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Home Made Star Plate

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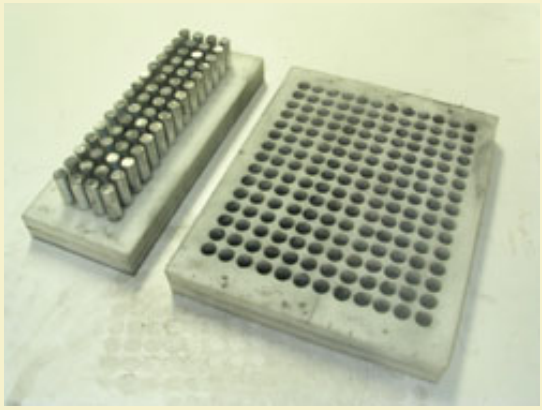

Figure 1: A 180 hole star plate with 60 pin plunger.

Figure 2: Polyethelene cutting board from Home Depot.

Materials:

- (1) 18" x 14" x 1/2" thick chopping block
- (3) 36" long x 3/8" diameter aluminum or brass rods
- (1) 3/8" or 23/64" drill bit
- (1) 23/64" or 13/32" drill bit
- (2) 1" to 2" long 1/8" diameter rods or nails
- Carpet tape

Introduction:

Pumped stars are the most precision type of stars you can make, and their ease of ignition is second only to cut stars. Their cylindrical shape is also ideal for roman candles, comets and other projectiles fired from a tube. However, pumping them one at a time is a time consuming activity that is too much work when large quantities are needed.

Star plates are the only practical way to go about making pumped stars in any useful quantity. As seen in Figure 1, a star plate is simply a plate full of holes with a matching pin plate that mates with it. The procedure for using such a plate is described here.

Most commercial star plates are made of machined aluminum or brass, and they can be rather expensive. If you were to purchase a commercial plate of the size shown here, you would likely pay a few hundred dollars for it. Following the instructions given here, you can make your own star plate capable of pumping out 180 3/8" stars for only about $25 using parts available at any Home Depot hardware stores.

Acquiring Materials:

The hardest part about making your own star plates is finding a suitable material for the plate itself. It has to be the right thickness, be rigid, hold up to solvents and allow easy machining. Aluminum is the ideal material due to its strength, weight and resistance to solvents. However, it can be rather expensive in thicker sizes and requires more time, skill and tools to work with. Plastics such as plexiglass will also work, except thicker sheets are hard to find and

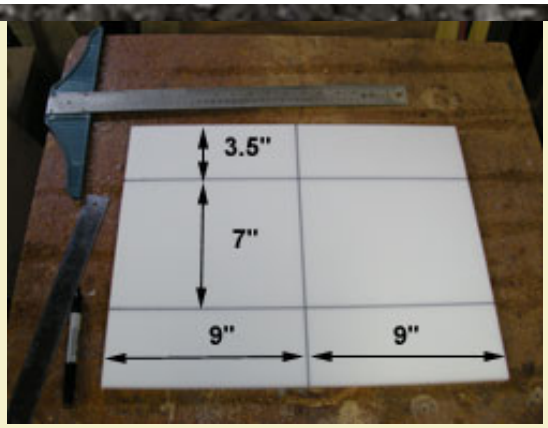

Figure 3: Marking the cutting lines with a felt tip marker.

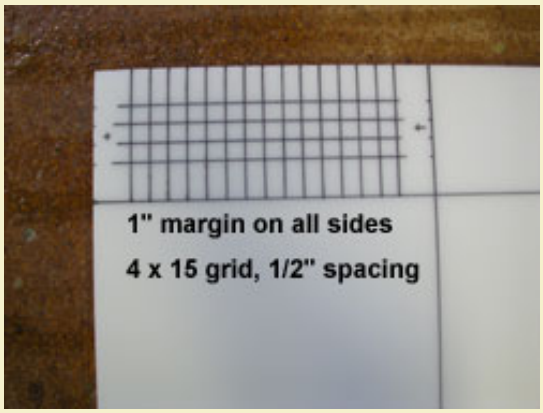

Figure 4: Marking the hole centerpoint grid.


Figure 5: Cutting out the pieces on a band saw.

prohibitively expensive when you do find them. Most plastics also will melt if used with acetone or other solvents used in pumping certain types of stars. The nice part about using plastic is that the pins can be secured in place using glue, unlike the aluminum pins that must be individually fastened with set screws.

Luckily it is possible to find polyethylene cutting boards that work well for making your own star plates. Home Depot sells a particularly large one without any fancy grooves around the edges, which is well suited to this project (see Figure 2). The board is 1/2" thick, which is a good size for making a range of star plates. Larger plates are made by stacking the boards together to form thicker plates. A 1/4" star plate uses just one sheet, a 3/8" plate uses two sheets, and a 1/2" plate uses 3 sheets sandwiched together.

Polyethylene can not be melted by any solvents that I know of, which is good and bad. It is good in that the finished star plate will hold up to anything you expose it to, but bad in that there is no way to easily glue multiple sheets together. I've tried epoxy, glues and even carpet tape in an attempt to hold parallel sheets together, but all came apart eventually. The only good way to keep the plates together is to weld the edges together using heat to melt the plastic.

Aluminum pins are used for the pin plate, and these are easily found in most hardware stores as 36" long rods in various diameters. You will need to get three 3/8" diameter rods, but be careful in selecting them, since the rods found in most stores are not very exact in their diameter. Some are slightly less than 3/8", while others are slightly more. This means you need to get a drill bit gauge from somewhere else in the store and use it to gauge each rod to make sure they are all the same size.

Because the pins will be press fit into the pin plate, the pins actually need to be very slightly larger than the holes they will fit into. When choosing your rods, you can select three that fail to fit into the 3/8" drill guide hole, then use a 3/8" bit to drill out the pin plate. If you can only find rods that are actually the correct diameter and fit into the hole, then you will need to buy a 23/64" bit for drilling out the pin plate holes. Before drilling out your pin plate, be sure to test fit your rods into a test hole drilled in a piece of scrap plastic. The pin should fit tight enough to require a hammer to tap it into place, and you should not be able to pull it out by hand.

Construction:
Figure 3 shows the cutting lines for the 18" x 14"

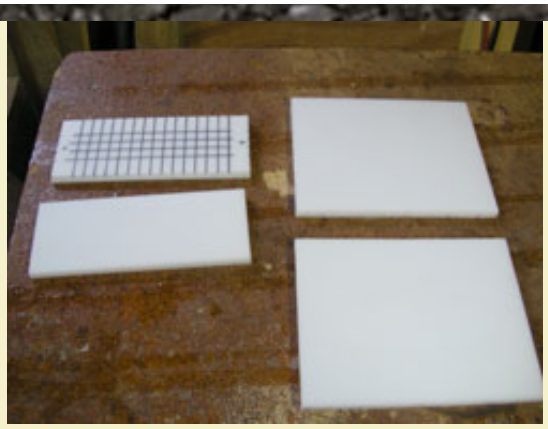

Figure 6: Two sets of identical pieces to be joined together.

Figure 7: Using a blowtorch to heat the edges when melting the two pieces together into one thick piece.

Figure 8: Using a monokote hobby iron to aid in melting the seam together.

sheet sold at Home Depot ($12 at time of this writing). It is also a good idea to lay out your pin grid at this time, as seen in Figure 4. Note the center points marked on each edge for the alignment pin holes. These are located 3/8" from each edge and centered as shown.

A band saw is ideal for cutting out the pieces, as seen in Figure 5, since the material removed by the thin blade is so small that you don't have to account for it. Polyetheylene cuts and drills very easily and it will not chip or crack, which is another nice thing about it. If you don't have a band saw, you could probably clamp the piece to a table and use a thin hand saw to cut out the pieces. The edges do not have to be pretty, and you are going to melt any ugly cut marks when joining the pieces together.

Figure 6 shows the four pieces you will need to cut out. There will be two other leftover pieces, which you can use as a backing when punching spolette holes in disks or as a hot glue drip pad. You can even cut it into cubes and use it for replacement blade guides for your band saw, which you can see on my own saw in Figure 5 (white cube next to blade).

Next you will need to join the two big plates together to form one thick plate. If you plan to pump stars using the method shown here, then you don't have to join two plates together and can ignore this step. However, if you prefer to pump stars using the granulation method shown here, then you will need the double thick plate.

Like I mentioned, trying to glue this material together is hopeless. You have to seal the edges together using heat. Figure 7 shows a blowtorch used to heat the edges while the two pieces are clamped together on the edge of a table. A monokote hobby iron, which can be found in most hobby shops for building remote control airplanes, will help smear the melted plastic around when doing this. You could also just heat a metal trowel with your torch and use it the same way. All four edges need to be melted together as shown.

This star plate design uses a 1/3 size pin plate in order to save you time and money, as well as to reduce binding problems when inserting and removing the pin plate. You only need to make 60 pins to have a 180 capacity plate. When you start cutting those pins, trimming the burrs and sanding the face of each one, you will thank me for cutting your work by 66%. You're welcome!

Now, the pin plate will be used as a template for

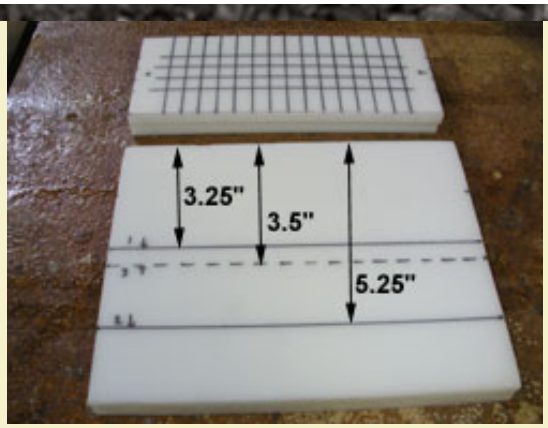

Figure 9: Alignment markers on hole plate to aid hole template placement.

drilling three sets of holes. Thus there will be three sets of alignment holes needed for the three positions it will be in during this process. Figure 9 shows the guide lines you will need to draw on the plate, which will be used to line up the edge of the pin plate when drilling the alignment pin holes. The dotted line is the third position, and it will align with the back edge of the plate, while the solid lines will align with the front edge of the pin plate from the perspective shown in Figure 9.

More...

Home-Made Star Plate...

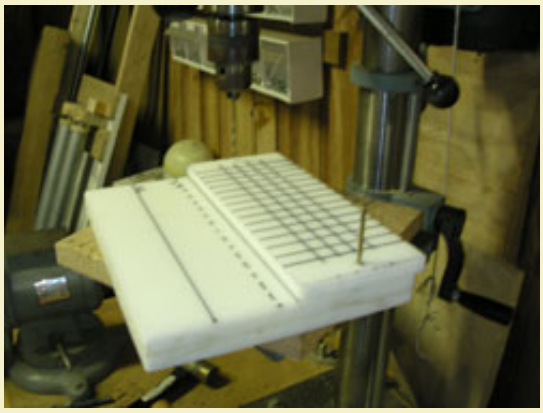

Figure 10: Drilling 1/8" holes for alignment pins.

Figure 10 shows the pin plate being aligned on top of the hole plate, with one brass pin already in place. It is important to drill and insert the pin on one side before drilling the other side, otherwise the plate will slip on you and the holes will not be aligned.

After pinning the first position, remove the holding pin and relocate the pin plate to the second position, which is the solid line below the dotted line. Drill and pin one side as described already. Finally, move the plate to the last position and pin both sides. At this point you can just leave the plate pinned on both sides because the next step is drilling out the holes.

Now you are ready for the dreaded task of drilling 180 holes. If this were aluminum, then it would probably take you all day to drill this many holes due to the slower drilling speed, using cutting oil etc. However, the polyethylene drills quite easily and fast. Figure 11 shows the drilling in progress. The wire brush shown here can be used to clean the turnings off the drill bit without the need to turn the drill press off and on 180 times during this tiresome process.

Figure 11: Drilling pin plate and first set of plate holes.

For the first set of holes, you will be drilling through both the pin plate and then all the way through the hole plate. Once all 60 pin plate holes have been drilled, the plate is moved to the next position and serves as a template to guide the bit when drilling the next set of 60 holes in the hole plate. And if that isn't exciting enough, you get to move the pin plate one more time to drill the final set of 60 holes.

Once all the holes are drilled, and I hate to say this, but you have to re-drill all 180 of the holes in the hole plate with a slightly larger drill bit. These holes need to be a tad bit larger than the pins that will fit into them, otherwise the pins will bind. If your aluminum rods were the slightly oversized variety and you used a 3/8" bit to drill the plate holes, you will need a 27/64" bit to resize the holes. Otherwise you can use a 13/32" bit. Either way it is an oddball size that is probably going to cost you a trip to the hardware store. Make sure you get the standard type of bit with a tapered tip, since you will be drilling without a center point to guide the bit.

Do not be tempted to make these holes any larger than you absolutely have to, otherwise your stars will have little rims around the top if the pin clearance is too much. The openings of each hole in the hole plate can be trimmed by hand twisting a large diameter bit into the hole opening, such as a 3/4" bit. It is important that both sides of the hole plate are smooth and flat, so any extrusions caused by the drilling process need to be reamed out in this way.

Figure 12: Drilling second group of holes using pin plate as a guide.

Once all the holes are bored out to the larger size, you have only one grueling, monotonous task left: cut 60 aluminum pins that are 1-1/2" long from your three rods. If you are using the single 1/2" thick hole plate, then the rods only need to be 1" long.

If you are lucky enough to have a horizontal band saw, such as the one shown in Figure 13 (lucky me), then you can make short work of the cutting process. This type of saw has a stop-block for consistently cutting lengths of material to the same size. The stock is fed into the back by hand and the hinged bandsaw assembly is brought down on top of it to make rapid cuts. The alternative is a hand held metal cutting saw and a lot of elbow grease.

Once all your pins are cut, you will need to clean up the rough edges and sand one end of them smooth. I use a belt sander mounted on it's side for doing this, but a table grinder can do the job just as well.

With all your pins cut and cleaned up, the worst is over. Now all you need to do is assemble the pin plate and you are done. Start by taking the pin plate that doesn't have the holes in it and melting it onto the piece that does have the holes, using the same technique you used to join the two hole plate pieces together. Be sure that the side of the drilled out plate with the guide lines is covered by the top plate.

Figure 13: Cutting pins using a horizontal type band saw.

All that is left now is to tap each pin into the holes in the hole plate, making sure they seat all the way down to the backing plate. Figure 14 shows this last step in progress. The flexible quality of the polyethylene makes press fitting the pins a very simple and effective way to hold them in place. This technique would not be possible with more brittle types of plastic such as acrylic.

With the right tools, this project can be completed in about 3 or 4 hours. The parts are easy to find and the cost is very low. The only drawback is the monotony of dealing with so many holes and pins. But once the project is complete, your pumped star production will be drastically increased and the plate will likely last you forever. 🔥

Figure 14: Installing pins in pin plate.