

A Method of Construction for a 12" Double-Petalled Chrysanthemum w/ pistil

By Jim Widmann

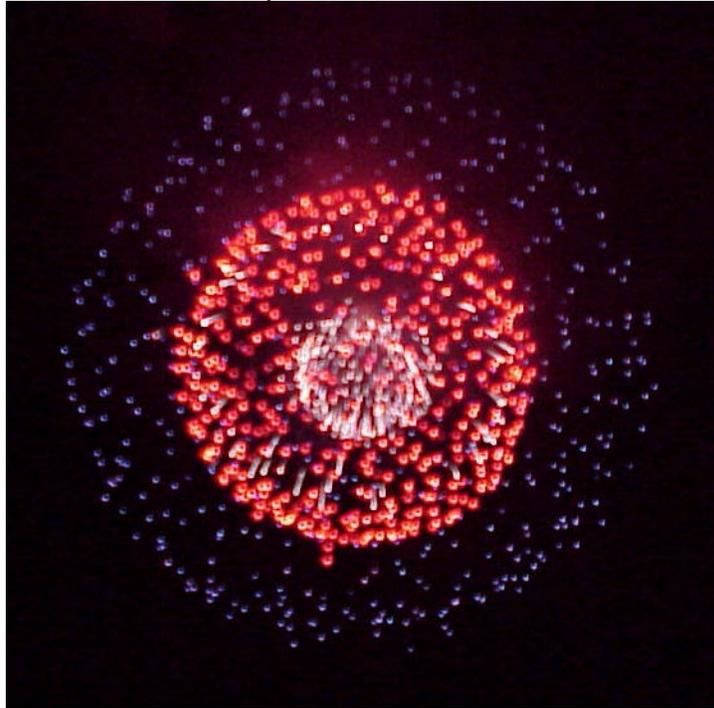


Photo by Larry Nemeč

The word that I think best describes the essence of a successful 12" chrysanthemum flower is orderliness. Orderliness of shape, of color changes, of extinguishment, -all are required in a good fancy round shell. This orderliness demonstrates the shell makers control of fire. And coaxing fire into obedience is what the spherical shell is all about.

This objective of precisely taming fire can be attributed to the Japanese sensibilities that inform the art form. In *Fireworks The Art, Science and Technique*, Dr. Takeo Shimizu explains the origination of the round flower this way: "The fireworks flower was originally created in an effort to bring the capricious fire phenomena, which are almost always inharmonic, into harmony,

and as a result it has reached the perfectly round chrysanthemum pattern.”

The beauty of the multi-petalled chysanthemum is like the beauty of an intricately woven tapestry in which not a stitch is out of place. It is the beauty of coloring precisely within the lines, of a perfectly manicured English garden.

This orderly taming of the “capricious fire phenomena” is at the heart of the chrysanthemum flower, and makes it a disciplined medium in which to express one’s artistry. But within the precision of a fancy multi-petalled shell, there is plenty of room for creative expression. This article is offered to encourage readers to explore these areas.

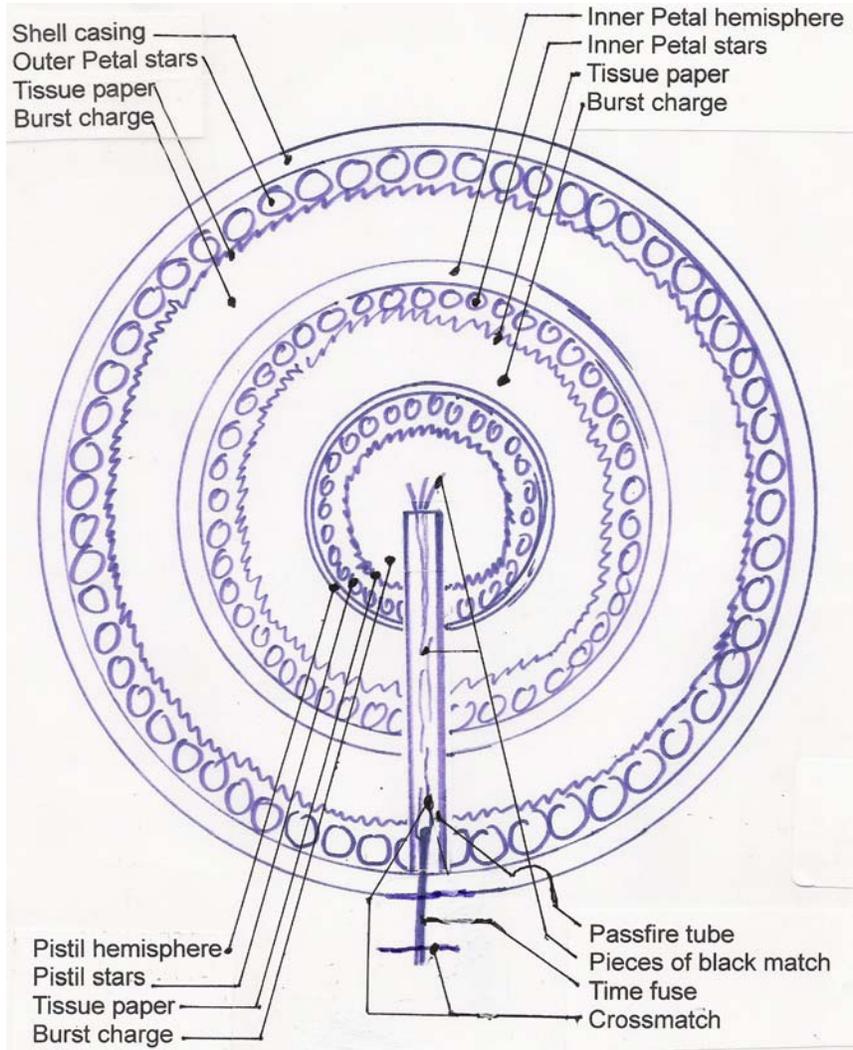
Clarity and Perceptibility

A good 12” shell must present its contents in a clean, orderly fashion so that the viewer can comfortably perceive the evolution of the flower. This is very important. The human eye and mind’s ability to digest visual information are limiting factors that must be respected. Good symmetry and crisp, orderly color changes make it easier for the viewer to accept the complex, evolving images of a fancy multi-petalled shell. A successful flower unfolds with clarity of shape, color and time. Let us examine these three considerations:

The Three Aspects of Design: Spatial, Timing, Color

A multi-petalled fireworks flower is a complex artistic expression that I have divided into three areas of perception; spatial, timing and color. The interweaving of these elements is the artistry of the flower, and success depends on presenting them in harmony.

First, some terminology: The stars at the center of the flower are called a pistil, and the middle sphere(s) are called inner petals. The outer-most sphere is called the outer petal. The diagram below illustrates the components of the Double Petalled Chrysanthemum w/Pistil.



SPATIAL

There are many spatial (or positional) relationships between the stars in a fancy chrysanthemum flower, and they are sorted into the following categories: **Spherical, Petal size, and Petal density.**

Spherical

Of course the primary requirement is that the stars of a petal are presented in a spherical pattern. The petals and pistil must not only be spherical individually, but share a common center point. Unless designed otherwise, petals should extinguish while they are round and before they appear to droop.

In reality the entire flower is drooping from the effect of gravity from its inception, but it does not appear to be doing so if the stars maintain their spherical positioning relative to one another. This is a good reason for using stars that burn out before they lose their momentum, because a star that stalls will move out of “synch” with the rest of the flower

Petal size

The relative size of the concentric spheres in a fancy warimono flower is another spatial consideration for the designer. The petals of a fireworks flower must certainly be distinct from one another, but their relative size is open to aesthetic judgment. The pistil is typically quite small because its main purpose is to provide a central point to the display. The size of the inner petal(s) is a matter of choice. The Japanese use the word “Choji” to describe a chrysanthemum with a large inner petal, and this is a look I favor. A large inner petal typically uses larger stars which have a longer burn time that allow for complex color changes.

The chart below presents some typical values

Shell size	Pistil	Inner petal	Outer petal
8”	2 - 2-½”	4” - 5”	8”
10”	3 - 4”	5 - 6”	10”
12”	4 - 5”	6 - 8”	12”

The size chosen for the inner petal(s) should also reflect consideration of the

relative brightness and compatibility of the adjacent petals or pistil. For example: A shell made with outer petal stars of a transformation composition that requires some time to achieve its effect would be better fitted with a small inner petal because it wouldn't obscure the developing firefly effect.

Petal density

There is also the matter of the number of stars you use in a petal. More (smaller) stars make for a greater density of the petal and will more exactly define the spherical pattern of the petal. Smaller stars can also make a color appear stronger. Their shortcoming is they don't burn for very long.

Larger stars have the advantage of a longer burn time for multiple color changes. In most cases they are also heavier which aids in a longer, straighter trajectory. The downside to using fewer, larger stars in a petal is that the spherical shape becomes defined by fewer points of fire and can appear misshapen. Tellingly, Shimizu describes as "lonely" a fireworks flower that has too few stars in it.

TIMING

The second aspect of shell design to be considered is timing. Timing is used in every stage of the presentation of a warimono shell. There is the timing of the ascending flowers that precede a fancy shell, and the timing of the bursting of the main shell itself. And there is also the timing of the color changes of the petals within the flower, which is certainly the most complex and is the element that will be considered here.

Timing of color changes

A fancy 12" Warimono shell should present its flower in about 5 seconds and within this time the pistil and inner and outer petals may put forth 7 or more separate color changes. The outer petal will typically change 2 or 3 times and the pistil and inner petal will each change twice. The challenge is to present this volume of visual information with clarity so that it can be comfortably perceived. To do so, here are two suggestions:

- 1) Try to establish an even cadence (or timing) between color changes. This makes it easier for the viewer to anticipate the changes and enjoy the shell.

2) When convenient and appropriate, you can change colors within different petals at the same time. When done accurately this will greatly increase a flower's clarity. When done inaccurately, confusion is the sure byproduct, and the flower will not convey an orderly and satisfying image.

Exactly sizing your stars is how exact timing of color changes is achieved and there is no shortcut to this. The warimono shell requires **every** star to be exact, and when one isn't, the entire flower suffers. There are many methods for sizing stars during manufacture. Sieves made from wire mesh stretched across wooden frames are easy to make and yield good results. The motorized star separators that use divergent turning rods can achieve perfectly satisfactory results. Whatever method is employed, remember that your flower can only be as good as the accuracy of your star sizing.

The graph below shows a typical time line for the evolution of a 12" double petalled shell with pistil. It features two concurrent color changes. The outer petal stars are on the first line, the inner petal is next and the pistil is third. The bottom line is the time line.



On paper this seems like a simple enough plan. You can easily imagine the flower blooming with successive layers of silver-tipped petals. The difficulty is in translating this time line into the design of stars of three different sizes that are layered with compositions of unequal burning speeds.

The graph below shows the star design plan for the same 12" double petalled shell with pistil. It shows the size that the stars must be prior to priming and/or transitioning to the next color. The outer petal stars are on the first line, the inner petal is next and the pistil is 3rd with the star sizes on the bottom line.

5/16 silver	7/16 blue	3/4 charcoal
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3/16 silver	1/2" blue
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3/16 flash	3/8 red
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1/8"	1/4"	3/8"	1/2"	5/8"	3/4"
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This is a physical description of stars that will yield the results from the time-line graph when they are made using standard perchlorate formulations.

Constructing stars that change color accurately

The real excellence of a fancy warimono shell is locked up inside the stars that comprise each petal and the pistil. The ease of perception to the viewer depends on the absolutely accurate sizing of the stars at each color change. It also requires dependable transition of the flame from one composition to the next, as well as proper initial priming.

At each color change, stars should be rolled to the designed size and then set aside to dry. They should then be screened at least twice to render very accurately sized stars. This creates a "benchmark" at each color change where it can be expected that every star will perform henceforth in unison.

When changing color, stars should be step-primed to the next composition. Step priming is a gradual mixing of the adjacent compositions within a star. Different compositional transitions require different degrees of step priming and some transitions require none at all. Suffice to say, that when transitioning to a composition with a high ignition temperature, careful step priming is required, and this is often the case in the stars within warimono shells.

In typical situations, I recommend step priming that applies the adjacent compositions in the following ratios: 1:2, 1:1, 2:1. These mixtures are put together inexactly with measuring scoops, mixed together in a capped vessel, and applied in separate layers of each mixture ratio. The overall thickness of the step priming is determined by the following three parameters:

- 1) The stars' speed during transition
- 2) The burn and ignition temperatures of the adjacent compositions
- 3) The size of the star at color change

Generally a step-priming layer of approximately 1/16" will yield good results. Less is needed when the star has slowed at the end of its trajectory, more may be required between compositions of disparate burn/ignition temperatures and/or directly after the shell break.

It should also be noted that when transitioning directly from a low temperature composition to a high temperature composition, especially at high speeds, a star may require a separate transitional composition to ensure complete ignition. In cases where a BP based composition must change to a high-temperature Perchlorate based composition while the star is traveling fast, a composition I call "Igniter Comp." can be used effectively. It has a relatively low light output and is easy to use in practice. It should be step-primed in between the adjacent color compositions.

Igniter Composition: (Origin uncertain -Shimizu based)

Kclo4	77
C	8
Red Gum	12
Dark Aluminum	3
+ Binder (Dextrin)	4

It should be remembered that the inclusion of this additional layer between the color compositions is generally undesirable because it takes away from the amount of time the color compositions have to establish their colors. It is

recommend that its use be limited to transferring from low temperature compositions to high temperature compositions.

Time Vs. Gravity

The Warimono flower should never appear to droop. Remember that the purpose of the flower is to demonstrate the shell maker's control of fire by coaxing it into a succession of perfect colorful spheres. Gravity must not undermine this assertion. In truth, the flower as a whole moves downward from the effect of gravity. But if the stars maintain symmetry to each other, the illusion of defying gravity can be achieved.

The best way to keep a flower from drooping is to design it to be succinct by using properly sized stars, specifically ones that are not too large. The stars should burn out some time *before* they loose their momentum -not after. This is a very important requirement and is often ignored by well-meaning artificers who mistakenly think larger stars will make a more impressive flower.

COLOR

Color is perhaps the most creative component in the design of fancy warimono shells. In this disciplined art form, where accurate shape and form are requisite and open to little artistic interpretation, the colors chosen for the transitions within the various petals are probably the most fertile ground for creative expression.

But this does not mean "anything goes". When planning the juxtaposition of different colors that have different light outputs, the shell designer must consider and defer to the limitations of the human eye.

Generally, a flower should evolve from low light output compositions to compositions of greater light output. The pupil is much more comfortable transitioning from dark to light, and when it is asked to do the opposite, it will impart a momentary "white-out" to one's vision that interrupts the clear perception of the flower.

However, there are exceptions and this does not mean that every petal must

start with a low-light output composition. One must consider the size of the adjacent petals and their relative light output. For example; it is customary to “pin” (or center) a fancy spherical flower around a small, bright pistil of fast burning stars. This provides a distinct center point for the flower, and greatly adds to the orderliness of the presentation. But the pistil’s effect is brief and concentrated and in most cases will not impede the perception of the adjacent inner petal that is presenting a composition of a lower light output.

The Outer Petal stars

The backdrop and the final color change

When a shell breaks, the outer-most stars precede the interior stars as they travel outward. If the outer petal stars are designed to leave a spark trail, they effectively create a colored backdrop for the interior stars. This is a great opportunity for the shell designer to accentuate the depth of the colors used in the interior petals.

An example would be a shell that opens with outer petal stars of a charcoal based composition (perhaps Chrysanthemum #6 by Shimizu). The viewer’s pupils will expand to perceive the low light charcoal effect. At this point an inner petal of a deep blue could be introduced from stars that have great color but not a strong light output. Because the viewer’s eyes have already dilated to accept the charcoal composition’s low light output, the deep blue is perceived and its depth of color appreciated.

To produce long lasting spark trails that effectively produce a spark “backdrop“, outer petal compositions typically employ one (or more) of the four following compositional approaches:

1) **Charcoal:** Charcoal derived from “dense wood” tree species and granulated to particular specifications can yield exceptional results. I define “dense wood” as fruit trees or other slow-growing, tightly grained, hardwood species. Commercial charcoal works just fine, with slightly inferior results. Charcoal based compositions give a nice even backdrop of soft orange sparks that last quite a while. It is a cheap mixture that takes fire well and is easy to work with in practice.

2) **Ferrotitanium** is an alloy of Titanium and Iron that is added to charcoal

compositions (like the above) and renders a beautiful backdrop. It is slightly brighter than charcoal, yet not so bright as to overwhelm interior petal colors. It delivers a lasting spark trail of grain (or density) determined by the particle size of the material.

3) **Glitter compositions** are Potassium Nitrate based compositions that typically use magnallium and/or magnesium and aluminum to achieve their spark effect. Good results require close attention to the particle size of the metals, and consistent manufacturing procedure. Glitter compositions are generally brighter than Charcoal and Ferrotitanium mixtures and produce a less even spark trail. But they boast easy ignition, and offer a wide variety effects.

4) **Lampblack:** Lampblack compositions create a silken fire dust trail that can only be described as elegant. It's sparks are exceptionally fine grained, very long lasting and of a deep orange hue. Compositions made with it tend to be slow burning and it has very modest light output. It is also one of the most disagreeable compounds that a pyrotechnist will ever handle. But a shell made with lampblack stars is one the most beautiful things in fireworks and even the worst color will appear vibrant in contrast.

Following are some formulas suitable for creating an outer petal fire-spark backdrop:

Golden Chrysanthemum

Kno3	30
Charcoal Air float (homemade preferred)	30
Sulfur	8
Titanium (40-100 sponge)	27
Dextrin	5

Firefly Chysanthemum

Kno3	38
Charcoal Air float (homemade preferred)	40
Sulfur	7
Aluminum Flake (10-18)	8
Dextrin	7

Gold Glitter

Kno3	48
Charcoal Air Float (homemade preferred)	9
Sulfur	9
Antimony Sulfide	10
Aluminum (Atomized 325 mesh spherical)	14
Sodium Oxalate	7
Barium Carbonate	1
Dextrin	5

Ferrotitanium

Kno3	30.3
Charcoal Air float (homemade preferred)	30.3
Sulfur	6
Ferro-Ti (40-100)	27
Dextrin	6.4

Chrysanthemum 6 (Shimizu)

Kno3	55
Sulfur	7
Pine Charcoal	33
Starch (or Dextrin)	5

The Final Color Change

After providing the backdrop for the color changes that occur within flower, the outer petals stars oftentimes are designed to deliver the final color change of the shell. This is usually a bright composition that can produce a good quantity of light even though the star at this point is quite small (3/16" – 5/16" for outer petal stars). If a high temperature Kclo4 or BaNo3/Aluminum based composition is transitioned to from a low temperature Kno3 based composition, the igniter comp mentioned earlier can be employed.

Following is a bright burning composition that is Perchlorate based and is suitable for a final color. This formula takes fire very easily because of the magnalium, and produces a large white flame envelope. Three-stage step priming will work with this formula when transitioning from low temperature KNO3/Charcoal compositions.

Silver Flitter

Kclo4	39.1
Red Gum	7.6
Atomized AL (-325)	36.6
Mg/Al (50/50 -200)	6.3
S	4.4
Boric Acid	1.3
Dextrin	4.4

The Inner Petal Stars

The color and brightness of the inner petal (middle sphere) stars are chosen with consideration of the color and brightness of the adjacent petals within the flower. Generally, the IP (inner petal) stars should be brighter than the outer petal stars while at the same time being compatible with the brightness of the Pistil stars. The colors chosen should be complimentary to each other.

It is desirable for the IP stars to present their color as soon as possible after the shell break. A good way to do this is to use a relatively thin layer (about 1MM) of BP prime that is then step-primed into a color formula that has the ability to keep its fire during high ejection speeds. This arrangement will allow the inner petal to fully establish its color while the pattern is still quite dense, thereby increasing the color saturation that is perceived by the viewer's eye.

The final color change can be to a brilliant white (like the Silver Flitter comp. Mentioned above) or to a different color complimentary to the other colors of the flower. Generally a color of greater brightness than the star's initial color is chosen because it is easier for the eye to transition in that order. I recommend a Final color size of between 3/16 and 1/4" for IP stars on shells 8" – 12".

Following are some easy to roll formulas that are suitable for the high ejection speeds that the IP (and other stars) will encounter. These should be rolled with a mixture of alcohol and water. Generally that mixture should be 20% Alcohol and 80% water. Some formulas will work with less alcohol and some may require more. If the stars start "spiking" (forming small bumps on the surface) then more alcohol is required. Finely divided charcoal comps. are typical of those that require more alcohol.

Bright Spider

Meal D (homemade OK)	62
Charcoal 80 mesh	6.2
Charcoal Air float (homemade preferred)	12.4
Dextrin	4.0
Titanium (40-100 mesh sponge)	15.4

Blue-49 (Shimizu Pyrotechnica)

Kclo4	61.2
Parlon	11.6
Red Gum	9.0
Cuo	12.3
Dextrin	4.2
Mag/Al (optional for greater brightness)	1.5

Red (Klumac)

Strontium Nitrate	50
Kclo4	15
Parlon	12
Red Gum	8
Magnalium (200-400 mesh)	10
Dextrin	5
Boric Acid	2

Green (Klumac)

Barium Nitrate	50
Kclo4	15
Parlon	12
Red Gum	8
Magnalium (200-400 mesh)	10
Dextrin	5
Boric Acid	2

Orange (Joel Baechle) (slow burning, good color)

Kclo4	53
SrCo3	20

Sodium Oxalate	7
Potassium Benzoate	3
Rosin (Sub. Red Gum)	13
Charcoal Air float	3
Dextrin	4

Yellow

BaNo ₃	60
Dark Aluminum	16
Cryolite	8
Parlon	5
Sulfur	4
Dextrin	6
Boric Acid	1

Purple (Steve Majdali)

Kclo ₄	50
SrNo ₃	8
Cuo	13
Parlon	15
Magnalium (50/50 200 mesh)	3
Reg Gum	7
Dextrin	4

The Pistil Stars

The pistil stars will only burn for approximately 2 seconds. Being small in diameter, they generate a relatively small flame envelope and consequently it is important to get them burning into their initial color quickly. This is accomplished by priming them with a little less than 1MM of prime and then quickly changing to the color composition with 3 brief step mixtures as explained earlier.

Because the shell is ignited from the center first, the pistil stars are the first to take fire and as a result, they have been burning for some number of milliseconds before the shell actually breaks. (This is also true to a lesser degree for the IP and OP stars). So it is often the case that the pistil stars emerge from the shell having burned through their prime layer and into their first color layer, which is good and helps ensure 100% ignition.

Pistol stars should almost always be made from a bright composition that will stand out from the IP and OP stars, and they usually end with a bright flash composition (silver flitter).

Star Cores

A star core is the initial “seed” that the pyrotechnic composition is rolled around in a round star. In fact, some of the items used as cores *are* seeds with Rape seeds being one of them the author has successfully used. Other things used are; Bird seed millet, molecular sieves, certain small pastas, lead shot and small, dried granules of the star composition itself. #6 Lead shot will give great results and is very easy to roll stars around, but does have the negative quality of introducing small quantities of lead into the environment.

BURST CHARGES

The key to getting a nice spherical burst with complete star ignition is the correct relationship between the burst charge and the constraint offered by the shell pasting (pasted paper). It is a balancing act between the “expelling” force of the burst charge and the “containment” strength of the pasted paper. If too little expelling force is used with too little containment strength, the results will be a drooping flower that doesn’t reach its full diameter. Conversely, if too much expelling force is used with too much containment strength, the result will be stars blown blind or even reduced to powder by the shell break.

The expelling force of burst charge can be measured in several ways, but for the purpose of this article I will list the commonly used compositions in ascending order of power, and the shell size for which they are normally used.

Black Powder (Homemade, commercial charcoal)	12” – 16”
Black Powder (Homemade, willow charcoal)	12”
Black Powder (Commercial Meal D)	10” – 12”
KP (Shimizu)	6” -- 10”
H-3 (Shimizu)	3” -- 6”

The expelling force of a burst charge is also closely related to the medium it is coated on, and how thickly it is applied. The more surface area of burst composition available to ignite, the greater the expelling force. But this is somewhat counter-intuitive, as a medium with large surface area will create less total surface area of burst within a shell than a medium of small surface area, because more of the latter can be pressed into the shell.

The thickness of coating will also effect the total amount of surface area of burst charge in a given shell size. A thick coating will ultimately take up space that could have been filled by additional pieces of coated medium had a thinner coating been used. The result is less burst charge surface area.

Listed below are the burst mediums in ascending order of surface area provided within a given size of shell:

Cork granules (1/2 medium)	16"
Cotton seed	10"-16"
Cork granules (4/10)	8" – 12"
Puffed rice	6" – 12"
Rice Hulls	3" – 12"

It should be remembered that there are many combinations of burst composition, burst medium and shell size that will give excellent results. The key is to arrive at the correct balance of the available materials.

KP Burst (Smimizu)

Kclo4	70
Charcoal Air float	18
Sulfur	12
Binder	2

H-3 (Shimizu)

Kclo3	75
Charcoal	25
Binder	2

PASTE WRAPPING SHELLS

To achieve a spherical break it is most important to put the pasted paper on the assembled shell in a uniform manner. When finished, the shell should be encased with paper of equal thickness all around. The paper should be smoothly applied with no voids or air bubbles trapped between layers.

To paste a layer of paper it must first be cut into strips of length and width appropriate to the size of the shell. The correct length is just less than $\frac{1}{2}$ the circumference. When pasted in succession around the shell, strips of proper length will leave two, small, un-pasted areas at either end of the shell which define the "poles" of the axis of that particular layer of paper. These poles are covered over with strips of paper to complete each layer. Here are the correct sizes for the open poles for larger shells.

6" shell = 1-1/2" open poles
8" shell = 2-1/2" open poles
10" shell = 3" open poles
12" shell = 4" open poles



Open pole on an 8" shell

The correct width for the strips of paper is one that allows the paper to be spread smoothly across their width, without excessive creasing. The paper grain should be perpendicular to the length of the strip to aid in this. An exception is when using gummed paper tape, where the grain runs parallel to the strip length. Here are some suitable widths for larger shells:

6" shell	=	1"
8" shell	=	1-1/4"
10" shell	=	1-1/2"
12" shell	=	2"

Each layer consists of enough strips of paper to go around the shell once, plus the additional pieces of paper required to seal the poles. Wrapping a shell with one complete covering of pasted paper constitutes a "layer" and each layer is repeated starting from a different position on the shell. The trick is to start each layer of paper from positions spaced evenly around the sphere.

To accomplish this, I have developed a 7-axis pasting schedule that does a very good job of equally spreading the layers of pasted paper or gummed tape around the shell.

7-Axis Pasting Schedule

I will explain this as if you are looking at the shell head on, with the fuse up. I will use the numbers on a clock face to identify the pole positions of the shell.

Axis 1 is vertical (at the 12:00 and 6:00 positions)

Axis 2 is horizontal (at the 9:00 and 3:00 positions)

Rotate the shell $\frac{1}{4}$ turn (90 degrees) in either direction on the horizontal axis.

Axis 3 is horizontal (at the 9:00 and 3:00 positions)

Axis 4 is a 45 degree diagonal (at 10:30 and 5:30)

Axis 5 is a 45 degree diagonal (at 7:30 and 1:30)

Rotate the shell $\frac{1}{4}$ turn (90 degrees) in either direction on the horizontal axis

Axis 6 is a 45 degree diagonal (at 10:30 and 5:30)

Axis 7 is a 45 degree diagonal (at 7:30 and 1:30)

The following photos show hands pointing to the 7 axes. *In these photos the shell remains stationary.*



Axis 1: Vertical



Axis 2: Horizontal



Axis 3: Horizontal (front/back)



Axis 4: 45 degree left



Axis 5: 45 degree Right



Axis 6: 45 degree (front/back)



Axis 7: 45 degree (back/front)

A good way to keep track of all this is to attach a “flag” of masking tape to the time fuse and have it securely pointing in one direction. This will allow you to accurately rotate the shell 90 degrees and serves the dual purpose of providing a convenient place to mark down each successive layer applied to the shell.



Number of Layers Required for Standard Aerial Shells w/ BP Burst

Shell Size	Weight of Paper	Number of Layers
8"	60 lb.	16-18
10"	60 lb.	20-22
12"	60 lb	22-24

These values can be adjusted when different materials or Burst charges are used. They are offered as a starting point for determining the optimal arrangement for any given shell.

Construction of the double petalled chrysanthemum w/pistil shell

In this method of construction, the pistil and inner petal stars are held in place by perforated hemispheres that are positioned along a central pass fire tube. The pistil is constructed first and the successive petals are assembled around it. An advantage of this method is that the stars are firmly held in place by the perforated hemispheres, and therefore produce very accurate spheres of burning stars. A disadvantage is that it is a somewhat time consuming technique.

The best way to convey this method is through photographs, so following is a series of pictures that detail the various procedures.



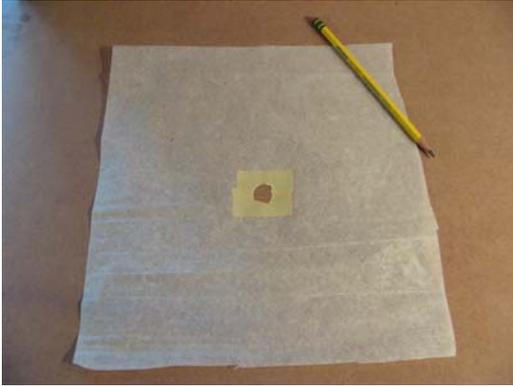
A 12" shell casing hemisphere (outer petal), an 8" inner petal perforated hemisphere, and a 4" perforated pistil hemisphere.



A 4" perforated pistil hemisphere with pass-fire tube glued in place. Pass fire-tube should be flush with pistil hemisphere top and its length equal to the interior depth of the final shell casing.



Pistil hemisphere is filled about $\frac{1}{2}$ way with stars



Tissue paper is prepared with masking tape gasket and hole for pass-fire tube and then inserted around pass-fire tube and over stars



Burst is loaded to a level equal to the stars



Stars are loaded in up to the edge of the hemisphere casing. Burst is added as needed to keep the stars pressed against the hemisphere wall.



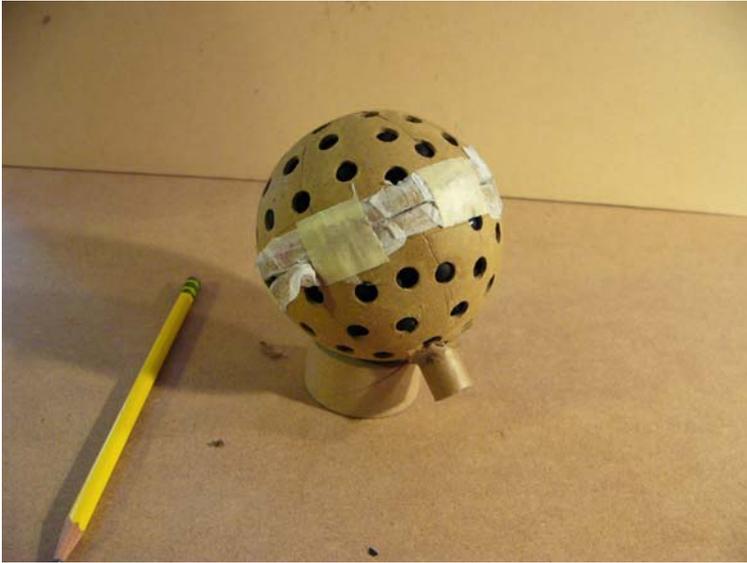
Stars held in place by tissue and burst. Tissue edge is folded over hemisphere edge and pasted down with wheat paste or other glue.



The other 4" hemisphere is loaded with stars.



A small quantity of burst is placed in tissue paper and set atop stars. This technique keeps the tissue from ripping. Burst is added as required and then the tissue is folded back and pasted to the hemisphere exterior as was done with the other half.



Hemispheres are brought together and held temporarily with tape. (Note: Pass-fire tube shown here is shorter than it should be).



Pistil is now spiked with off-center spiking pattern. Pass-fire tube has been lengthened to proper height.

The pistil has now been constructed and the next step is to build the inner petal around it. This is accomplished through the following steps:



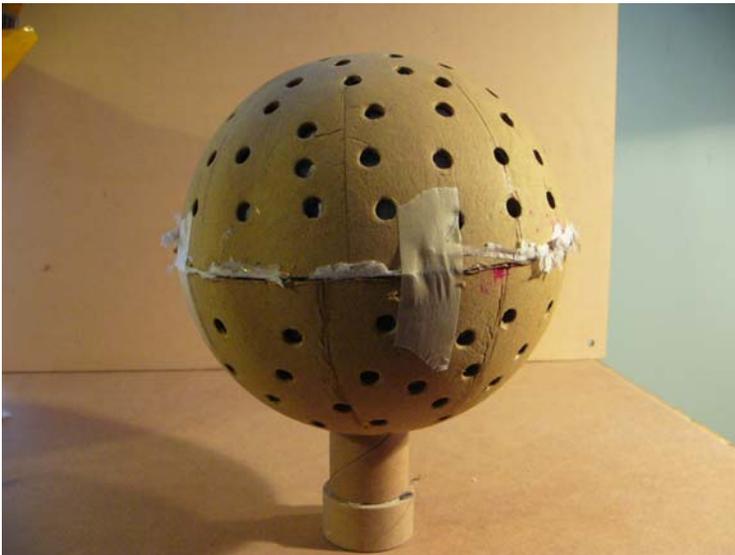
Large sheet of tissue paper (with masking tape gasket and hole) is affixed to pass-fire tube. The proper height for the tissue can be determined by pre-fitting the Inner Petal hemisphere so that it is level with the Pistil seam. The Tissue should be one star diameter higher.



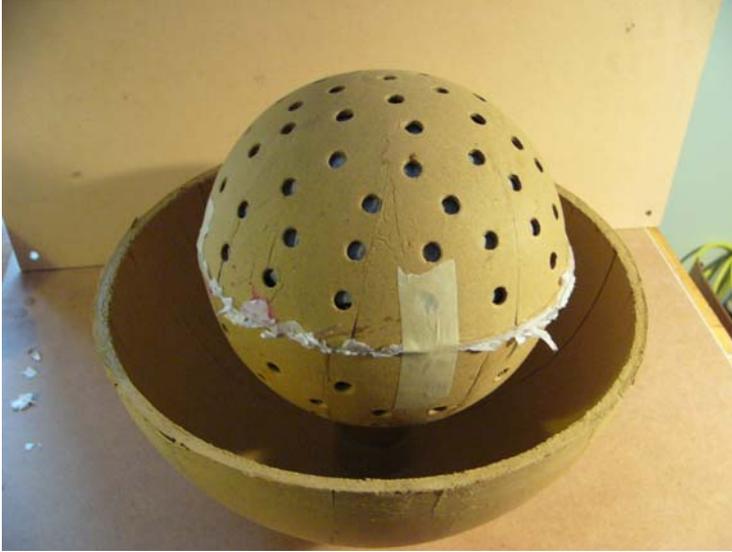
Pistil assembly and tissue is inserted and glued into inner petal hemisphere. Edge of IP hemisphere is even with the seam of the Pistil hemispheres. The stars and burst are added in the same manner as in the Pistil construction. Inner Petal hemisphere is then sealed with a layer of tissue paper.



The other half of the Inner Petal is loaded with stars and burst. A cavity is formed with a 4" shell casing and the tissue paper keeps the burst in place. *Important:* The 4" casing is removed prior to joining together the Inner Petal hemispheres.



Inner Petal hemispheres joined together. Inner petal assembly is then spiked with twine using the same offset pattern as was used for the Pistil.



Inner petal assembly placed in 12" shell casing. Repeat the same procedures that were used to construct the Inner Petal to assemble the final shell. (Note: Inner Petal is shown not yet spiked).

Time Fusing

The time fuse is attached to the shell in a conventional manner, with the interior end inserted into the passfire tube. It should be crossmatched on the interior end and the passfire tube **MUST** be loaded with several short lengths of good quality black match to transfer the fire to the center of the shell.

Some random suggestions for the spherical shell artificer

- A light coating of commercial Meal-D (or homemade equivalent) on rice hulls will yield a very energetic burst that works well on 12" shells. Rice hulls should be wetted, drained, and then coated with powder (+3% Dextrin) until they all appear to be black. Stir in one or two more scoops of powder and then set aside to dry.
- It is imperative that the contents of the shell stay in their intended positions during and after the impact and acceleration imparted by the lift charge. The way to do this is by tightly packing the shell with burst charge. At

every point where burst charge is introduced into the shell, it should be tightly consolidated so that it is strongly pressing the stars against their respective casings. And when joining the hemispheres of any size together, they should come together grudgingly, requiring a lot of hand pressure and light tapping with a stick.

- It is preferable to break a shell without the use of explosive accelerants like Whistle powder or Flash powder. These additives are distracting visually and audibly, and also impart too much speed and not enough momentum to a star.
- For large shells, BP is the Burst composition of choice because it is relatively slow burning yet produces a large quantity of gases. These qualities allow the stars to fully take fire before the shell casing ruptures from the increasing gas pressure. The stars emerge with their layer of prime fully enflamed, able to withstand the high initial velocity of the shell break.

The information presented in this article is offered to encourage fireworkers to pursue the manufacture of large fancy aerial shells. There are few things more impressive than a good 12" Warimono shell breaking in the dark of a still, evening sky. It is my hope that this article will cause a few more flowers to bloom forth, to the lasting pleasure of all.