Make Your Own Paper Ball Shell Casings

— Steve Hubing September 2015 —

Paper ball shell casings or “hemi’s” are the container that stars, inserts, and burst is placed when making a ball shell. The casings contain and hold the pyrotechnic materials during the shell making process, and contribute to the shell strength of the finished shell.

Commercial ball shell casings from China are typically made of strawboard, which is a weak type of paper fiber that is pressed into a mold under pressure to produce a hemisphere. Commercial Japanese ball shell casings are made in a similar manner, but are made with higher quality paper and are usually rounder and thicker. Japanese ball shell casings are very difficult to find and purchase.
Why Make Your Own Ball Shell Casings?

**Quality and Consistency**

If you make your own ball shell casings you have control of the material and the process you use to make the casing. This can lead to better quality and more consistent casings. Consistency and quality are two major factors in making good shells.

**Availability**

It’s not easy to find and purchase paper ball shell casings, especially good quality casings. When you make them yourself you will always be able to get the casing you want.

**Use of different shell casing materials**

You can make your casings from materials other than pressed strawboard.

For example you can use newspaper (which makes a very high quality casing), paper mulch, kraft paper (virgin or non-virgin), or gummed paper tape.

**Cost**

You can make a good quality ball shell casing at a fraction of the cost of buying a commercial casing. This is especially true of the larger casings.

For example, a low quality 12 inch ball shell casing can cost you as much at $20, but you can make a 12 inch casing of higher quality for as little as $6 or less.

**Custom Sizes**

When you make your own casings, you can make them any size and wall thickness you want.

If you need a casing for a 7 inch shell, you can make it. If you need a thin casing for a inner shell petal, you can make it.
Examples of homemade paper ball shell casings.

- 12 inch, 7 inch, 5 inch inner petal, and 4 inch casings made from gummed tape.
- 3 inch and 4 inch made from newspaper.
Step 1 — Determine the size

- Casing Inside Diameter
- Casing Mold Diameter
- Casing Outside Diameter
- Finished Shell Diameter

Reinforcement Thickness (Outer Wrap)

Casing Thickness
Ned Gorski’s Rule #1

Shell finished diameter = 0.95 (95%) x Mortar Inside Diameter

Example for a 12” shell (this is ID of mortar or “nominal” shell diameter = 0.95 x 12 = 11.4”

Ned Gorski’s Rule #2

Ideal thickness of outer wrap (reinforcement thickness) =

0.014 X nominal shell diameter

Example for a 12” shell —- 0.014 x 12” = 0.168”

Increase in shell diameter with ideal outer wrap thickness (reinforcement thickness) =

(0.014 X nominal shell diameter) x 2 = 0.028 X Nominal Diameter

Example for a 12” shell —- 0.028 x 12” = 0.336”

Optimal outside diameter of shell casing

Shell finished diameter minus Increase in shell diameter due to outer wrap thickness

12 inch shell example:

(0.95 X 12) - (0.028 x 12) = 11.4” - 0.336 = 11.064 (or 11”)

Casing Mold Diameter

Ned Gorski uses shell casings with a wall thickness of 0.125” (1/8 in).

If the shell casing wall thickness is 0.125” (1/8 in) then the diameter of the shell casing will increase by 0.25” (1/4 in) as it’s pasted over the shell casing mold.

Casing Mold Diameter = Outside diameter of shell casing - 0.25”

12 inch shell mold example:

11.064” - 0.25” = 10.814” (or about 10 3/4 inches)
Mold diameter

11.4 inch - 0.168 - 0.168 - 0.125 - 0.125 = 10.814 inch

(10 3/4 inch is close enough)
Step 2 — Find or Make a Mold

Now that you know the size of mold you need for the shell you want to build, you have to either find a ball of the right size or make one.

Some possible things you could use as a mold would be things like, a baseball, a softball, undersized hemi’s, bowling ball, or some type of athletic or exercise ball that you can deflate or inflate to the right size.

You can also make your own mold, some possibilities are:

- Find a paper or plastic hemi and use it to mold a hemi with bondo, fiberglass resin or plaster or paris.
- Made on on a shaping jig and plaster of paris to form a hemi.
- Print one on a 3D printer.
Jim Widman’s Shaping Jig

Jim Widman came up with a simple design for making a shaping jig to make any size plaster-of-paris ball you want. Once you get the knack of working with plaster-of-paris, the jig works pretty good.

An inner hemi that is smaller than the mold hemi you want to make is mounted to the large wood disc.

Plaster-of-paris is put on the smaller hemi and the wood disc is rotated by hand to wipe off the excess plaster and shape the hemi. It may take a couple of plaster applications to get a smooth hemi.

The wiper blade is made with the proper 1/4th hemi size to get the correct sized hemi that you want.

Proper placement of small hemi on the round table is important as is proper alignment of the wiper blade.
Step 3 — Prepare The Mold

If you can, it helps a lot to glue two magnets into the poles of each mold hemi. This will help you later to find the poles when wrapping and cutting the hemi from the mold.

![Magnet glued flush into each mold hemi.](image)

Next you will need to place a layer of gummed paper tape, with the gummed side out over the entire surface of the mold.

And then place another layer of gummed paper tape, with gummed side in over the entire surface of the mold.

Use a gummed tape that has the right width.

3 & 4 inch — 3/4 inch tape
5 & 6 inch — 1 inch tape
7 & 8 inch — 1 1/4 inch tape
10 & 12 inch — 1 1/2 inch
After the gummed side in layer is placed on the casing mold, burnish the mold using a board.

After burnishing

Burnish with a board to get the tape to lay flat

After burnishing

After the first two layers (one gum side out, one gum side in) of tape are put on the shell, locate the poles (embedded magnets) with other magnets and draw a circle around each pole.
Step 4 — Wrapping The Mold

Begin putting on wetted gummed paper tape by starting out on the edge of one of the circled poles.

Continue putting tape around the shell, passing on the pole circle on opposite sides as you go around the shell. At the equator of the shell you should overlap the tape by half. This will create the tape pattern you see in this picture.

Keep applying tape until the entire shell is covered with tape. Since you are overlapping each wrap of tape by 1/2 you effectively are putting on 2 layers of tape.
After the first complete layer is put on, burnish the shell casing as before and again find the poles with your magnets.

Make the new poles 90 degrees from the last set of poles and draw a circle.

You want to stagger the poles so you don’t get tape build up on the shell casing by having the poles in the same place.

After the new poles are marked, start putting on another layer of tape just like you did the previous layer.

Remember each layer you put on is effectively 2 layers of tape.

Keep putting on layers of tape until you reach your target shell casing diameter.

Be sure to position each layers poles in a different place than the other poles.

Also you will want to burnish each layer before adding the next layer.
Another way to check the shell casing to see if it is at the desired diameter is to calculate the circumference for that diameter and then measure it.

\[ \text{Diameter} \times 3.1416 = \text{Circumference} \]

Example for this 6 inch shell casing

\[ 5.5 \text{ (target diameter)} \times 3.1416 = 17.27 \]

As you can see this shell is at my target diameter of 5.5 inch because the circumference is measured at ~ 17.27 inch.

Once the shell casing has reached the target diameter, measure down from one of the poles by 1/4 of the circumference to establish an equator.

I made a bunch of dots as I measured and then connected them together with a line.
Step 5 — Cutting The Casing Off The Mold

Using a sharp utility knife cut around the marked equator until you cut through the paper casing.

Before taking the paper hemi’s off the mold mark the hemi’s so you can match them up when you put them together.

After separating the hemi’s from the mold, place them back on the mold to dry. This will ensure that they dry without deforming.
Using your WASP to make the shell casing is much faster than making it by hand. All of the steps to make a shell casing on the WASP are the same as making it by hand, except after the shell casing mold is prepared with two layers of gummed tape (one with the gum side out and the other with the gum side in) you apply the needed wraps of gummed tape with the WASP to bring the shell casing up to the target diameter.

You will have to make a new WASP setting for using the shell mold and this does take some time to dial in the settings to get a good tape pattern with the shell mold’s diameter. But once it’s done, just save the settings and you’re good to go for the next one using the same mold.
Using Motorized Cutter to Cut The Shell Casing

Jim Widman has come up with a way to cut the shell casings using a motorized turn table. This is a motorized cutter that I made using his design. I modified his design from his original design to use materials I had on hand. The cutter works very good.
This ends the tutorial on making your own ball shell casings. And while there are other ways to do this, I have found this method to produce very good shell casings with the least amount of work. Especially if you have a WASP.

While I used may sources of information and much of my personal experiences, I want to specifically thank the following people for providing a wealth of information about making shell casings and wrapping shells with gummed tape.

Ned Gorski (www.fireworking.com) did much of the experimentation and design this tutorial is based on. His site is rich with pyro information.

Jim Widman (www.ctpyro.com) designed, makes and markets the WASP shell pasting machine which has revolutionized the making of paper ball shells. He also designed the Shell Casing Cutter and plaster-of-paris hemi shaper, and while he doesn’t sell them, you can make your own based on his work. He also makes a lot of paper shell casings with gummed paper tape with the WASP method.

Kyle Keply (www.passfire.com) authored an article on pasting shells by hand with gummed paper tape. This article got me into pasting paper shells before I got my WASP.

If your not a member of Ned’s or Kyle’s websites, I encourage you to join. They both have a wealth of pyrotechnic information.

And if you’re really serious about making ball shells, visit Jim’s site and consider purchasing a WASP. You’ll never regret the purchase.

The End