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Volume 3, Issue 3

Making Cross Match

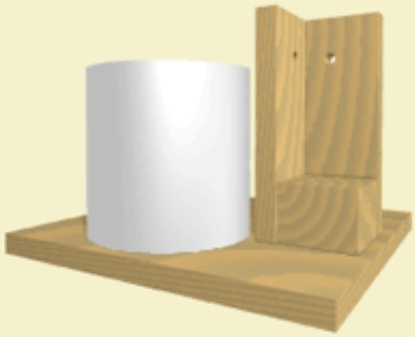

Figure 1: Sizing up the spool brackets with the slurry bucket.

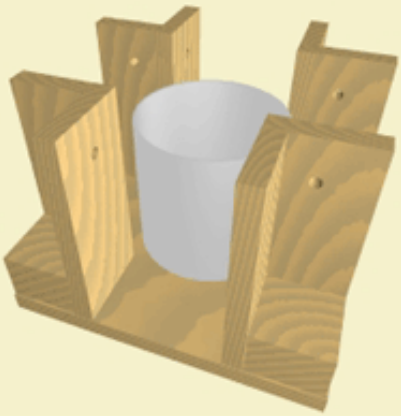

Figure 2: Bracket placement around slurry bucket.

Figure 3: Making spools with brass tubing and 3" end disks.

Introduction:
Cross match is a thin diameter type of fuse used to pass fire into a piece of time fuse. The time fuse is punched through with a small diameter hole into which a short segment of cross match is inserted. Black match is most frequently used for cross match because it takes fire easier than other types of small diameter fuses such as visco or thermolite. Black match can also take fire at any point instead of just at the ends such as with visco. This side-ignite characteristic helps reduce the time required to pass fire to the main time fuse.

Because the reliability of the cross match is detrimental to insuring quick and effective ignition in shells and inserts, it is important to be able to make good cross match. Thin match that only contains a shell of powder around the outside tends to bend easily when inserted, resulting in the outer powder layer cracking off and creating a void in the powder train. This little inch of fuse can make the difference between a lot of effort working properly vs. smashing to the ground.

While the method for making black match described here can be used to make smaller diameter cross match, the method described in this article produces a more consistent diameter fuse with good powder saturation. While this technique requires more effort in fabricating the initial tooling, it is generally faster and less messy at producing match than other methods.

Making the Spool Rack:
The basic idea here is to feed four individual strands of cotton thread down into a bucket of black powder slurry, where they then merge as one strand up through a diameter regulating hole and onto a rotating frame. This way each strand is coated before merging into one strand, insuring that there is powder on the inside of the fuse as well as on the outside.

The first component you will need to make is a bucket around which four spools of string are situated. The actual dimensions will depend on whatever bucket you can find, so Figures 1 through 5 show the basic design. The bucket should be at least six inches in diameter, but no larger than 8" or you will wind up wasting a lot of slurry per fuse batch. The depth of the bucket should also be at least 6".

You will need to make four brackets that look similar to the one shown in Figure 1. The hole near the top is used to hold a rod around which the spool can spin. The bracket should be made so that the hole is about 2" above the lip of the bucket when placed next to it. The wood block at the bottom of the L shaped bracket helps hold the pieces together and gives you something to screw into when fastening the brackets to the base board. The width of each

bracket face should be about 2", while the height will be determined by your bucket.

Figure 4: Spools mounted in brackets.

The brackets should be spaced around the bucket as shown in Figure 2. The spacing between each bracket pair should be equal to the diameter of your bucket. Use wood glue and screws to secure each bracket to the base board, screwing from the bottom side of the base board up into the brackets.

The four spools are made using brass tubing and chip board end disks for 3" shells. The length of the brass tubes, which can be found in the K&S Metal centers of some hardware stores, will need to be equal to the diameter of your bucket, minus about 1/4". I use 1/4" rod as the axle, so the brass tubes are 3/8" O.D. and easily slide over the axle. Drill a center hole in a set of end disks such that they make a tight fit onto the brass tube, as seen in Figure 2. The disks can be secured with hot glue if they are not a tight fit. Be sure to leave at least 1" of brass tube sticking out on both sides of the disk, which you will need for fitting into a drill chuck when loading them with string.

You will need four axle rods for the spools to spin on, which are cut 2-1/2" longer than the length of the brass tubes. This can be something like 1/4" threaded rod or 1/4" aluminum tubing with threads cut onto each end so that a nut can be threaded on. Figure 4 shows all four spools in place. The nuts at the end of each axle need only be hand tight so that the spools can be removed without the need for any tools.

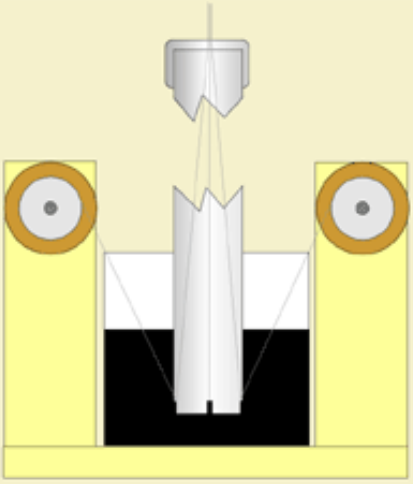

Figure 5: Thin cotton twine fed into notched bottom of PVC pipe, then up through a 1/8" hole in the capped end.

Next you will need a segment of 2" diameter of PVC that is about 2 feet long. An end cap with a 1/8" hole drilled in the center is placed on one end (not glued). The bottom end is notched with four equally spaced channels for the string to pass through. This is easily done with a thin kerf pull saw or hacksaw blade.

Figure 5 shows a cutaway of all components being used to feed string down into the slurry bucket, into the bottom of the pipe and up through the hole in the top. The pipe is stirred in actual use, which further helps coat the string with slurry. Excess slurry scraped off the string at the sizing cap falls back down the pipe into the slurry bucket, making the operation quite clean.

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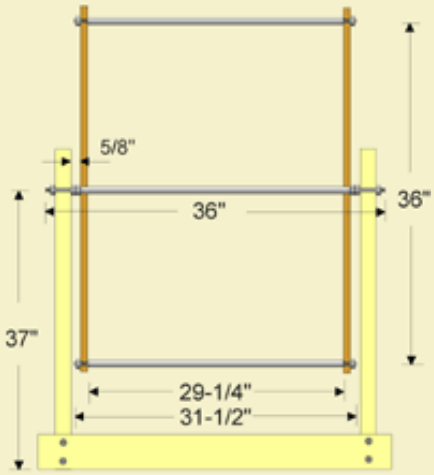

Figure 6: Match loom dimensions.

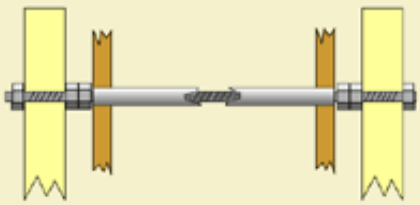
Figure 7: Details of center pivot.

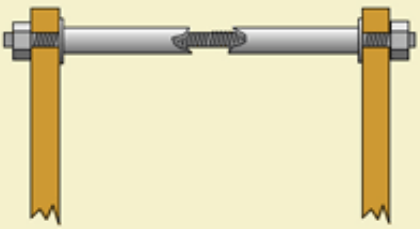
Figure 8: Details of tie-rods at each end of frame.

Making the Frame:
The frame used for this process is a little smaller than the ceiling mounted frame described here. Because the operator sits in front of the frame when making the match, a large frame would get in the way and be too difficult to manage.

The first step in making the frame piece is to cut the threaded rods and aluminum tubing to the following sizes:

(2) 29-1/4" long 1/2" O.D. aluminum tubing
(1) 30-3/4" long 1/2" O.D. aluminum tubing
(2) 31-1/2" long 3/8" dia threaded rod
(1) 36" long 3/8" dia threaded rod

You will also need the following components for assembly:

(4) 3/8" washers
(4) 3/8" hex nuts
(6) 3/8" lock nuts
(2) 38" long 1x2 lumber
(2) 39" long 2x4 lumber
(1) 40" long 2x4 lumber
(4) 3" long 1/4" lag screws
(4) 1/4" washers

A 3/8" hole is drilled on center one inch from each end of the 38" long 1x2s, which is easiest to do by clamping them together and drilling through both of them at once. A 1/2" hole is drilled on center at the midpoint of the boards, which will be the pivot point.

The frame is assembled by putting a lock nut onto one end of the two shorter pieces of threaded rod and feeding them both through the top and bottom of one frame board. A washer is now slipped onto each threaded rod, followed by the shorter 1/2" tubes, another washer, the other frame board and finally another lock nut. After the lock nuts are tightened snugly, both ends of the frame should look like Figure 8.

Before placing the second frame board onto the threaded rods as mentioned above, it is a good idea to insert the longer 1/2" tube into the center hole of one board so that it will fall into place when the two halves are put together. Otherwise the center tube will have to be slid into the side of the frame once it is assembled.

Next you will need to take the two 39" long 2x4s and drill a 3/8" dia hole on center at two inches from the end of each one. Lay the frame flat on the ground and run the remaining threaded rod through the center tube, then spin

Figure 9: Fixed wheel dolly for operator to sit on.

two hex nuts onto each end such that they do not actually contact the frame. There should be enough threaded rod remaining that each 2x4 post can be fitted on each side and secured with a lock nut as shown in Figure 7. The two nuts on the other side are tightened against each other and are only there as spacers.

The remaining 2x4 is used to connect the support posts at the bottom using the lag screws as shown in Figure 6. The frame may be fitted with feet to keep it upright, but I prefer to leave these off so that the frame can be stored flat up against the wall. I attach bar clamps to the bottom board to act as temporary support when I use the frame. Some hinged pieces that fold out could be used for a similar space saving purpose.

Making the Dolly:
The last component you will need is the dolly shown in Figure 9, which is simply a 33" x 16" piece of 3/4" thick particle board with some 1x4 support planks on each edge so that it will not bend. Four fixed position casters are attached so that the dolly can only move side to side. The purpose of this platform is to allow the operator and the slurry bucket to easily move sideways as the frame is loaded with match.

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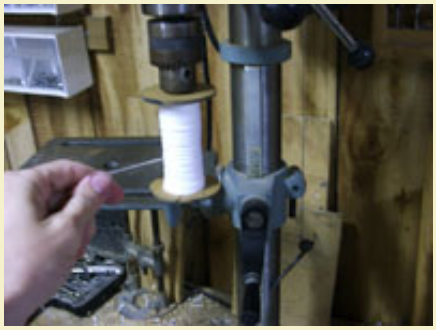

Figure 10: Loading the spools using a drill press.

Figure 11 Loaded spools and threaded axle rods.

Figure 12: Match making station with slurry bucket loaded and PVC threaded.

Match Making Procedure:

The first step in preparing to make a batch of cross match is to load your spools up with string. The type of string I use is a thin mercerized cotton that is sold for crochet in arts and craft stores. You can sometimes find it in large balls, but typically it comes wound on smaller 3" dia. cardboard tubes in various colors. Each spool will require one of these smaller balls.

The thin cotton twine used to make commercial match will not work for this process because it is too weak. You should not be able to easily break the string with your hands if it is to survive the tension of being pulled under the PVC and up onto the rotating frame.

The spools are easily loaded if you have a drill press. Simply chuck up a spool as shown in Figure 10, put your ball of string in a bucket on the floor, tie off the string to the spool and run the drill at a low speed while guiding the string with your hand. Make sure you wear a glove or you will get some serious rope burn!

Figure 11 shows all the spools ready to go. A fully charged spool will do more than one frame but not quite two frames. So next time around you will have to tie on to the existing string when you recharge the spool. The knots will not cause any problems getting through the 1/8" sizing hole.

Prepare a few pounds of meal powder with 5% dextrin and add boiling water until it is a thick, muddy consistency. The bucket needs to be at least half full with the slurry so that the strings will be exposed to more of it during their passage through the tube.

Figure 12 shows the full setup ready to go. The small stool is where the operator sits during the process. A five gallon bucket with some padding on top works just as well for a seat.

Remove the cap from the PVC pipe and feed the four strands of string from the side spools up through the bottom and out the other end. Bring the ends together and run them through the hole in the cap, then secure the cap back onto the pipe. The group of four strings is tied off on one end of the frame and the sliding platform is moved to that side. At this point you can submerge the pipe and string into the slurry, as shown in Figure 13.

Assuming you start at the left end of the frame, use your left hand to spin the frame while stirring the slurry with the pipe in your right hand. Slowly spin the frame and guide each strand of black match so that there is about 1/2" space from the previous strand. If you start to see white spots on the strings, slow the pace down or stir the pipe more so the string is worked into the slurry longer.

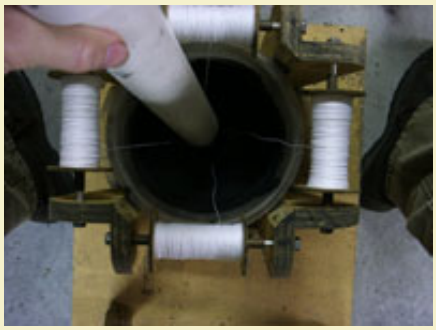

Figure 13: Stirring slury with one hand while spining the match onto the frame with other hand.

Figure 14: Fully loaded frame ready for drying.

It is usually necessary to periodically add more water to the slurry, since the string takes on slightly more water than it does powder. When the slurry starts gloping up around the edges without flowing back to the center when stirring the pipe, that's when it is time to add more water. Be careful not to add too much water, because it doesn't take much to get the consistency back to where it should be.

After about a half our of this, when your arm is ready to fall off from stirring the pipe so long, you should have a nice frame full of cross match as seen in Figure 14. The first few feet of the first strand will be uncoated, but you will simply discard that later. Allow the match to air dry for several days until fully dry, then remove by cutting along the bottom and pulling the loops off at the top.

I usually leave the top loop connected and just lift all the match off and store it in a cardboard mailing tube. Pieces of capped PVC also makes good black match storage.

If you find that the match has problems bending when being inserted through tight time fuse holes, you can make it stronger by substituting the 5% dextrin with 2.5% soluble glutinous rice starch (SGRS) in the slurry. The use of SGRS will increase the drying time substantially, but the finished match will be very stiff and less prone to cracking. It is recommended that SGRS match be removed from the frame after a few days and hung in a drying box of the type described here in order to speed up the drying time from weeks to days.

A single frame of this thin black match should last at least a year, since it can hold about 170 feet of match and you typically only use small segments of it per shell. This thin match will also work fine for piped shell leaders, but it is recommended that two strands be used instead of one. A different method for making larger quantities of thicker black match, ideally suited for shell leaders, can be found here.