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Casting Milling Media

Figure 1: Six inch lengths of copper tubing with foil tape plugging the bottom.

Figure 2: Twenty five pounds of Linotype lead scrap purchased on eBay.

Introduction:

Milling media cast from lead is a popular choice for do-it-yourself mill designers, mainly because it is cheap and easy to melt and cast. Because lead is so heavy, it grinds with more force than other types of media. Lead does not produce any spark risks and can be used to mill any type of pyrotechnic compound.

Tire weights, flashing, fishing sinkers and many other common sources of lead are pretty soft and will erode over time if they are used to produce milling media. Compositions milled using soft lead media are a possible health concern, as the lead wears off into the powder and then becomes airborne in the smoke generated when the powder burns, possibly exposing anyone breathing the smoke to traces of lead that can build up in their body over time. No studies have been done, thus it is hard to say how much lead you would likely be exposed to or if the risk is statistically noteworthy, but the possibility is there.

In a previous article on casting milling media located here, a method was described of filling brass tubes with melted lead tire weights. The brass sleeve idea got around the erosion problem by encapsulating the lead in a sleeve of harder material, which also boosted the milling efficiency of the media. However, there are a few drawbacks to this method that are worth mentioning. The biggest problem is that over time, perhaps two or three years, the brass sleeves will start to crack and start separating from the media. It is thought that the constant pounding acts to harden the brass and make it brittle. When they crack, it is one pretty straight crack that runs the full length of the media, then it is only a matter of time before the inner lead falls out. Of course all sleeves don't crack at the same time, so over a long period you get a mixture of progressively more bare media as more and more sleeves crack off. This type of media is also more difficult to produce because you have to cut a segment of tubing for each media segment. So every couple of years you would have to cut all new sleeves, re-melt the old lead and cast all new media. A third disadvantage is the undesirable presence of copper in the brass sleeves if they are being used to mill Ammonium Perchlorate.

One solution to the above mentioned problems is to use stainless steel sleeves, which are hard, non sparking and very corrosion resistant. However, they are also more expensive and more difficult to cut. When using soft lead, however, stainless sleeves are the best option.

Figure 3: A melting pot made with a Colman propane stove and bricks.

Figure 4: Filling copper pipes buried in the sand.

Figure 5: Cooling off the lead in water after it solidifies.

Another solution is to use a harder grade of lead and just cast solid media without an external sleeve. An ideal source of hard lead can be found as scrap from the printing industry under the name of Linotype lead. These are usually little blocks of lead with letter faces on one end, which fit into a printing press for stamping out text or other characters. The lead is considerably harder than tire weights or fishing weights, and those who have been milling with Linotype media report virtually no erosion over time. The media described in this article is made using Linotype lead.

Finding the Lead

Linotype lead is apparently scrapped from printing operations on a regular basis, as there is no shortage of it for sale on eBay at any given time. Figure 2 shows a 25 pound lot of Linotype that was purchased on eBay for $18 plus $8 shipping. Linotype is surprisingly easy to find on eBay, as many people buy it for casting their own bullets. It is usually sold in 25 pound lots because that is the maximum amount that can be crammed into a Priority Mail Flat Rate box for $8 shipping cost. It's a bit surprising to see the battered paper envelope straining under the 25 pound load actually survive the trip to your mailbox, but the system seems to work! Just one more example of life made better by eBay.

Melting the Lead

The simple setup I use for melting lead is shown in Figure 3. A Colman propane tank is fitted with a screw-on stove burner that can be found in any store that carries camping supplies. The tank is buried in the ground for stability, then some bricks are used to build up a wall around the sides to help keep the melting pot from falling off. Any all-metal pot can be used to contain the lead, just make sure it doesn't have any kind of non-stick surface or any other kind of coating inside. The types with aluminum or copper bottoms will help to transfer heat faster, but will still work with just a cheap no-frills pot. A metal ladle is also required for transferring the lead from the pot to your mold tubes.

Making the Molds

I had heard of people rolling tubes from paper and aluminum foil and using these to produce long rods of lead that were then chopped down into smaller pieces. This seemed like a good idea to me, but I get poor results with this method. If the inside portion of the tube is rolled from aluminum foil, the aluminum tends to expand and crinkle when the hot lead fills it, giving you deformed surface textures and even foil that gets embedded inside the lead. If paper is used on the inside of the tube, a porous texture results on the surface of the lead bars. Both defects are undesirable and difficult to prevent. Not only that, but you have to roll a bunch of tubes before hand and then spend time trying to unravel their charred remains from the finished bars.

A far easier method is to cast the lead into lengths of copper plumbing tubes. For my own media I use 3/4" I.D. tubes cut to six inch lengths. Twenty five tubes of this size will produce all the media you would need to charge one standard size 6" Sponen PVC jar.

The pipes should be cut with a hack saw or cut-off saw, not a rotary type pipe cutter. The rotary pipe cutters will reduce the pipe diameter

Figure 6: Removing the lead bars from the tubes.

at the edges, which will trap your lead bar inside. After cutting the pipes, a de-burring tool should be used to clear the inside edge of the pipe from any debris that could prevent the lead bar from easily sliding out. You may prefer to only cut twelve fill tubes and then do two fills, or you can just go ahead and make all twenty five or however many you need to cast all the media you need in one fill session. The nice thing about these copper tubes is that you only have to make one set, then you can keep reusing them to cast all your media in the future.

Casting the Lead

It is a good idea to spray the insides of each tube with a lubricant like WD-40 prior to each casting, which helps the lead bars slide out of the sleeves when completed. The WD-40 will not boil or catch fire during the casting, but it will leave small dimples in the surface of the finished bars. The dimples will get hammered out during milling however. While sometimes the bars will eject without lubricant, more often they will get stuck and trying to pound them out only makes them more stuck.

Figure 7: Smooth lead bars ready for segmenting into media.

Next the tubes are prepared for casting by first fixing a square of foil tape to the bottom in order to keep the lead from running out, as seen in Figure 1. A good quality, thick foil tape should be used so that the lead can not burn its way through. It is also a good idea to wrap another piece of foil tape around the bottom of the tube so that it seals around the edges of the tape that was applied to the end, otherwise the weight of the liquid lead can sometimes cause it to leak out through the wrinkles in the foil and make a mess that ruins the casting.

The tubes are filled by first inserting them into sand at least half their length, as seen in Figure 4. The molten lead is then poured in using the ladle. It is not a problem if it takes two or three fills from the ladle to fill the tube, just don't let one fill solidify before adding the next. This process is a bit hazardous, so be sure to wear long jeans, a long sleeved shirt with thick material, gloves, safety glasses and a good respirator to protect against lead fumes. Obviously this is a process that needs to be done outdoors.

Figure 8: Defect from pouring with lead that isn't hot enough.

It is important to let the lead solidify before moving the tubes, so just let them sit a good fifteen minutes minimum. Once they set up, you can use tongs to transfer the tubes into a tub of water to speed up the cooling process, as seen in Figure 5. This step can be skipped if you just let the tubes sit for several hours after casting.

Surprisingly, the lead does not adhere to the inside of the copper tube at all-especially if the inside was coated with a lubricant. To remove the lead bars, a wood dowel rod is placed on a table and the lead filled tube is placed on top of it. The tube and dowel rod are held together and hit down against the table surface, using the weight of the lead as a hammer. This will push the lead from the tube as seen in Figure 6. Care must be taken not to use too much force when pushing the bars out, otherwise the lead can get compressed and expand sideways-resulting in the bar getting permanently stuck inside the tube. When this happens you will need to heat the entire assembly to recover the lead and then discard the copper tube.

Figure 9: Defect that occurs with certain types of linotype lead.

There are two types of common defects in the castings that you will run into. The first one shown in Figure 8 is a wrinkly texture that usually occurs near the bottom of the bar. This defect occurs when the lead hasn't been sufficiently heated prior to pouring. The copper pipe and surrounding sand will absorb heat rapidly from the lead when it first enters a cold tube. This causes the lead to solidify right away, causing the wrinkles as new lead falls on top of it. This is a simple defect to avoid.

The second type of defect only occurs with certain types of linotype lead. A rough, porous surface will form at the top end of the lead bar as seen in Figure 9. This type of defect will not fix itself during milling so it must be discarded and returned to the melting pot. It seems the harder the lead is, the more this phenomenon occurs. It's almost like some component of the lead is floating to the top portion of the lead bar as it cools, since this defect always occurs in the top 20% of the bar. When pouring with this kind of lead, you just have to accept the fact that 20% of each pour will be unusable.

Figure 10: Using a Japanese hand saw to make rapid cuts through the lead.

Occasionally you will find that a void forms in the end of the bar due to shrinkage as the lead cools. Media that has holes in the surface that lead to internal voids can be salvaged by filling the internal void with hot glue, otherwise just melt these pieces back down. Do not mill with exposed hollows in your media, otherwise chemicals will build up inside that could cause contamination problems later.

Finishing the Media

Figure 7 shows the smooth, shiny surface of the lead bars, which makes an ideal milling surface. You don't want to see air bubbles or other concave indentations on the sides. The ends will be a bit messy, and you will have to peel off the aluminum tape or burn it off, but these areas will pound themselves into a smooth surface once you start milling.

Figure 11: Using a cut-off band saw to make even more rapid cuts.

The last step is to cut the longer bars into the shorter segments that you need. This can be tedious if you try hand cutting them with a standard fine tooth metal cutting saw, which cuts very slowly. A better choice is the thin kerf Japanese type hand saws seen in Figure 10, which will cut quite fast. An even better tool is a cut-off type band saw if you have one, which is seen in Figure 11. These have a depth stop that allow you to make all cuts to the same length without having to measure out cutting marks on each one.

The finished media is seen in Figure 12. I like to sand the sharp edges on a vertically mounted belt sander after cutting the media, but these will also pound themselves round during milling if you just leave them as-is.

Figure 12: Finished media ready for use.