be too thick for ſo ſmall a bore; the moulds for rain falls, ſhould be made of braſs, and turned very ſmooth in the inſide; or the caſes, which are ſo very thin, would tear in coming out, for the charge muſt be drove in tight; and the better the caſe fits the mould, the more driving it will bare. Theſe moulds have no nipple, but inſtead of which they are made flat; as it would be very tedious and trouble-ſome, to ſhake the compoſition out of ſuch ſmall ladles, as are uſed for theſe caſes; it will be neceſſary to have a fun-nel made of thin tin, to fit on the top of the caſe, by the help of which you may fill them very faſt; for ſingle rain falls for four ounce rockets, let the dia-meter of the former be two ſixteenths of an inch, and the length of the caſe two inches; for eight ounce rockets, four ſixteenths, and two diameters of the rocket long; for one pound rocket five ſixteenths, and two diameters of the

rocket

rocket long; for two pound rockets, five ſixteenths, and three inches a half long; for four pound rockets, ſix ſixteenths, and four inches and a half long; and for ſix pounders, ſeven ſixteenths diameter, and five inches long.

Of double rain falls, there are two ſorts; as for example, ſome appear firſt like a ſtar, and then as rain; and ſome appear firſt as rain and then like a ſtar: when you would have ſtars firſt; you muſt fill the caſes within half an inch of the top, with rain compoſition, and the remainder with ſtar compoſition; but when you intend the rain ſhould be firſt, drive the caſe half an inch with ſtar compoſition, and the reſt with rain. By this method, may be made many changes of fire; for in large rockets, you may make them firſt burn as ſtars, then rain, and then again as ſtars, or they may firſt ſhew rain, then ſtars, and afterwards finiſh with a report, but when they are thus managed, cut open the firſt rammed end, after they are filled and bounced, at which place prime them; the ſtar compoſition for this purpoſe muſt be a little ſtronger than for rolled ſtars.

Of

## Of Strung Stars.

First take ſome thin paper, and cut it into pieces of an inch and a half ſquare, or therabouts, 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 paſt 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 three or four inches from one another: but any number of ſtars may be ſtrung together by joining the match.

## Of Tailed Stars.

Thoſe ſort of ſtars are called tailed ſtars, becauſe there are a great number of ſparks iſſue from them, which represent a tail like that of a comet; of those stars there are two sorts, which are rolled, and drove; when they are rolled they must be moistened, with a liquor made of half a pint of spirit of wine, and half a gil of thin size, of this 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 spirit of wine only, and not made so wet as for rolling; one and two ounce 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 five or six eighths 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 spirit of wine.

## Of Drove Stars.

Cafes for drove ftars, are rolled with pafte, but are made very thin of paper; before you begin to fill them, damp the compofition, with fpirit of wine that has had fome camphor diffolved in it; you may ram them indifferently hard, fo that you do not break, or fack the cafe, and to prevent which they fhould fit tight in the mould: they are drove in cafes of feveral fizes, from eight drams to four ounces; when they are filled in half ounce cafes, cut them in pieces, of three quarters of an inch in length; if one ounce cafes, cut them in pieces of one inch; if two ounce cafes, cut them in pieces of one inch and a quarter in length, and if four ounce cafes, cut them in pieces one inch and a half in length; having cut your ftars of a proper fize, prime them at both ends, with wet meal powder; ftars of this fort are feldom put in rockets, they being chiefly intended for air ballóóns, and drove in cafes, to prevent the compofition from being broke by the force of the blowing powder in the fhell.

Of

## Of Rolled Stars.

Rolled ſtars are commonly made a-bout the ſize of a muſket ball, though they are rolled of ſeveral ſizes, from the bigneſs of a piſtol ball, to one inch diameter; and ſometimes they are made very ſmall, but then they are called ſparks; great care muſt be taken in making of ſtars, firſt, that the ſeveral ingredients be reduced to a fine powder; ſecondly, that the compoſition be well worked and mixed together. Before you begin to roll, take about a pound of compoſition, and wet it with the following liquid, enough to make it ſtick together and roll eaſy; ſpirit of wine, one quart, in which diſſolve a quarter of an ounce of iſinglaſs; if a great quantity of compoſition be wetted at once, the ſpirit, will evaporate, and leave it dry, before you can roll it into ſtars; having rolled up one proportion, ſhake the ſtars in meal powder, and ſet them to dry, which they will do in three or four days. But if you ſhould want them for immediate uſe, dry them in an earthen pan over a ſlow heat, or, in an oven: it being very difficult to make the ſtars all of an equal ſize, when the compoſition is taken up promiſcuouſly with the fingers; therefore I ſhall here ſet down a method by which you may make them very exact, which is thus: When the mixture is moiſtened properly, roll it on a flat ſmooth ſtone, and cut it into ſquare pieces, making each ſquare, large enough for the ſtars you intend; there is another method uſed by ſome to make ſtars, which is by rolling the compoſition, in long pieces, and then cutting off the ſtar, ſo that each ſtar will be of a cylindrical form; but this method is not ſo good as the former, for to make the compoſition roll this way, it muſt be made very wet, which makes the ſtars heavy as well as weaken them. All ſtars muſt be kept as much from air, as poſſible, otherwiſe they will grow weak and bad.

## Of Scrolls for Sky Rockets.

Caſes for ſcrolls, ſhould be made four or five inches in length, and their interior diameter three eighths of an inch; one end of theſe caſes muſt be pinched quite

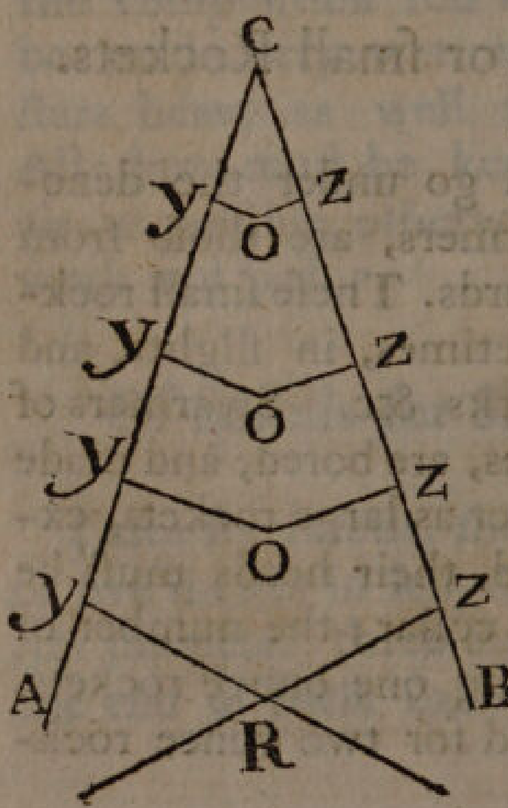
quite cloſe, before you begin to fill, and and when filled, cloſe the other end, then in the oppoſite ſides make a ſmall hole at each end, to the compoſition, in the ſame manner as in Tourbillons; and prime them with wet meal powder: you may put in the head of a rocket, as many of theſe caſes as it will contain; theſe caſes being fired 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.

## Of Swarmers or ſmall Rockets.

Rockets which go under the denomination of ſwarmers, are thoſe from two ounces downwards. Theſe ſmall rockets are fired ſometimes, in flights, and in large water-works, &c. Swarmers of one and two ounces, are bored, and made in the ſame manner as large rockets, except when headed, their heads muſt be put on without a collar; the number of ſtrokes, for driving one ounce rockets, muſt be eight; and for two ounce rockets, twelve.

All rockets under one ounce, are not bored, but muſt be filled to the uſual height, with compoſition, which is generally compoſed, of fine meal prowder four ounces, and charcoal or ſteel duſt two drams; the number of ſtrokes for ramming theſe ſmall ſwarmers, is not very material, ſo as they are rammed true, and moderately hard. The necks of unbored rockets, muſt be in the ſame proportion, as in common caſes.

## Of the cauſe of ſky Rockets riſing.




Having promiſed in the ſecond ſection, to prove that the effect of ſky rockets, and proportion of their charge, depends on the ſize of the cavity in the compoſition; I ſhall here endeavour to give a mathematical demonſtration thereof.

Let

Let ABC be the hollow cone for the fire, AYCZB, the ſuperficies of that cone, all the lines OZ at right angles with BC, all the lines OY at right angles with AC: now all the angles ZOY being towards R, whether the angles ZOY are obtuſe or acute, but the more acute the better. The rays of fire ZO and YO iſſuing from the ſides of the cone BC and AC, and continually acting with the greater force one upon another at O, forcing the whole BCA upward from the point R; and the wider the cone is, (ſo as not to exceed one third at bottom, and one ſixth at top, of the exterior diameter of the rocket,) the greater velocity will the rocket riſe with.

## Of Stands for Sky Rockets.

Care muſt be taken, in placing the rockets, when they are to be fired, in order 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 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 from one another, with their points turning ſideways, 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, drove perpendicular 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.

N. B. When ſky rockets are made to perfection, and fired, they will ſtand two or three ſeconds on the hook before they riſe, and then mount up briſkly, with a ſteady motion, carrying a large tail from the ground all the way up, and juſt as they turn, break and diſperſe the ſtars.

## Of Griandole Cheſts, for flights of Rockets.

Griandole cheſts, are generally compoſed of four ſides, of equal dimenſions, but

but may be made of any diameter, according to the number of rockets, deſigned to be fired; its height muſt be in proportion to the rockets, but muſt always be a little higher than the rockets, with their ſticks; when the ſides are joined, fix in the top, as far down the cheſt as the length of one of the rockets with its cap on. In this top, make as many ſquare or round holes, to recieve the rocket ſticks, as you intend to have rockets, but let the diſtance between them, be ſufficient for the rockets to ſtand without touching one another; then from one hole to another, cut a groove, large enough for a quick-match to lay in: the top being thus fixed, put in the bottom, at about one foot and a half diſtance from the bottom of the cheſt; in this bottom muſt be as many holes, as in the top, and all to correſpond, but theſe holes need not be ſo large, as thoſe in the top.

To prepare your cheſt, you muſt lay a quick-match, in all the grooves, from hole to hole; then take ſome ſky rockets, and rub them in the mouth, with wet meal powder, and put a bit of match up the cavity of each, which match, muſt be long enough, to hang, a little below

the

the mouth of the rocket; your rockets and cheſt being prepared, according to the above directions, put the ſticks of the rockets, through the holes in the top and bottom of the cheſt, ſo that their mouths may reſt on the quick-match in the grooves; by which all the rockets, will be fired at once; for by giving fire to any part of the match, it will communicate to all the rockets, in an inſtant. As it would be rather troubleſome, to direct the ſticks from the top, to the proper holes in the bottom, it will be neceſſary to have a ſmall door in one of the ſides, which when opened, you may ſee how to place the ſticks. Flights of rockets, being ſeldom fired at the beginning of any fireworks, for which reaſon, they are in danger of being fired, by the ſparks from wheels, &c. Therefore to preſerve them, a cover ſhould be made to fit on the cheſt, and the door in the ſide kept ſhut.

Of

## Of Serpents or Snakes for Pots des Aigrettes, Small Mortars, Sky Rockets, &c.

Serpents for this uſe, are made from two inches and and an half, to ſeven inches in length, and their formers from three ſixteenths, to five eights of an inch diameter, but the diameter of the caſes, muſt always be equal to two diameters of the former; they are rolled and choaked like other caſes, and filled with compoſition from five eights of an inch, to one inch and an half high, according to the ſize of the mortars, or rockets, they are deſigned for, and the remainder of the caſes, bounced with corn-powder, and afterwards their ends pinched and tied cloſe: before they are uſed their mouths muſt be primed with wet meal-powder.

## Of Leaders, or Pipes of Communication.

The beſt paper for leaders, is a large ſort of white paper, called Elephant, which

which you cut into long ſlips, two or three inches broad, ſo that they may go three or four times round the former, (but not more) for when they are very thick, they are too ſtrong for the paper which faſtens them to the works, and will ſometimes fly off, without leading the fire: the formers for theſe leaders, are made from two, to ſix ſixteenths of an inch diameter, but four ſixteenths is the ſize generally made uſe of; the formers are made of ſmooth braſs wire; when you uſe them, rub them over with greaſe, or keep them wet with paſte, to prevent their ſticking to the paper, which muſt be paſted all over; in rolling of pipes, make uſe of a rolling board, but uſe it lightly; having rolled a pipe, draw out the former with one hand, holding the pipe, as light as poſſible with the other, for if it preſs againſt the former, it will ſtick and tear the paper.

N. B. Make your leaders of different lengths, or in cloathing of works, you will cut a great many to waſte. Leaders for marron Batteries muſt be made of ſtrong cartrige paper.

SECT.

## SECT. V.

### Of Aquatick Fireworks.

ALL works that ſhew themſelves in the water, are much admired by moſt people who are fond of fireworks, particularly water rockets; but as theſe ſeem of a very extraordinary nature to thoſe who are acquainted with this art, I ſhall endeavour to explain the method of making them, in as full and eaſy a manner as poſſible, as well as other devices for the water.

### Of Water Rockets.

Water rockets may be made from four ounces. to two pound, but if larger they are too heavy, ſo that it will be difficult

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 water rockets, are made in the ſame manner and proportion as ſky rockets, only a little thicker of paper; when you fill theſe rockets which are drove ſolid, put in firſt, one ladle full 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 ladle full 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 your rockets, (according to the above directions) dip their ends in in melted roſin, or ſealing wax, or elſe ſecure them well with greaſe. When you fire theſe 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 drive them with an e-
qual

qual quantity of compoſition, and fire them all together.

## To make Pipes of Communication, which may be uſed under Water.

Pipes for this purpoſe, muſt be a little thicker of paper, than thoſe for land works; having rolled a ſufficient number of pipes, and kept them till thoroughly 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; for if they were oiled all over, when you come to join them, the paſte would not ſtick, where the paper is greaſy; after the leaders are joined, and the paſte dry, oil the joints. Theſe ſort of pipes will lay many hours under water, without receiving any damage.

## Of Horizontal Wheels for the Water.

Firſt get a large wooden bowl without a handle, then have an octogon wheel made

made of a flat board, eighteen inches diameter, ſo that the length of each ſide will be near 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 eight four ounce caſes, filled with a proper charge, each about ſix inches in length. Now to cloath the wheel with theſe caſes, get ſome whitiſh-brown paper, and cut it into ſlips, four or five inches broad, and ſeven or eight long, theſe 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, this caſe tie on one of the ſides of the wheel, near the corners of which, muſt be holes bored, through which you put the pack-thread 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 is to communicate to any thing on 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, ſo that they are 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.

## Of Mines for the Water.

For theſe ſort of mines you muſt have a bowl, with a wheel on it, made in the ſame manner, as the water wheel, only in the middle of the wheel muſt be a hole, of the ſame diameter you deſign to have the mine; thoſe mines are nothing more than a tin pot, with a ſtrong bottom, and a little more than two diameters in length; your 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 des aigrettes, but in their center, 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 ſort of wheels are to be cloathed as uſual.

## Of Fire Globes for the Water.

Bowls for water globes, muſt be very large, and the wheels on them of a decagon form, on each ſide of which 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, fill'd with a grey charge, then carry a leader from

from the tail of one caſe to the mouth of the other.

Globes for theſe wheels, are made of two tin hoops, with their edges outwards, fixed one within the other, at right angles. The diameter of theſe hoops muſt be ſomewhat leſs than that of the wheel. Having made a globe, drive in the center of a wheel, an iron ſpindle, which muſt ſtand perpendicular, and its length, four or ſix inches more than the diameter of the globe.

This ſpindle ſerves for an axis, on which the globe is fixed, which, when done, 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. You are to obſerve that there need not be any port fires, at the bottom of the globe within four inches of the ſpindle, for if there were, they would have no effect, but only burn the wheel; all the port fires, muſt be placed perpendicular from the center ter of the globe, with their mouths outwards; and muſt all be cloathed with leaders, ſo as all to take fire with the ſecond caſe of the wheel; which 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 wheels of this ſort, is, by carrying a leader from the mouth, of one of the firſt caſes, to that of the other, which leader being burnt through the middle, will give fire to both at the ſame time.

## Of Odoriferous Water Ballóóns.

Theſe ſort of Ballóóns, are made in the ſame manner, as air Ballóóns, but very thin of paper, and in diameter one inch and three quarters, 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 ſort of Ballóóns, muſt be fired at the vent, and put into a bowl of water. Odoriferous works, are generally fired in rooms.

Com-

## Compoſition I.

Salt petre two ounces, flower of ſulphur one ounce, camphor half an ounce, yellow-amber half an ounce, charcoal-duſt, three quarters of an ounce, flower of benjamin, or aſſa odorata half an ounce, all powdered very fine; and mixed well together.

## Compoſition II.

Salt petre 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.

## Compoſition III.

Salt petre two ounces, ſulphur half an ounce, antimony half an ounce, amber half an ounce, cedar raſpings a quarter of an ounce, all mixed with the oil of roſes, and a few drops of bergamot.

## Compoſition IV.

Salt petre four ounces, ſulphur one ounce, ſaw-duſt of juniper half an ounce, ſaw-duſt of cypreſs one ounce, camphor a quarter of an ounce, myrrh two drams, dryed roſemary a quarter of an ounce, cortex-elaterii half 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.

## Of Water Ballóóns.

Having made ſome thin paper ſhells, of what diameter you pleaſe, fill ſome with the compoſition for water ballóóns, and ſome after this manner. Having made the vent of the ſhells pretty large, fill them almoſt full with water rockets, marrons, ſquibs, &c. Then put in ſome blowing powder, ſufficient to burſt the ſhells, and afterwards fix in the vent a water rocket, long enough to reach the bottom of the ſhell, and its neck to project

ject a little out of the vent; this rocket muſt be open at the end, in order to fire the powder in the ſhell, which will burſt the ſhell, and diſperſe the ſmall rockets, &c. in the water. When you have well 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 ballóón above water.

## Of 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 center, 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;

thefe cafes, muft be fired, at the beginning of the laft cafe of the wheel, and the mortar, at the conclufion of the fame.

## To reprefent a fea fight with fmall fhips, and to prepare a fire-fhip for the fame.

Having procured four, or five, fmall fhips, of two, or three feet in lenghth, (or as many as you defign to fight) make a number of fmall reports, which are to ferve for guns. Of thefe, range as many as you pleafe, on each fide of the upper decks; then at the head and ftern of each fhip, fix a two ounce cafe, eight inches long, filled with a flow port-fire receipt, but take care to place it, in fuch a manner, that the fire may fall in the water, and not burn the rigging; in thefe cafes, bore holes at unequal diftances, from one another, but make as many in each cafe, as half the number of reports, fo that one cafe may fire the guns, on one fide, and the other thofe on the oppofite. The method of firing theguns, is, by carrying a leader, from the holes in the cafes, 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.

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.

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 them in the other ſhips, and place it at the ſtern; in every port, place a large port fire, filled with a very ſtrong compoſition, and painted in imitation of

a gun,

a gun, and let them all be fired at once by a leader from the ſlow fire, within two, or three diameters of its bcttom; all along both ſides, on the top of the upper deck, lay ſtar compoſition about half an inch in thickneſs, and one in breadth, 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, in order to hold it faſt to the deck, this muſt be fired juſt after the ſham guns, and when burning will ſhew 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, fix two running blocks, at what diſtance you chuſe the

ſhips

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 windlaſs's; round one of them, turn one end of a ſmall cord, and the other end, put 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 what diſtance you think proper, but theſe ſtrings, muſt not be more than two feet in length each; the looſe end of each of theſe cords, make faſt, to a ſhip, juſt under her bow-ſprit; but 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 windlaſs's, to which faſten a cord, and to it tie the other half of the ſhips, as before directed: when you fire the ſhips, pull in the cord, with one of the windlaſs's, in order to get all the ſhips together; and when you have ſet fire to the firſt, turn that windlaſs, which draws them out,

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 chuſe.

## To repreſent Neptune in his Chariot.

In order to repreſent this, to perfection, 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 ſwiming, as they are ſhown by Fig. 35. 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, paſte board, cut and painted like Neptune's coro-

coronet; then let the trident be made without prongs, but inftead of them, fix three cafes of a weak grey charge, and on each horfe's head, put an eight ounce cafe of brilliant fire, and on the mouth of each, fix a fhort cafe of the fame diameter, filled with the white flame receipt, enough to laft out all the cafes on the wheels; thefe fhort cafes muft be open at bottom, that they may light the brilliant fires; for the horfes eyes, put fmall port fires, and in each noftril, put a fmall cafe filled half with grey charge, and the reft with port fire compofition.

If Neptune is to give fire, to any building on the water; at his firft fetting out, the wheels of the chariot, and that on his head, together with the white flames on the horfes head, and the port fires in their eyes and noftrils, muft 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 muft manage it fo as not to let him turn about, till the brilliant fires on the horfes, and the trident, begins, for it is by the fire from the horfes, (which plays almoft upright) that the building, or work, is lighted;

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 ſhewn 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.

## To repreſent Swans and Ducks in the water.

If you would have the 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

this purpofe, muft be made of brafs, two inches in length and filled with a flow bright charge; in the middle of one of thefe cafes, make a little hole, then put the port fire, in the eye hole of the fwan, 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 fwan, within two inches of one of the eyes, bore a hole flant-ways, to meet that in the port fire; in this hole put a leader, and carry it to a water rocket, that muft be fixed under the tail with its mouth upwards; on the top of the head, place two one ounce cafes, four inches in length each, drove with brilliant fire; one of thefe cafes muft incline forwards, and the other backwards; thefe muft be lighted at the fame time as the water rocket; to do which, bore a hole between them, in the top of the fwans head, down to the hole in the port fire, to which carry a leader; if the fwan be filled with rockets, they muft be fired, by a pipe, from the end of the water rocket under the tail. When you fet the fwan a fwiming light the two eyes.

## Of fire Fountains for the Water.

To make a fire fountain, you muſt firſt have a float made of wood, three feet diameter, then in the middle of it, fix a round perpendicular poſt, four feet in height, 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 foot two inches diameter, and fixed at two feet diſtance from the firſt wheel. 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 eighteen 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, thirteen caſes of the ſame ſort, and in the ſame manner, as thoſe on the firſt wheel; on the third wheel, place eight more of this ſort of caſes, in the ſame manner as before, and on the top of the poſt, fix a gerbe, then cloath all the caſes, with leaders, ſo that both they and the gerbe; may take fire at the ſame time. Before you fire this work, try it in the water, to ſee if the float be properly made, ſo as to keep the fountain upright.

SECT.

## SECT. VI.

### To make Crackers.

CUT ſome 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; then open it, and lay all along the channel which is formed, by the folding 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; then hold all theſe folds flat and clofe, and with a fmall pinching cord, give one turn round the middle of the cracker, and pinch it clofe, then bind it with pack-thread, as tight as you can then in the place where it was pinched, prime one end of it, and cap it with touch paper. When thefe crackers are fired they will give a report, at every turn of the paper: if you would have a great number of bounces, you muft cut the paper longer, or join them after they are made; but if they are made very long before they are pinched, you muft have a piece of wood, with a groove in it, deep enough to let in half the cracker, this will hold it ftraight, while it is pinching. Fig. 36. reprefents a cracker compleat.

## Of Single Reports.

Cafes for reports are generally rolled on one and two ounce formers, and are feldom made larger, but on particular occafions; they are made from two, to four inches long, and very thick of paper; having rolled a cafe, pinch one end quite clofe, and drive it down, then fill the cafe with corn powder, only leaving room

room to pinch it at top, but before you pinch it, put in a piece of paper at top of the powder: Reports are fired, by a vent, bored in the middle, or at one end, juſt as required.

## Of Marrons.

Formers for marrons, are from three quarters of an inch, to one and a half diameter; cut the paper for the caſes, twice the diameter of the former broad, and long enough to go three times round; when you have rolled a caſe, paſte down the edge, and tie one end cloſe, then with the former drive it down to take away the wrinkles and make it flat at bottom, then fill the caſe with corn powder one diameter and a quarter high, and fold down the reſt of the caſe tight on the powder; the marron being thus made, wax ſome ſtrong pack-thread, with ſhoemakers wax; this thread wind up in a ball, then unwind two, or three yards of it, and that part which is near the ball, make faſt to a hook; then take a marron, and ſtand as far from the hook as the pack-thread will reach, and wind it lengthwiſe round marron, as close as you can, till it will hold no more that way; then turn it, and wind the pack-thread on the short way, then lengthwise again, and so on till the paper is all covered; then make fast the end of the pack-thread, and beat down both ends of the marron, to bring it in shape. The method of firing marrons, is by making a hole at one end with an awl and putting in a piece of quick-match, then take a piece of strong paper, in which wrap up the marron, with two leaders, which must be put down to the vent, and the paper tied tight round them with small twine; these leaders are bent on each side, and their loose ends tied to other marrons, and are nailed in the middle to the rail of the stand, as may be seen by Fig. 37. The use of winding the pack-thread in a ball, is, that you may let it out as you want it, according to the quantity, the marron may require; and that it may not be tied in knots, which would spoil the marron.

## Of Marron Batteries.

Thoſe batteries, if well managed, will keep time to a march, or a ſlow piece of muſick. Marron batteries are made of ſeveral ſtands, with a number of croſs rails, for the marrons, which are regulated by leaders, by cutting them of different lengths, and nailing them tight, or looſe, according to the time of the muſick. In marron batteries you muſt uſe the large and ſmall ſort of marrons, and the nails for the pipes, muſt have flat heads.

## Of Line Rockets.

Line rockets are made and drove in the ſame manner as ſky rockets, but have no heads, and the caſes muſt be cut cloſe to the clay; they are ſometmies made with ſix, or ſeven changes, but in general not more than four, or five; the method of managing thoſe rockets, is as follows; firſt have a piece of light wood, the length of one of the rockets, turned round about two inches and a half diameter, with a hole through the middle lengthwiſe, large enough for the line to go eaſily through; if you deſign four changes, have four grooves cut in the ſwivel, one oppoſite the other, to lay the rockets in.

The mouths of the rockets being rubbed with wet meal powder, lay them in the grooves, head to tail, and tie them faſt; from the tail of the firſt rocket, carry a leader to the mouth of the ſecond, and from the ſecond to the third, and ſo on to as many as there are on the ſwivel, making every leader very ſecure, but in fixing theſe pipes take care, that the quick-match does not enter the bores of the rockets; the rockets being fixed on the ſwivel, and ready to be fired, have a line of a hundred yards in length, ſtretched and fixed up tight, at any height from the ground, but be ſure to place it horizontal; this length of line will do for rockets of half a pound, but if larger, the line muſt be longer, before you put up the line, put one end of it through the ſwivel, and when you fire the line rocket, let the mouth of that rocket which you fire firſt, face that end of the line where you ſtand, then the firſt rocket will carry the reſt to the other end of the line, and the ſecond will bring them

back

back again, and ſo they will run out and in according to the number of rockets: at each end of the line, there muſt be a piece of flat wood, for the rocket to ſtrike againſt, or its force would cut the line. Let the line be well ſoaped, and the hole in the ſwivel very ſmooth.

## Of the different Decorations for Line Rockets.

To line rockets may be fixed many ſorts of things, ſuch as flying dragons, mercuries, ſhips, &c. Or they may be made to run on the line like a wheel, which is done in this manner; have a flat ſwivel, made very exact, and on it, tie two rockets obliquely, one on each ſide, which will make it turn round all the way it goes, and form a circle of fire; the charge for theſe rockets, ſhould be a little weaker than common; if you would ſhew two dragons fighting, get two ſwivels made ſquare, and on each tie three rockets together, on the under ſide; then have two flying dragons made of tin, and fix one of them on the top of each ſwivel, ſo as to ſtand upright; in the mouth of each dragon put a ſmall caſe

caſe of common fire, and another at the end of the tail; you may put two or three port fires of a ſtrong charge, on one ſide of their bodies, in order to ſhew them. This being done put them on the line, one at each end; but let there be a ſwivel in the middle, of the line, to keep the dragons from ſtriking together; before you fire the rockets light the caſes on the dragons, and if care be taken in firing both at the ſame time, they will meet in the middle of the line, and ſeem to fight. Then they will run back, and return again, with great violence, which will have a very pleaſing effect. The line for theſe rockets muſt be very long, or they will ſtrike too hard together.

## Of Chineſe Flyers.

Caſes for flyers, may be made of different ſizes, from one to eight ounces; they muſt be made thick of paper, and eight interior diameters long; they are rolled in the ſame manner as tourbillons, with a ſtraight paſted edge, and pinched cloſe at one end; the method of filling them is thus; the caſe being put in a mould, whoſe cylinder, or foot, muſt be flat

## Of Table Rockets.

Table rockets are deſigned merely to ſhew the truth of driving, and the judgment of a fireworker, they having no other effect, when fired, than ſpinning round in the ſame place, where they begin; till they are burnt out, and ſhewing nothing more than an horizontal circle of fire.

The method of making theſe ſort of rockets, is as follows: Have a cone turned out of hard wood, two inches and a half diameter, and as much in height; round the baſe of it draw a line, on this line fix four ſpokes, two inches in length each, 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 tourbillons, and muſt be rammed with the greateſt exactneſs.

Your 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 made in ſuch a manner, that the fire of of each caſe may act the ſame way; from theſe vents carry leaders to the top of the cone, and tie them together. When you would fire the rockets ſet them on a ſmooth table, and light the leaders in the middle, and all the caſes will fire together (See fig. 38.) 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 from one another: 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.

## To make Wheels and other Works incombuſtible.

It being neceſſary, when your works are new, to paint them of ſome dark colour; therefore, if inſtead of which, you make uſe of the following compoſition, it will give them a good colour, and in a great meaſure prevent their taking fire ſo ſoon, as if painted. Take brick-duſt, coal

coal ashes, and iron filings, of each an equal quantity, and mix them together, with a double size, made hot. With this wash over your works, and when dry wash them over again; this will preserve the wood greatly against fire. Let the brick-dust, and ashes, be beat to a fine powder.

## Of Single Vertical Wheels.

There are different sorts of vertical wheels, some having their fells of a circular form, others of an hexagon, octagon, or decagon form, or any number of sides, according to the length of the cases, you design for the wheel: your spokes being fixed in the nave, nail slips of tin, with their edges turned up, so as to form grooves for the cases to ly in, from the end of one spoke to another; then tie your 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

the ſame time, and all the caſes filled alike, to make them keep time together, which they will do if made by the following directions. In all the caſes of both wheels, except the firſt, on each wheel, drive two, or three ladles full of ſlow fire, in any part of the caſes, but be carefull to ram the ſame quantity in each caſe, and in the end of one of the caſes, on each wheel, you may ram one ladle full of dead fire compoſition, which muſt be very lightly drove; you may alſo make many changes of fire, by this method.

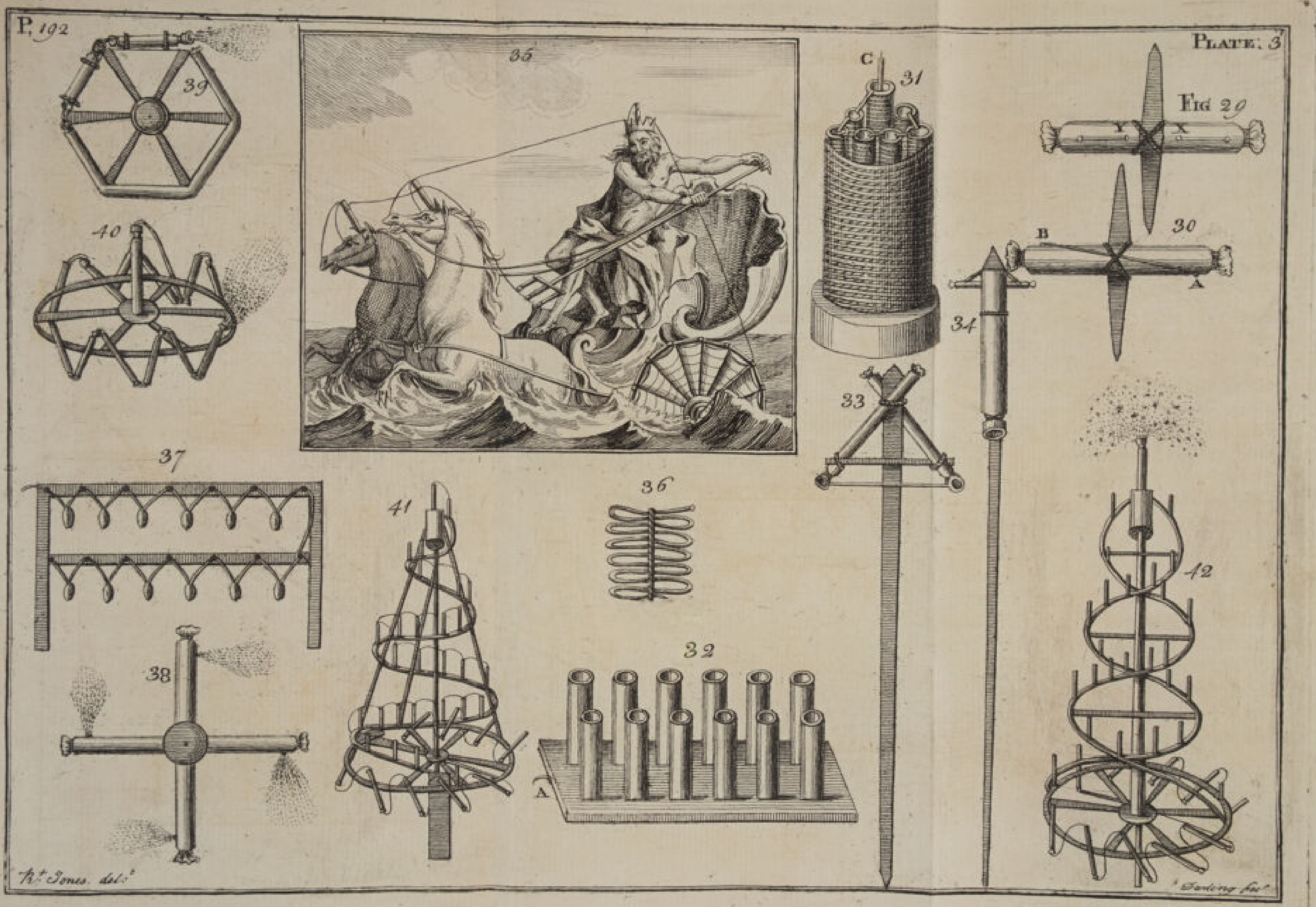
Let the hole in the nave of the wheel be lined with braſs, and made to turn on a ſmooth iron ſpindle. On the end of this ſpindle let there be a nut, to ſcrew off and on; when you have put the wheel on the ſpindle, ſcrew on the nut, which will keep the wheel from flying off. Let the mouth of the firſt caſe be a little raiſed. See fig. 39. 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 fourteen, or ſixteen inches diameter, which is the proportion generally uſed. The beſt wood for wheels of all ſorts, is a light, and dry beech.

Of

## Of Horizontal Wheels.

Horizontal wheels 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 center 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. Theſe pieces fix 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 near together; from the tail of one caſe, to the mouth of the other carry a leader, which ſecure with paſted paper. Beſides theſe pipes, it will be neceſſary, to put a little meal powder inſide the paſted paper, in order 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, burn-

ing


P. 192
PLATE. 3
FIG 29
30
31
32
33
34
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41
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A
B
C

ing 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; ten or twelve inches will be enough for the diameter of wheels, with ſix ſpokes. Fig. 40. repreſents a wheel on fire, with the firſt caſe burning.

## Of ſpirali Wheels.

Spirali wheels are nothing more than double horizontal wheels, and are thus made: The nave muſt be about ſix inches long, and ſomewhat thicker than the ſingle ſort; inſtead of the pintle at top, there muſt be a hole for the caſe to be fixed in; there muſt alſo be 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 three inches and a half in length each from the nave, 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 to play up, but let the third or fourth caſe play horizontally. The caſe in the middle may begin with any of the others, you pleaſe; ſix ſpokes will be enough for each ſet, ſo that the wheel may conſiſt of twelve caſes, beſides that on the top: the caſes for theſe ſort of wheels need not be more than ſix inches in length each.

## Of Plural Wheels.

Plural wheels are made to turn horizontally, and to conſiſt of three ſets of ſpokes, placed in the following manner, ſix at top, ſix at bottom, and four in the middle, which muſt be a little ſhorter than the reſt; let the diameter of the wheel be ten inches; the caſes muſt be tied on the ends of the ſpokes, in grooves cut

cut on purpoſe, or in pieces of wood, nailed on the ends of the ſpokes, with grooves cut in them as uſual; in cloathing theſe wheels, make the upper ſet of caſes play obliquely downwards, and them at bottom obliquely upwards, and them in the middle horizontally. In placing the leaders, you muſt order it 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 ladles full 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.

## Of the 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 in length each, and three quarters of an inch in breadth each; one end of each of theſe pieces, nail to the fell of the wheel, at an equal diſtance from one another, and the other ends nail to a block with a hole in its bottom, which muſt be perpendicular, with that in the block of the wheel, but not ſo large. The wheel being thus made, have a hoop planed down very thin and flat, then nail one end of it to 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, ſee fig. 41.

## Of the Double Spiral Wheel.

For this wheel, the block, or nave, muſt be as long as the height of the worms, or ſpiral lines, but muſt be made very

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; theſe worms cloath with illuminations, the ſame as thoſe on the ſingle wheels, but the horizontal wheel, you may cloath as you like. At top of the worm, place a caſe of ſpur-fire, or an amber light, ſee fig. 42. This figure is ſhewn without leaders, to prevent a confuſion of lines.

## Of Ballóón Wheels.

Ballóón wheels 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 tin pots, three inches diameter and ſeven inches in height 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; ſome of the pots load 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.

## Of Fruiloni Wheels.

First have a nave made nine inches in length, and three in diameter, near the bottom of this nave fix eight ſpokes, with a hole in the end of each large enough to receive a two, or four ounce caſe. Each of theſe ſpokes may be fourteen inches in length from the block; near the top of this block, fix eight more, of the ſame ſort of ſpokes, exactly over the others, but not ſo long by two inches; as this wheel is to run horizontally, all the caſes in the ſpokes, at top, muſt play obliquely upwards, and all them in the ſpokes at bottom obliquely downwards. This being done, have a ſmall horizontal wheel made with eight ſpokes, each five inches in length from the block; on the top of this wheel, place a caſe of brilliant fire; all the caſes on this wheel muſt play in an oblique direction downwards, and burn two at a time,

time, and thoſe on the large wheel, four at a time, that is, two of thoſe in the top ſet of ſpokes, and two of them in the bottom ſet of ſpokes.

The four firſt caſes on the large wheel, and the two firſt on the ſmall wheel, muſt be fired at the ſame time, and the brilliant fire at top, at the beginning of the laſt caſes. The caſes of the wheels may be filled with a grey charge; when theſe wheels are compleated, you muſt have a ſtrong iron ſpindle, made four feet ſix in length, and fixed perpendicular on the top of a ſtand; on this put the large wheel, whoſe nave muſt have a hole quite through from the bottom to the top. This hole muſt be large enough to turn eaſy round the bottom of the ſpindle, at which place there muſt be a ſhoulder, to keep the wheel from touching the ſtand; at the top of the ſpindle, put the ſmall wheel, and join it to a large one with a leader, in order to fire them them both together.

## Of Port fires for Illuminations.

Thefe fort of port fires, have their cafes made very thin of paper, and rolled on formers, from two to five eighths of an inch diameter, and are made from two, to fix inches in length; they are pinched clofe at one end, and left open at the other; when you fill them, put in but a little compofition at a time, and ram it in lightly, fo as not to break the cafe. Three or four rounds of paper, with the laft round pafted, will be ftrong enough for thefe fort of cafes.

## Of Common port fires.

Common port fires are intended purpofely to fire the works, their fire being very flow, and the heat of the flame fo intenfe, that, if applyed to rockets, leaders, &c, it will fire them immediately. Port fires may be made of any length, but are feldom made more than twenty one inches in length; the interior diameter of port fire moulds, fhould be ten fixteenths of an inch, and the diameter of the former, half an inch. The cafes muſt be rolled wet with paſte, and one end of them pinched, or folded down. The moulds ſhould be made of braſs, and to take in two pieces lengthwiſe; then when the caſe is in the two ſides, they are held together by braſs rings, or hoops, which are made to fit over the outſide. The bore of the mould muſt not be made quite through, ſo that there will be no occaſion for a foot. Thoſe port fires when uſed, are held in copper ſockets, fixed on the end of a long ſtick; theſe ſockets are made like port crayons, only with a ſcrew, inſtead of a ring.

## Of Caſcades of Fire.

Caſcades are made of any ſize, but one made according to the dimenſions of that ſhewn in plate 4. fig. 43. will be large enough for eight ounce caſes. Let the diſtance from A to B, be three feet; from B to C, two feet ſix inches; and from C D, two feet; and let the croſs piece, at A, be four feet in length; then from each end of this piece, draw a line to D; then make the other croſs pieces of ſuch a length as to come within

within thoſe lines. The top piece D, may be of any length ſo as to hold the caſes, at a little diſtance from one another; all the croſs pieces are fixed horizontally, and ſupported by brackets; the bottom croſs piece ſhould be about one foot ſix inches broad in the middle, the ſecond one foot, the third nine inches, and the top piece four inches; the caſes may be made of any length, but muſt be filled with a brilliant charge; on the edges of the croſs pieces muſt be nailed bits of wood, with a groove cut in each piece, large enough, for a caſe to lie in. Theſe bits of wood are fixed ſo as to incline downwards, and that the fire from one teer of caſes may play over the other; all the caſes being tied faſt on, carry leaders from one to the other, and let there be a pipe, hang from the mouth of one of the caſes, covered at the end with a ſingle paper, which you burn to fire the caſcade.

## Of the Fire-Tree.

To make a fire-tree, as ſhewn by fig. 44. you muſt firſt have a piece of wood ſix feet in length, and three inches ſquare,

ſquare, then at E, nine inches from the top, make a hole in the front, and in each ſide, or inſtead of holes you may fix ſhort pegs, to fit the inſide of the caſes. At F, nine inches from E, fix three more pegs; at G, one foot nine inches from F, fix three pegs; at H, nine inches from G, fix three pegs, inclining downwards, but all the other pegs, muſt incline upwards, in order that the caſes may have the ſame inclination as you ſee in the figure; then at top place a four inch mortar, loaded with ſtars, rains, or crackers. In the middle of this mortar, place a caſe filled with any ſort of charge, but let it be fired with the other caſes: a brilliant charge will do for all the caſes, but the mortar may be made of any diameter, and the tree of any ſize, and on it any number of caſes, provided they are placed in the manner deſcribed.

## Of Chineſe Fountains.

To make a Chineſe fountain, you muſt have a perpendicular piece of wood, ſeven feet in length, and two inches and a half ſquare. Sixteen inches from

from the top; fix on the front, a crofs piece, one inch thick, and two and a half broad, with the broad fide upwards; below this, fix three more pieces, of the fame width and thicknefs, at fixteen inches diftance from each other; let the bottom rail be five feet in length, and the others of fuch a length, as to allow the fire pumps to ftand 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 diftances; on the fecond rail place four pumps; on the third, three; on the fourth, two; and on the top of the poft, one; but place them all to incline a little forwards, that when they throw out the ftars, they may not ftrike againft the crofs rails; having fixed your fire pumps, cloath them with leaders, fo that they may all be fired together. fee fig. 45.

Of

## Of Illuminated Globes with Horizontal Wheels.

The hoops for theſe ſort of globes, may be made of wood, tin, or iron wire, about two feet diameter; for a ſingle globe take two hoops, and faſten them together, one within the other at right angles; then have a horizontal wheel made, whoſe diameter muſt be a little wider than the globe, and its nave ſix inches long, on the top of which the globe is fixed, ſo as to ſtand three or four inches from the wheel; on this wheel you may put any number of caſes, fill'd with what charge you like, but let two of them burn at a time; they may be placed horizontally or to incline downwards juſt as you chuſe. Now when the wheel is cloathed, fix on the hoops as many illuminations as will ſtand within two inches and a half of one another; theſe you faſten on the hoops, with ſmall iron binding wire, and when they are all on, put on your pipes of communication, which muſt be ſo managed, as to light them

them all with the ſecond or third caſe on the wheel; the ſpindle on which the globe is to run muſt go through the block of the wheel, up to the inſide of the top of the globe, where muſt be fix'd a bit of braſs or iron, with a hole in it to receive the point of the ſpindle, on which the whole weight of the wheel is to bear, as is ſhewn by fig. 46. which repreſents a globe on its ſpindle. By this method may be made a crown, which is done by having the hoops bent in the form of a crown. Sometimes globes and crowns, are ordered ſo as to ſtand ſtill, and the wheel only to turn round; but when you would have the globe or crown to ſtand ſtill, and the wheel to run by itſelf, the block of the wheel muſt not be ſo long, nor the ſpindle any longer than to juſt raiſe the globe a little above the wheel; and the wheel caſes, and the illumination muſt begin together.

Of

## Of the Dodecaedron.

This piece is called a dodecaedron, becauſe it nearly repreſents a twelve ſided figure, and is made thus. Firſt have a ball turned out of ſome hard wood, fourteen inches diameter, when done, divide its ſurface into fourteen equal parts, from which bore holes, one inch and a half diameter, perpendicular to the center, ſo that they may all meet exactly 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 in length, 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 up, 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 you 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 in in length; theſe ſides muſt have grooves cut in them large enough to receive a two or four ounce caſe; when theſe wheels are cloathed, 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 this 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 your work will be ready to be fired. By this leader the powder and match in the center is fired, which will light the match at the ends of the ſpokes, all at once, whereby all the wheels will be lighted at one and the ſame time; there may be an addition to this piece, by fixing a ſmall globe, on

each

each wheel, or one on the top wheel only. A grey charge will be proper for the wheel cafes.

## Of the Yew Tree of Brilliant Fire.

A yew tree of fire is reprefented by fig. 47. as it appears when burning; firft, let A be an upright piece of wood, four feet in length, two inches broad and one thick; at top of this piece, on the flat fide, fix a hoop, fourteen inches diameter, and round its edge and front place illuminations, and in the center a five pointed ftar; then at E, which is one foot and a half from the edge of the hoop, place two cafes of brilliant fire, one on each fide; thefe cafes fhould be one foot in length each; below thefe, fix two more cafes of the fame fize, and at fuch a diftance that their mouths may almoft meet them at top; then, clofe to the ends of thefe cafes, fix two more of the fame fort of cafes; thefe muft ftand parallel to them at E. The cafes being thus fixed, cloath them with leaders; fo that they, with the illuminations and ftar at top, may all take fire together.

## Of Stars with Points for Regulated Pieces, &c.

Theſe ſort of 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 are made with four ounce caſes, four or five inches in length; the caſes muſt be rolled with paſte, and twice as thick of paper as 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, according to the length of the caſes, with which it is to burn; at top of the charge drive ſome clay; for, as the ends of theſe caſes are ſeldom punched, 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

ſecure it with paper; this paper muſt be put on in the manner of that on the ends 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, in order to give fire to the points of the ſtar. Theſe ſort of ſtars may be made with any number of points.

## Of the Fixed Sun with a Tranſparent Face.

To make a ſun of the beſt ſort, there ſhould be two rows of caſes, as in fig. 48, which will ſhew a double glory, and make the rays ſtrong and full; the frame or ſun wheel, muſt be made after the following manner; have a circular flat nave made very ſtrong, twelve inches diameter; to this fix ſix ſtrong flat ſpokes, A, B, C, D, E, F. 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

divide the fells into as many equal parts as you would have cafes (which may be done from twenty four, to forty four;) at each divifion, fix a flat iron ftaple; thefe ftaples muft be made to fit the cafes, fo as to hold them faft on the wheel; let the ftaples be fo placed, that one row of cafes may lay in the middle of the intervals of the other.

In the center of the block of the fun, drive a fpindle, on which put a fmall hexagon wheel, whofe cafes muft be filled with the fame charge, as the cafes of the fun; two cafes of this wheel muft burn at a time, and begin with them on the fells; having fixed on all the cafes, carry pipes of communication from one to the other, as you fee in the figure, and from one fide of the fun to the wheel in the middle, and from thence to the other fide of the fun. Thefe leaders will hold the wheel fteady while the fun is fixing up, and will alfo be a fure method of lighting both cafes of the wheel together. A fun thus made is called a brilliant fun, becaufe the wood work is entirely covered with fire from the wheel in the middle, fo that there appears nothing but fparks of brilliant fire; but if you would have a tranf-

parent

parent face in the center, you muſt have one made of paſte board, 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 ſort of face, you may have one painted on oiled 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 center, ſo that the light of it may illuminate the face; by this method you may have in the front of a ſun VIVAT REX, cut in paſte board, or Apollo painted on ſilk, but for a ſmall collection of fireworks, 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.

## Of three Vertical Wheels Illuminated, which turn on their own Naves upon a Horizontal Table.

A plan of this is ſhewn by fig. 49. Let D be a deal table three feet ſix inches diameter; this table muſt be fixed horizontally on the top of a poſt; on the top of this poſt muſt be a perpendicular iron ſpindle, which muſt come through the center of the table; then let A, B, C, be three ſpokes joined to a triangular flat piece of wood, in the middle of which make a hole to fit eaſily over the ſpindle; let E, F, G, be pieces of wood, four or five inches in length each, and two inches ſquare, fixed on the under ſides of the ſpokes; in theſe pieces make holes lengthwiſe to receive the thin part of the blocks of the wheels, which when in, are prevented from coming out by a ſmall iron pin being run through the end of each; K, L, M, are three vertical octagon wheels, eighteen inches diameter each; the blocks of theſe wheels muſt be long enough

enough for three or four inches to reſt on the table, round which part drive a number of ſharp points of wire, which muſt not project out of the blocks more than one ſixteenth of an inch; the uſe of theſe points is, that when the blocks run round, they will ſtick in the table, and help the wheels forward; if the naves be made of ſtrong wood, one inch will be enough for the diameter of the thin part, which ſhould be made to turn eaſy in the holes in the pieces E, F, G. On the front of the wheels, make four or five circles of ſtrong wire, or flat hoops, and tie on them as many illuminations as they will hold at two inches from one another; inſtead of circles, you may make ſpiral lines cloathed with illuminations at the ſame diſtance from one another, as thoſe on the hoops: when illuminations are fixed on a ſpiral line in the front of a wheel, they muſt be placed a little on the ſlant, the contrary way that the wheel runs: the caſes for theſe wheels may be filled with any coloured charge, but muſt burn only one at a time.

The wheels being thus prepared, you muſt have a globe, crown, or ſpiral wheel, to put on the ſpindle in the middle of the table; this ſpindle ſhould be juſt long enough to raiſe the wheel of the globe, crown, or ſpiral wheel, ſo high that its fire may play over the three vertical wheels; by this means, their fires will not be confuſed, nor will the wheels receive any damage from the fire of each other; in cloathing this work, let the leaders be ſo managed, that all the wheels may light together, and the illuminations after two caſes of each wheel are burnt.

## Of the Illuminated Chandelier.

Illuminated works are much admired by the Italians, and indeed are a great addition to a collection of works; for in a grand exhibition an illuminated piece ſhould be fired after every two, or three wheels, or fixed pieces of common and brilliant fires, and likewiſe illuminated works may be made cheap, quick, and eaſy.

To make an illuminated chandelier, you muſt firſt have one made of thin wood; ſee fig. 50. The chandelier being made, bore in the front of the branches, and in the body, and alſo in the

the crown at top, as many holes for illuminations as they will contain, at three inches diſtance from each other; in theſe holes put illuminations filled with white, blue, or brilliant charge; having fixed in the port fires, cloath them with leaders ſo that the chandelier and crown may light together. The ſmall circles on this figure repreſent the mouths of the illuminations, which muſt project ſtraight from the front.

## Of the Illuminated Yew Tree.

Firſt have a tree made of wood, ſuch as is ſhewn by fig. 51. The middle piece or ſtem, on which the branches are fixed, muſt be eight feet ſix inches in height; at the bottom of this piece draw a line, at right angles, two feet ſix inches in length at each ſide; then from L, which is one foot ſix inches from the bottom, draw a line on each ſide to C and D; theſe lines will give the length of the two firſt branches. Then put on the two top branches parallel to them at bottom; let the length of each of theſe branches be one foot from the ſtem; from the ends of theſe two branches,

branches, draw a line to C and D; then fix on five more branches at an equal diſtance from each other, and their length will be determined by the lines A C and E D; when the branches are fixed, place illuminating port fires on the top of each, as many as you chuſe: behind the top of the ſtem faſten a gerbe, or white fountain, which muſt be fired at the beginning of the illuminations on the tree.

## Of Flaming Stars with Brilliant Wheels.

To make a flaming ſtar, you muſt firſt have made a circular piece of ſtrong wood, about one inch thick and two feet diameter; round this block fix eight points, two feet ſix inches in length each; four of theſe points muſt be ſtraight, and four flaming; theſe points being joined on very ſtrong and even with the ſurface of the block, nail tin or paſte board on their edges, from the block to the end of each, where they muſt be joined; this tin muſt project in front eight inches, and be joined where they meet at the block; round the

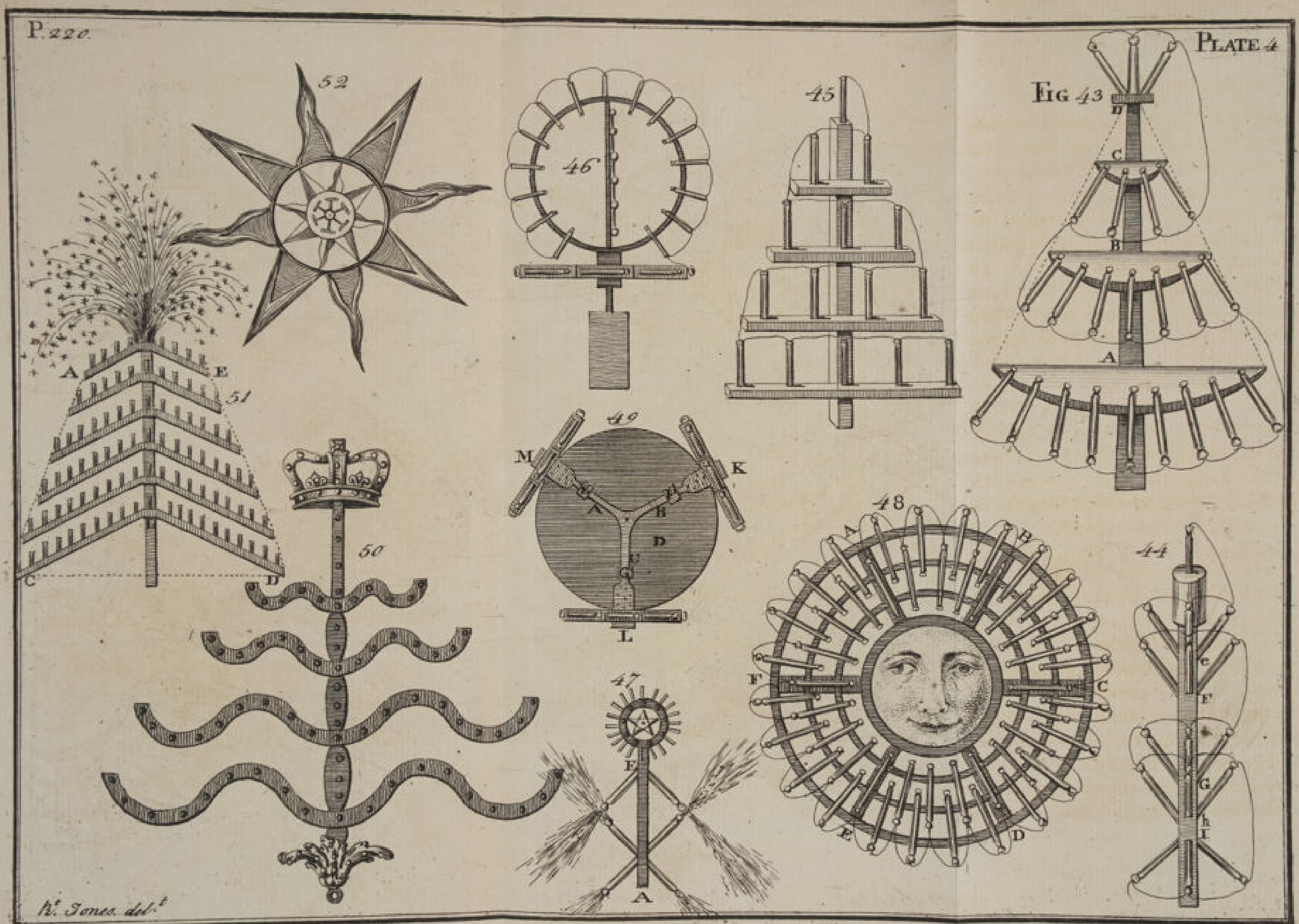
the front of the block fix four pieces of thick iron wire, eight inches in length each, equally diſtant from each other; this being done, cut a piece of paſte board round two feet diameter, and draw on it a ſtar, as may be ſeen in fig. 52. This ſtar cut out, and on the back of it paſte oiled paper, then paint each point half red, and half yellow, lengthwiſe; but the body of the ſtar muſt be left open, wherein muſt run a brilliant wheel, which is made as follows: Have a light block turned nine inches long; at each end of it, fix ſix ſpokes, at the end of each ſpoke put a two ounce caſe of brilliant fire; the length of theſe caſes muſt be in proportion to the wheel, and the diameter of the wheel when the caſes are on muſt be a little leſs than the diameter of the body of the ſmall ſtar; the caſes on the ſpokes in front muſt have their mouths incline outwards, and them on the inſide ſpokes muſt be placed ſo as to form a vertical circle of fire. When you place your leaders, carry the firſt pipe from the tail of one of the caſes in front to the mouth of one of the inſide caſes, and from the tail of that to another in front, and ſo on to all the caſes; your

wheel

wheel being made, put it on a ſpindle, exactly in the center of the ſtar; this ſpindle muſt have a ſhoulder at bottom, to keep the wheel at a little diſtance from the block. This wheel muſt be kept on the ſpindle by a nut at the end; having fixed on the wheel, faſten the tranſparent ſtar to the four pieces of wire; then when you fire the wheel, you will firſt ſee nothing more than a common horizontal wheel; but when the firſt caſe is burnt out, it will fire one of the vertical caſes, which will ſhew the tranſparent ſtar, and fill the large flames and points with fire; then it will again appear like a common wheel, and ſo on for twelve changes.

## Of Touch Paper for Capping of Serpents, Crackers, &c.

Diſſolve, in ſome ſpirits of wine or vinegar, a little ſalt petre, then take ſome purple or blue paper, and 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


P. 220.
Plate 4
Fig 43
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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.

## Of a Projected Regulated Piece of Nine Mutations.

A regulated piece, if well executed, is as curious a work as any in fireworks; for it conſiſts of fixed and moveable pieces on one ſpindle, repreſenting various ſorts of figures, which take fire ſucceſſively one from another, without any aſſiſtance after lighting the firſt mutation; but, for the better explanation of this piece, I ſhall give a full deſcription of the method of communicating the fire from one mutation to the other, with a figure of each as they ſtand on the ſpindle. Regulated pieces are made of many ſorts, and of any number of mutations, from two to nine, which is the greateſt number I ever knew a piece to conſiſt of, except one of my own making, which was compoſed of fifteen mutations, all different fires, and figures. But, as an explanation of ſo large a piece, would be very difficult, to comprehend, I ſhall omit it, leaving ſo many changes to thoſe who have made a great progreſs in this art, and only teach the manner of making a piece of nine mutations, as ſhewn in Plate V, fig. 53. As it will be neceſſary that every mutation ſhould be ſeparately explained, I will firſt give the name of each, with the colour of fire, and ſize of the caſe belonging to it: after which ſhall proceed, with the proportion of each mutation, together with the nature of the ſpindle, and manner of placing the leaders

## Firſt Mutation

Is a hexagon vertical wheel, illuminated in front with ſmall port fires tied on the ſpokes; this wheel muſt be cloathed with two ounce caſes, filled with black charge; the length of theſe caſes, are determined by the ſize of the wheel, but muſt burn ſingly.

by filling the cafes half with brilliant charge and half with grey.

## Fifth Mutation

Is a fixed piece called the porcupine's quills; this piece confifts of twelve fpokes, ftanding perpendicular to the block in which they are fixed; on each of thefe fpokes, near the end, muft be placed a four ounce cafe of brilliant fire; all thefe cafes muft incline either to the right or left, fo that they may all play one way.

## Sixth Mutation

Is a ftanding piece called the crofs fire. This mutation confifts of eight fpokes fixed in a block; near the end of each of thofe fpokes, muft be tied two four ounce cafes of white charge, one acrofs the other, fo that the fires from the cafes on one fpoke, may interfect the fire from cafes on the other.

## Seventh Mutation

Is a fixed wheel, with two circular fells, on which are placed fixteen eight ounce

ounce cafes of brilliant fire, in the form of a ftar: this piece is called a fixed ftar of wild fire.

## Eighth Mutation.

This is a beautiful piece, called a brilliant ftar piece, it confifts of fix fpokes, which are ftrengthened by two fells of a hexagon form at fome diftance from each other; at the end of each fpoke, in the front, is fixed a brilliant ftar of five points; and on each fide of every ftar is placed a four ounce cafe of black or grey charge; thefe cafes muft be placed with their mouths fide ways, fo that their fires may crofs each other.

## Ninth Mutation

Is a wheel piece; this is compofed of fix long fpokes, with a hexagon vertical wheel at the end of each; thefe wheels run on fpindles in the front of the fpokes; all the wheels are lighted together: two ounce cafes will do for thefe wheels, and may be filled with any coloured charge.

After having ſpoke of the ſeveral parts of the regulated piece, each by their proper names and colour of fire, I ſhall next proceed with the proportion of every mutation, together with the method of conveying the fire from one to the other, and the diſtance they ſtand one from the other on the ſpindle.

## Firſt Mutation

Muſt be a hexagon vertical wheel, fourteen inches diameter; on one ſide of the block, whoſe diameter is two inches and a quarter, is fixed a tin barrel A, ſee fig. 53, N°. 1; this barrel muſt be a little leſs in diameter than the nave; let the length of the barrel and block be ſix inches. Having fixed the caſes on the wheel, carry a leader from the tail of the laſt caſe into the tin barrel through a hole made on purpoſe two inches from the block; at the end of this leader let there be about an inch or two of looſe match, but take care to well ſecure the hole wherein the pipe is put, to prevent any ſparks falling in, which would light the ſecond mutation before its time, and confuſe the whole piece.

Second

## Second Mutation

Is thus made. Have a nave turned two inches and a half diameter, and three long; then let half an inch of that end which faces the firſt wheel be turned ſo as to fit eaſy into the tin barrel of the firſt mutation, which muſt turn round it without touching; on the other end of the block, fix a tin barrel B, N°. 2, this barrel muſt be ſix inches in length, and only half an inch of it to fit on the block. Round the nave fix five ſpokes, one inch and a half in length each; the diameter of the ſpokes muſt be equal to a two ounce former; on theſe ſpokes put five ſeven inch two ounce caſes of ſpur fire, and carry leaders from the mouth of one to the other, that they may all light together; then from the mouth of one of the caſes, carry a leader, through a hole bored ſlantways in the nave, from between the ſpokes, to the front of the block near the ſpindle hole; the end of this leader muſt project out of the hole into the barrel of the firſt mutation, ſo that when the pipe which comes from the end of the laſt caſe on the firſt wheel flaſhes, it may take fire and light the ſecond mutation. To communicate the fire to the third mutation bore a hole near the bottom of one of the five caſes, to the compoſition, and from thence carry a leader into a hole made in the middle of the barrel B; this hole muſt be covered with paſted paper.

## Third Mutation

May be either an octagon or hexagon wheel twenty inches diameter; let the nave be three inches and a quarter diameter, and three and a half in length; one inch and a half of the front of the nave muſt be made to fit in the barrel B. On the other end of the block fix a tin barrel C, N°. 3; this barrel muſt be ſix inches and a half in length, one inch of which muſt fit over the block. The caſes of this wheel muſt burn two at a time; and from the mouths of the two firſt caſes carry a leader, through holes in the nave into the barrel of the ſecond mutation, after the uſual manner; but beſides theſe leaders let there be a pipe go acroſs the wheel from one firſt caſe to the other, then from the tail of one of the laſt caſes, carry a pipe into a hole

in

in the middle of the barrel C; at the end of this pipe, let there hang ſome looſe quick match.

## Fourth and Fifth Mutation.

We ſhall here ſpeak of thoſe two mutations under one head, as their naves are made of one piece, which from E to F is fourteen inches; E, a block four inches diameter, with ten or twelve ſhort ſpokes, on which are fixed eleven inch eight ounce caſes; let the front of this block be made to fit eaſy in the barrel C, and cloath the caſes ſo that they may all light together; and let a pipe be carried through a hole in the block into the barrel C, in order to receive the fire from the leader brought from the laſt caſe on the wheel. G, the nave of the fifth mutation, whoſe diameter muſt be four inches and a half; in this nave fix ten or twelve ſpokes one foot and a half in length each; theſe ſpokes muſt ſtand ſeven inches diſtance from the ſpokes of the fourth mutation; and at the end of each ſpoke tie a four ounce caſe, as ſhewn by N°. 5; all theſe caſes are to be lighted together, by a leader brought from the end of one of the

the cafes on N°. 4. Let F and H be of the fame piece of wood as E and G; but as much thinner as poffible, in order to make the work light.

## Sixth and Seventh Mutation.

The blocks of thefe two mutations, are turned out of one piece of wood, whofe length from F to P is fifteen inches. L a block five inches diameter, in which are fixed eight fpokes, each two feet four inches in length; at the end of each fpoke tie two four ounce cafes as fhewn by N°. 6; all thefe cafes muft be fired at the fame time, by a pipe brought from the end of one of the cafes on the fifth mutation. Let the diftance between the fpokes at L and thofe in the fifth mutation be feven inches. M, the nave of the feventh mutation, whofe diameter muft be five inches and a half; in this nave fix eight fpokes, and on the front of them two circular fells, one of four feet eight diameter, and one of three feet eleven inches diameter; on thefe fells, tie fixteen eight ounce or pound cafes, in the fame manner as reprefented by N°. 7, and

and carry leaders from one to the other, ſo that they may be all fired together; this mutation muſt be fired by a leader brought from the tail of one of the caſes on the ſixth mutation.

## Eighth and Ninth Mutation.

The blocks of theſe may be turned out of one piece, whoſe length from P to D muſt be twelve inches. O, the block of the eighth mutation, which muſt be ſix inches diameter, and in it fixed ſix ſpokes, each three feet in length; theſe ſpokes muſt be ſtrengthened by a hexagon fell within three or four inches of the ends of the ſpokes; cloſe to the end of each ſpoke, in the front, fix a five-pointed brilliant ſtar; then ſeven inches below each ſtar tie two ten inch eight ounce caſes, ſo that the upper ends of the caſes may reſt on the fells, and their ends on the ſpokes; each of theſe caſes muſt be placed parallel to the oppoſite fell, ſee N°. 8. NNN, &c. are the caſes, and kkk, &c. the ſtars.

The ninth mutation muſt be thus made; let D be a block ſeven inches diameter; in this block muſt be ſcrewed ſix ſpokes, ſix feet in length each, with holes and grooves in them for leaders, in the ſame manner as thoſe in the dodecaedron; at the end of each ſpoke, in the front, fix a ſpindle for a hexagon vertical wheel, ten inches diameter, as ſhewn by N°. 9. When theſe wheels are on, carry a leader from each into the block, ſo that they may all meet together; then lead a pipe from the end of one of the caſes of the eighth mutation, through a hole bored in the block D, to meet the leaders from the vertical wheels, ſo that they may all be fired together.

The ſpindles for large pieces are required to be made very ſtrong, and as exact as poſſible; for a piece of nine mutations, let the ſpindle be at the large end one inch diameter, and continue that thickneſs as far as the ſeventh mutation, and from thence to the fifth; let its diameter be three quarters of an inch; from the fifth to the fourth, five eighths of an inch; from the fourth to the ſecond, half an inch; and from the ſecond to the end, three eighths of an inch: at the ſmall end muſt be a nut to keep on the firſt wheel, and at the thick end muſt be a large nut, as ſhewn by by the figure, ſo that the ſcrew part of the ſpindle being put through a poſt, and a nut ſcrewed on tight, the ſpindle will be held faſt and ſteady; but you are to obſerve, that that part of the ſpindle, on which the moveable pieces are to run, be made long enough for the wheels to run eaſy without ſticking; the fixed pieces being made on different blocks, the leaders muſt be joined, after they are fixed on the ſpindle. The beſt method of preventing the fixed mutations from moving on the ſpindle, is, to make that part of the ſpindle which goes through them ſquare; but as it would be difficult to make ſquare holes through ſuch long blocks as are ſometimes required, it will be beſt to make them in the following manner; which is, to bore a round hole a little larger than the diameter of the ſpindle, and at each end of the block over the hole, faſten a piece of braſs with a ſquare hole in it to fit the ſpindle.

## To make a Horizontal Wheel change to a Vertical Wheel with a Sun in Front.

The ſudden change of this piece is very pleaſing, and gives great ſurprize to thoſe who are not acquainted with the contrivance. A wheel for this purpoſe ſhould be about three feet diameter, and its fell circular, on which tie ſixteen half pound caſes filled with brilliant charge; two of theſe caſes muſt burn at a time, and on each end of the nave muſt be a tin barrel of the ſame conſtruction as thoſe on the regulated piece; the wheel being compleated, prepare the poſt or ſtand after the following manner: firſt have a ſtand made of any height, about three or four inches ſquare, then ſaw off from the top, a piece two feet in length; this piece join again at the place where it was cut, with a hinge on one ſide, ſo that it may lift up and down in the front of the ſtand, then fix on the top of the bottom part of the ſtand, on each ſide a bracket; theſe brackets muſt project at right angles with the ſtand, one foot

foot from the front, for the ſhort piece to reſt on; but theſe brackets muſt be placed a little above the joint of the poſt, ſo that when the upper ſtand falls, it may lay between them at right angles with the bottom ſtand, which may be done by fixing a piece of wood, one foot in length, between the brackets and even with the top of the bottom ſtand; then, as the brackets riſe above the bottom ſtand, they will form a channel for the ſhort poſt to lay in, and at the ſame time keep it ſteady without ſtraining the hinge: on the ſide of the ſhort poſt oppoſite the hinge, nail a piece of wood; this piece muſt be of ſuch a length, that, when the poſt is perpendicular, it may reach about one foot and a half down the long poſt, to which being tied, it will hold the ſhort ſtand upright; the ſtand being thus prepared, in the top of it fix a ſpindle ten inches in length; on this ſpindle put the wheel, then fix on a brilliant ſun with a ſingle glory; the diameter of this ſun muſt be ſix inches leſs than that of the wheel. When you fire this piece, light the wheel firſt, and let it run horizontally till four caſes are conſumed; then from the end of the fourth caſe carry a leader

into

into the ten barrel that turns over the end of the ſtand; this leader muſt be met by another brought through the top of the poſt, from a caſe filled with a ſtrong port-fire charge, and tied to the bottom poſt, with its mouth facing the pack-thread which holds up the ſtand, ſo that when this caſe is lighted, it will burn the pack-thread, and let the wheel fall forward, by which means it will become vertical; then from the laſt caſe of the wheel, carry a leader into the barrel next the ſun, which will begin as ſoon as the wheel is burnt out.

## Of the grand Volute illuminated with a projected Wheel in Front.

Firſt have two hoops made of ſtrong iron wire, one of ſix feet diameter, and one of four feet two inches; theſe hoops muſt be joined to ſcroles A, A, A, &c. as ſhewn by fig. 54. Theſe ſcroles muſt be made of the ſame ſort of wire as the hoops; on theſe ſcroles, tie with iron binding wire as many illuminating port fires as they will hold, at two inches diſtance from each other; theſe port fires cloath with leaders, ſo that they may all take fire together; then let C be a circular wheel of four ſpokes, three feet ſix inches diameter, and on its fell tie as many four ounce caſes head to tail, as will compleat the circle, only allowing a ſufficient diſtance between the caſes, that the fire may paſs free, which may be done by cutting the upper part of the end of each caſe a little ſhelving: on each ſpoke fix a four ounce caſe about three inches from the fell of the wheel; theſe caſes are to burn one at a time, and the firſt of them to begin with thoſe on the fell, of which four are to burn at a time, ſo that the wheel will laſt no longer than one fourth of the caſes on the fell, which in number ſhould be ſixteen or twenty; on the front of the wheel form a ſpiral line, with ſtrong wire, on which tie port fires, placing them on a ſlant, with their mouths to face the ſame way as the caſes on the wheel; all theſe port fires muſt be fired with the ſecond caſes of wheel. Let D, D, D, &c. be ſpokes of wood, all made to ſcrew into a block in the center; each of theſe ſpokes may be in length about four feet ſix inches; in the top of each fix a ſpindle, and on each

ſpindle

wheel may be filled with a white charge, and thoſe of the ſpirali wheels, with a grey.

## Of the Moon and Seven Stars.

Let fig. 55, be a ſmooth circular board, ſix feet diameter; out of the middle of it cut a circular piece twelve or fourteen inches diameter, and over the vacancy put white Perſian ſilk, on which paint a moon's face, then let I, I, I, &c. be ſtars each four or five inches diameter, cut out with five points, and covered with oiled ſilk: on the front of the large circular board, draw a ſeven-pointed ſtar, as large as the circle will allow; then on the lines which form this ſtar, bore holes, wherein fix pointed ſtars. When this piece is to be fired, it muſt be fixed upon the front of a poſt, on a ſpindle, with a wheel of brilliant fire behind the face of the moon; ſo that while the wheel burns, the moon and ſtars will appear tranſparent, and when the wheel has burnt out, they will diſappear, and the large ſtar in front, which is formed of pointed ſtars, will begin, being lighted by by a pipe of communication from the laſt caſe of the vertical wheel, behind the moon; this pipe of communication muſt be managed in the ſame manner as thoſe in regulated pieces.

## Of the Double Cone Wheel illuminated.

This piece is repreſented by fig 56. Let A, be a ſtrong decagon wheel, two feet ſix inches diameter; then on each ſide of it fix a cone B and C; theſe cones are to conſiſt of a number of hoops, ſupported by three or four pieces of wood, in the manner of the ſpiral wheels; let the height of each cone be three feet ſix inches, and on all the hoops tie port fires horizontally, with their mouths outwards, and cloath the wheel with eight ounce caſes, all to play horizontally, two at a time: the cones may be fired with the firſt or ſecond caſes. The ſpindle for this piece muſt go through both the cones, and riſe three feet above the point of the cone at top, ſo that its length will be ten feet four inches from the top of the poſt H, in which it is fixed, allowing four

four inches for the thicknefs of the block of the wheel; the whole weight of the wheel and cones muft bear on a fhoulder in the fpindle, on which the block of the wheel muft turn; near the top of the fpindle, muft be a hole in the front, into which fcrew a fmall fpindle, after the cones are on; then on this fmall fpindle fix a fun D, compofed of fixteen nine inch four ounce cafes of brilliant fire, which cafes muft not be placed on a fell, but only ftuck into a block of fix inches diameter; then in the front of this fun muft be a circular vertical wheel, fixteen inches diameter; on the front of this wheel form with iron wire a fpiral line, and cloath it with illuminations, after the ufual method; as this wheel is not to be fired till the cones are burnt out, the method of firing it is as follows; let the hole in the block, at the top of the uppermoft cone, be a little larger than the fpindle which paffes through it; then from the firft cafe of the vertical wheel before the fun, carry a leader down the fide of the fpindle to the top of the block of the horizontal wheel, on which muft be a tin barrel; then this leader, being met by another brought from the end of the laſt caſe of the horizontal wheel, will give fire to the vertical wheel, as ſoon as the cones are extinguiſhed; but the ſun D muſt not be fired, till the vertical wheel is quite burnt out.

## Of Fire Pumps.

Caſes for fire pumps, are made in the ſame manner as thoſe for tourbillons, only they are paſted inſtead of being rolled dry. Having rolled and dryed your caſes, fill them in the following manner: 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 about one fourth leſs than the bore

of

form a ſcrole, either with a hoop or ſtrong iron wire; on this ſcrole tie caſes of brilliant fire, in proportion to the wheel, head to tail, as in the figure; when you fire this wheel, light the firſt caſe near the fell; then, as the caſes fire ſucceſſively, you will ſee the circle of fire gradually diminiſh; but whether the illuminations on the fell begin with the ſcrole or not, is immaterial, that being left intirely to the maker.

N. B. This wheel may be put in the front of a regulated piece, or fired by itſelf, occaſionally.

## Of Pin Wheels.

Firſt roll ſome paper pipes, about fourteen inches in length each; theſe pipes muſt not be made thick of paper, two or three rounds of elephant paper being ſufficient; when your pipes are thoroughly dryed, you muſt have made a tin tube, twelve inches in length, to fit eaſy into the pipes; at one end of this tube fix a ſmall conical cup, which being done, it is called a funnel, then bend one end of one of the pipes, and put the funnel in at the other, as far as it will reach,

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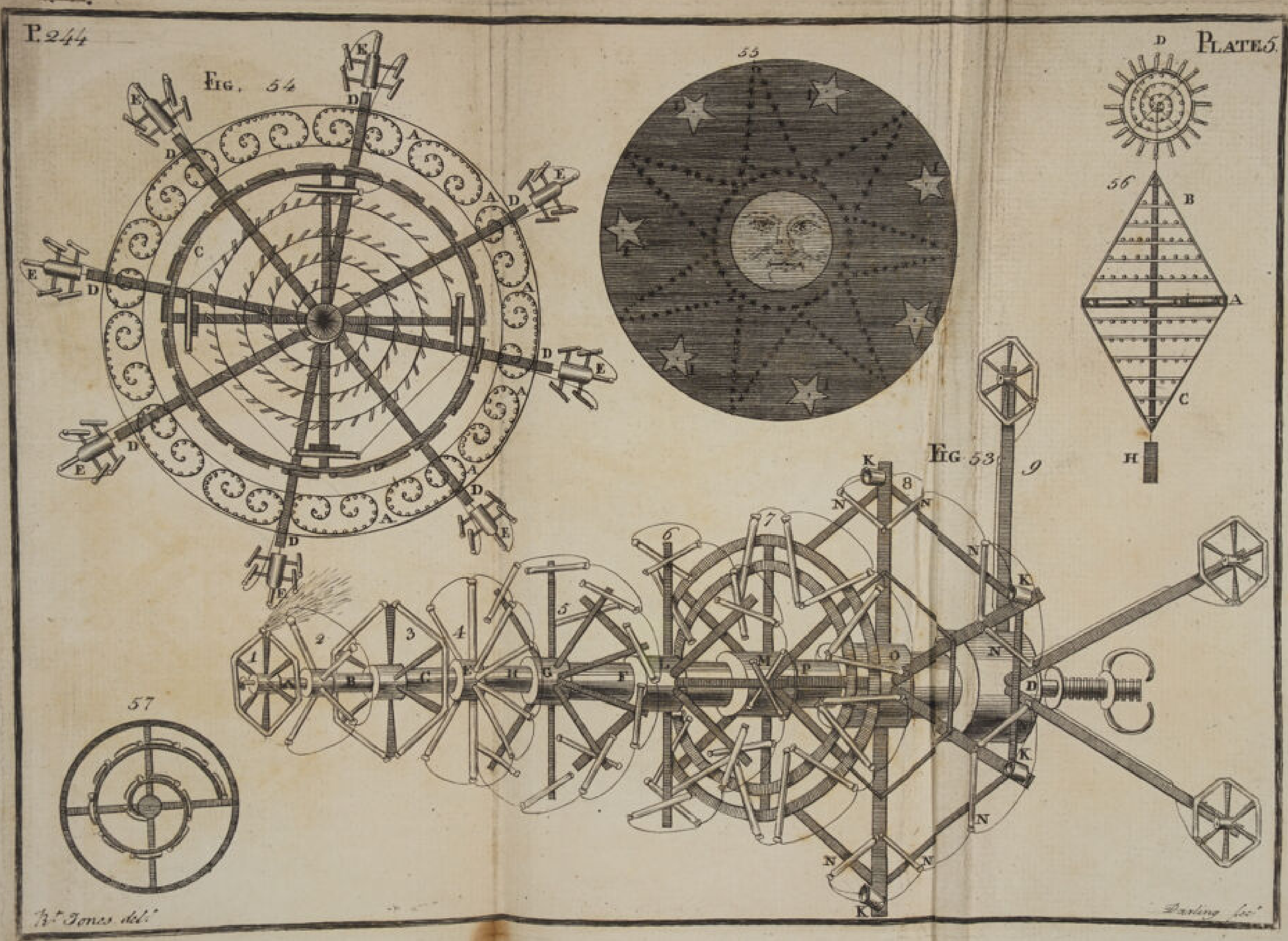
Plate 5.



reach, and fill the cup with compoſition; then draw out the funnel by a little at a time, ſhaking it up and down, and it will fill the pipe as it comes out; having filled ſome pipes, have made ſome ſmall blocks, about an inch diameter, and half an inch in thickneſs; 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 your 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, called the French method; which is, 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. The formers for theſe pipes are made from one and a half to four ſixteenths of an

 inch

inch diameter, and the compoſition for them as follows; meal powder eight ounces, ſalt petre two ounces, and ſulphur one; among theſe ingredients, may be mixed a little ſteel-filings, or the duſt of caſt-iron; this compoſition ſhould be very dry, and not made too fine, or it will ſtick in the funnel. Theſe wheels may be fired on a large pin, and held in the hand with ſafety.

## Of Fire Globes.

There are two ſorts of fire globes, one with projected caſes, and the other with the caſes concealed in the following manner; have a globe made of wood, of any diameter you chuſe, and divide the ſurface of it into fourteen equal parts, and at each diviſion bore a hole perpendicular to the center; theſe holes muſt be in proportion to the caſes intended to be uſed; in every hole, except one, put a caſe filled with brilliant, or any other charge, and let the mouths of the caſes be even with the ſurface of the globe; then cut in the globe a groove, from the mouth of one caſe to the other, for leaders, which muſt be carried from caſe to caſe, ſo that they may all be fired together; this being done, cover the globe with a ſingle paper, and paint it. Theſe ſort of globes may be uſed to ornament a building.

Fire-globes with projected caſes are made thus; your globe being made with fourteen holes bored in it as uſual, fix in every hole, except one, a caſe, and let each caſe project from the globe two thirds of its length; then cloath all the caſes with leaders, ſo that they may all take fire at the ſame time. Fire-globes are ſupported by a pintle, made to fit the hole in which there is no caſe.

## To thread and join Leaders, with the method of placing them on different Works.

Joining and placing of Leaders is a very eſſential part of fireworks, as it is on the leaders, that the performance of all complex works depend; for which reaſon I ſhall endeavour here to explain the method of conducting pipes of communication, in as plain a manner as poſſible. Your works being ready to be cloathed, proceed thus; cut your pipes of a ſufficient length to reach from one caſe to the other, then put in the quick match, which muſt always be made to go in very eaſy; when the match is in, cut it off within about an inch of the end of the pipe, and let it project as much at the other end; then faſten the pipe to the mouth of each caſe with a pin, and put the looſe ends of the match into the mouths of the caſes, with a little meal powder; this being done to all the caſes, paſte over the mouth of each two or three bits of paper; the preceding method is uſed for large caſes, and the following for ſmall caſes and illuminations; firſt thread a long pipe, then lay it on the tops of the caſes, and cut a bit off the under ſide, exactly over the mouth of each caſe, ſo that the match may appear; then pin the pipe to every other caſe, but before you put on the pipes, put a little meal powder in the mouth of each caſe; if the caſes thus cloathed be port-fires on illuminated works, cover the mouth of each caſe with a ſingle paper; but if they are choaked caſes, ſituated ſo that a number of ſparks from other works may fall on them before they are fired, ſecure them with three

three or four papers, which muſt be paſted on very ſmooth, that there may be no creaſes for the ſparks to lodge in, which often ſet fire to the works before their time; avoid, as much as poſſible, placing the leaders too near together, or one acroſs the other ſo as to touch, as it ſometimes happens that the flaſh of one will fire the other; therefore if your works ſhould be ſo formed, that the leaders muſt croſs or touch, be ſure to make them very ſtrong, and ſecure them well at the joints and at every opening.

When a great length of pipe is required, it muſt be made by joining ſeveral pipes together, in this manner; having put on one length of match as many pipes as it will hold, paſte paper over every joint; but if a ſtill greater length be required, more pipes muſt be joined, by cutting off about an inch of one ſide of each pipe near the end, and laying the quick match together, and tieing them faſt with ſmall twine; after which, cover the joining with paſted paper.

The

## The manner of placing Fireworks to be exhibited, with the order of Firing.

Nothing adds more to the appearance of fireworks, than the placing them properly; though the manner of placing them chiefly depends on the judgment of the maker. I ſhall give ſuch rules here, as have been generally obſerved; for example, whether your works are to be fired on a building, or on ſtands; if they are a double ſet, place one wheel of a ſort on each ſide of the building, and next to each of them towards the center, place a fixed piece, then wheels, and ſo on, leaving a ſufficient diſtance between them, for the fire to play from one without burning the other; having fixed ſome of your works thus in front, place the reſt behind them, in the center of their intervals; the largeſt piece, which is generally a regulated or tranſparent piece, muſt be placed in the center of the building, and behind it a ſun, which muſt always ſtand above all the other works: a little before the building or ſtands place your large gerbes, and at the back of the works, fix your marron batteries, pots des aigrettes, pots des brins, pots des ſauciſſons, air ballóóns, and flights of rockets; the rocket ſtands may be fixed behind or any where elſe, ſo as not to be in the way of the works.

Single collections are fired on ſtands, which ſtands are made in the ſame manner as theodolite ſtands, only the top part muſt be long or ſhort occaſionally; theſe ſort of ſtands may be fixed up very ſoon without much trouble. Having given ſufficient inſtructions for placing of fireworks, I ſhall proceed with the manner of firing them.

## Order of Firing.

1. Two ſignal rockets,
2. Six ſky rockets,
3. Two honorary rockets,
4. Four caduceus rockets,
5. Two vertical wheels illuminated,
6. Two ſpiral wheels illuminated,
7. Two tranſparent ſtars,
8. A line rocket of five changes,
9. Four tourbilions,
10. Two horizontal wheels,
11. Two air ballóóns illuminated,
12. Two Chineſe fountains,
13. Two regulating pieces of four mutations each,
14. Two pots des aigrettes,
15. Three large gerbes,
16. A flight of rockets,
17. Two ballóón wheels,
18. Two caſcades of brilliant fire,
19. Twelve ſky rockets,
20. Two illuminated yew-trees,
21. Two air ballóóns of ſerpents, and two compound,
22. Four tourbillons,

23. Two

23. Two fruiloni wheels,
24. Two illuminated globes with horizontal wheels,
25. One pot des ſauciſſons,
26. Two plural wheels,
27. A marron battery,
28. Two chandeliers illuminated,
29. A range of pots des brins,
30. Twelve ſky rockets,
31. Two yew-trees of fire,
32. A neſt of ſerpents,
33. Two double cones illuminated,
34. A regular piece of ſeven mutations,
    1. A vertical wheel illuminated,
    2. A golden glory,
    3. An octagon vertical wheel,
    4. Porcupines quills,
    5. Croſs fires,
    6. A ſtar piece with brilliant rays,
    7. Six vertical wheels,
35. A brilliant ſun,
36. A large flight of rockets.

When

When water works are to be exhibited, divide them into ſeveral ſets, and fire one ſet after every fifth or ſixth change of land and air works; and obſerve this rule in firing a double ſet of works, always to begin with ſky rockets, then two moveable pieces, then two fixed pieces, and ſo on, ending with a large flight of rockets or a marron battery; if a ſingle collection, fire a fixed piece after every wheel or two, and now and then ſome air and water works.

In this treatiſe, I have taught the method of rolling, pinching, and filling all ſorts of caſes, and the manner of pulveriſing, mixing, and preparing, all ſorts of compoſitions uſed in artificial fireworks; in ſo plain a manner, that all ſorts of fireworks may be made without any further inſtructions. A variety of pyrotechnical repreſentations only depends on the genious of the maker, by fixing different caſes and fires on works of various forms, of which there are numbers more than what I have treated of. But as thoſe I have mentioned are the principal ones, I ſhall here

here conclude, till I have an opportunity of extending this work which will depend on the approbation it meets with.

FINIS.