Braid your own battery cable.

What? Are you nuts??? Answer: No, just determined….

All over the world, some makers of radio broadcast receivers have used braided jacket, multi circuit cables for either interconnection between major components or to connect with external battery packs or power supplies. In the 1920s it was very common to make flexible wiring by extruding a rubber jacket over stranded wire. The rubber compound was almost always black in color and if bundled together to form cables would invariably fuse together over time. To prevent that, sometimes, the wire received a braided, usually cotton, thread covering. This thread could be dyed many colors to make it easy to trace cables. And since usually eight or more threads were used to plat the braid, there could be substitutions of one or two other colors yielding threads called tracers. Now with just 10 primary colors and two tracers you have many more combination possibilities for circuit identification.

These wires were either twisted in rope-like fashion to consolidate the bundle or gathered in parallel and wrapped with a widely spaced spiral of thin thread. This consolidated bundle was fed through the center of a multi-spindle braiding machine. The spindles carry bobbins wound with thread or 'floss' consisting of three to six fine threads gathered with just a bare minimum of twist. Depending on the diameter of the cable, the machine can have 12 to 24 spindles loaded with thread.

In at least consumer electronics products, long ago this method of manufacturing was abandoned in favor of various extruded petroleum derived jackets. The old cables were never designed to remain serviceable for many decades and eventually the rubber insulation becomes very brittle or turns to a sticky goo. The fabric braiding loses its fiber strength, fades in color and becomes the victim of mold, gnawing insects or other critters.

Braiding machines are still in use every day for making everything from shoe laces to shielding jackets for electrical cables but very rarely to make credible replicas for 1920s style cables. These perished cables have been a malady for restorers for 50 years now and only a very few people have contracted with modern suppliers in recent times to set up machines to braid vintage looking cables for things like two and three core mains cables for vintage fans, lamps (and yes) old radios. The 'deal killer items' for getting this done are setup charges and minimum order requirements.

Here in the USA there are several retail suppliers of 'cloth covered' flexible wire. It is either #20 AWG or #22 AWG - 7 strand wire with a <u>white</u> PVC extruded jacket. Over the top of this jacket there is a braid of colored cotton thread. It looks 'OK'ish' and much better than having glossy PVC insulation showing along its entire length. I still find this new wire to be an annoying distraction for two reasons. Number one is the fact that the PVC insulation should be BLACK in color to match the almost universal use of black rubber insulation in flexible wires for cable building so many years ago. Number two is that the modern PVC insulation used is considerably less flexible than the old black rubber insulation thus complicating its use in multi-circuit cables.

To my knowledge, only 4 and 5 circuit cables have been made to replicate battery cables for vintage radios. It so happens that I have five vintage radios well worth accurate restoration because of the interesting stories they illustrate. On one receiver, the cable had simply been cut off at the exit point from the cabinet. Another cable was still present in its full length but much of the braided jacket is destroyed and much of the insulation on separate wires has broken off so that there is no way for it to serve its electrical purpose. (Fig. 1) Three more receivers are missing 5 and 7 conductor battery cables that plug into a receptacle on the back of the radio. These feature individual, black rubber covered wires without cloth braid.

Figure 1 - Hard wired battery cable beyond salvage.

One cable has 6 circuits consisting of approximately 22 AWG wires and another cable has 5 circuits of 20 AWG wire plus 2 circuits of 16 AWG wire. The other cables have other combinations of wire sizes, with and without wire braid. What to do??? I certainly could not contract to have such a variety of cables built to my specifications.

My thoughts turned to asking myself if it were not somehow possible to build a simplified machine to braid jackets. A Google search lead me to You-Tube videos where people have thought of trying to make braiding machines using 3D printed parts made by hobby grade filament extrusion printers. The net result is that although attempts have been made, no one has yet built a machine this way that even comes close to doing truly useful work to answer our particular restoration needs.

I then began to think of even simpler machines or braiding aids. I thought of the braiding done by lace makers over the centuries… They move bobbins of thread in various patterns…. Any craft store has all kinds of colored thread and embroidery floss…. Could I do something similar?

I began to experiment with making a bobbin assembly that would contain a useful length of thread, floss or yarn. It had to be easy to wind and provide some form of tensioning of the floss to keep the bobbin from spilling its contents and to keep the thread pulled close to the wire bundle. My first thought was to apply drag to a bobbin held in a metal cage. Even as I made my first assemblies, I speculated that the tension could not remain constant as the fill diameter of the bobbin decreases as floss is pulled off. My first braiding attempts confirmed that I could not, in any way, make my braided jacket appear uniform.

The floss tensioning must be independent of the bobbin; but how to implement the function in a simple and compact way? It took several failed attempts, then I had an epiphany! (Fig. 2) I had some small rod type Neodymium magnets 6 mm diameter x 10 mm long. I thought that I could position a magnet to cling to the side of a common, steel semi-tubular rivet; then force the floss to pass between the magnet and rivet. The attraction should pinch and place a considerable degree of drag on the floss that does not change appreciably no matter the diameter of the wind on the bobbin. Yes! Success! (Fabrication details described at the end of this article.)

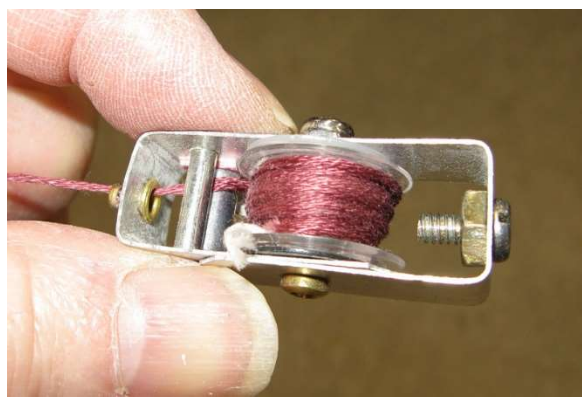


Figure 2 - Super magnet pinches floss against common semi-tubular steel rivet.

To keep the bobbins in order, I cut a simple plywood doughnut about 1 ½" wide and about 16" outside diameter and glued 16 simple wood stop blocks around the ring. (Fig. 3) These blocks help me avoid pulling off too much floss as I move the bobbins. My first idea was to simply have a little wooden peg in front of each stop block on which to hang the bobbin. That works, but then another epiphany! Why not hold the bobbin in place with the same size Neodymium super-magnet used to tension the floss? So, I inserted one rod magnet into a hole drilled in each stop block and added a steel screw and nut to the end of the aluminum bobbin. The bobbin carrier now sticks and releases from the stop blocks like a charm! It saves a little bit of finger movement each time you are repeating the process several thousand times. From just left of top-center on the ring, every other stop block is numbered clockwise from 1A to 8A. From just right of top-center on the ring, every other block is numbered counterclockwise 1B to 8B. Each bobbin carrier has a unique number from 1A to 8A or 1B to 8B marked on the side.

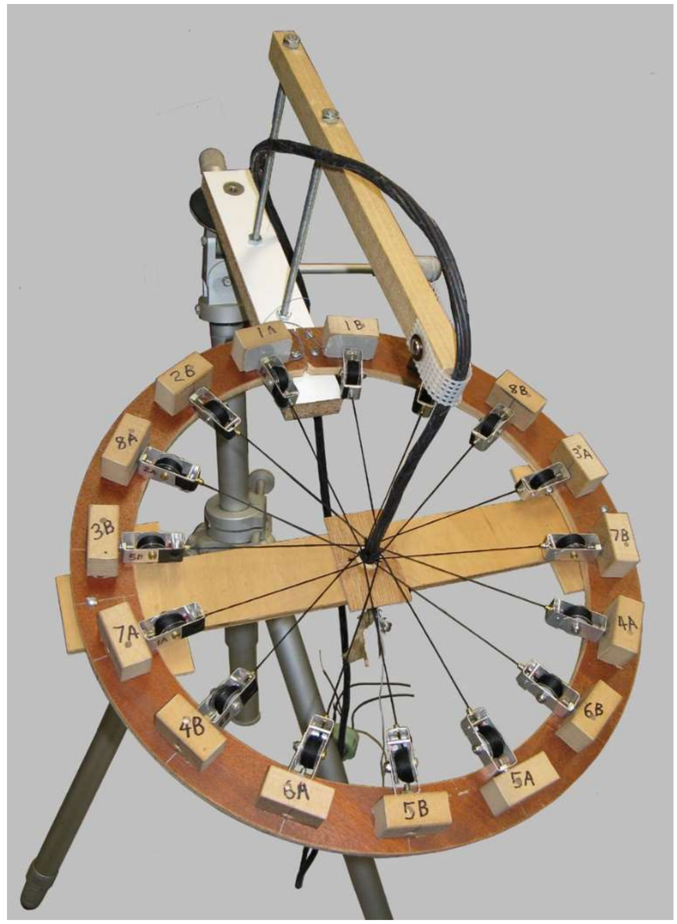


Figure 3 - Sturdy camera tripod holds braiding fixture in a comfortable position.

The plywood doughnut needs an eyelet to keep the wire bundle centered in the fixture. It is simply a piece of wood dowel with a hole just slightly larger than the finished braid, glued to either side of two small plywood plates. After the glue dries, the eyelet is split in half so it can be easily removed as required. The eyelet is captured by two half-moon cut-outs in the end of rectangular plywood slats that are held to the plywood ring with a large flat washer and thumb nut to a long machine screw screwed into the ring.

A simple arm with clamp positions the cable bundle axially over the eyelet. The whole assembly is supported by a sturdy camera tripod for easy adjustment to the optimum position you need for hours of braiding.

While the braiding process is simple, you need to keep aware of which direction you are braiding. Invariably you will be interrupted by a phone call or something else. It can take some time for you to sort-out where you should be if you lose your way; the numbering scheme is essential for this task. I have added leaf switches to the 1A and 1B stop blocks. They are simply a sheet of very thin plastic with a metal foil laminated to it salvaged from some old computer assembly. This sheet is spaced only a few thousandths off the face of the magnet. A press-fit wire contacts the side of the magnet. When the bobbin carrier sticks to the magnet, the circuit is closed. At some point I plan to add a flip-flop circuit driving a couple of LEDs to help me keep track of last braiding direction.

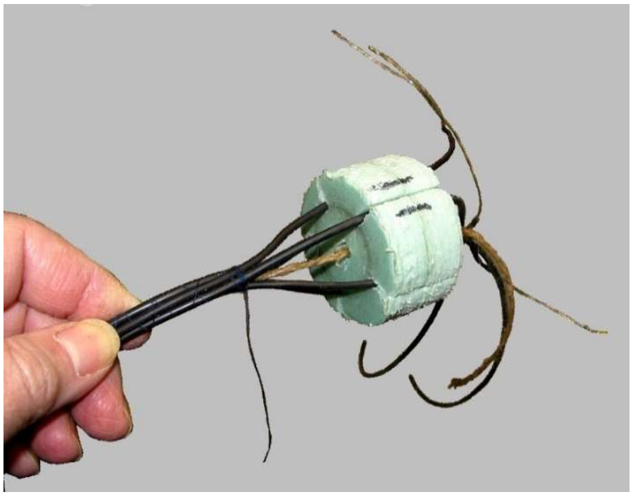


Figure 4 - Slotted foam plastic disk keeps wire parallel while wrapping thread.

The three replica cables I have made to date require that the wires be gathered into a parallel strand bundle. That is accomplished by using a simple disk of rigid, high density foam plastic about 2.5 to 3” diameter and about 1.5” thick. (Fig. 4) In the center is a hole to accept a length of coarse jute twine. There are narrow radial saw cuts to accept each conductor; narrow enough to require some force to push the individual wires down into the saw cuts. This foam doughnut holds the wires parallel around the tensioned jute twine while you make a long spiral wrap of sturdy sewing thread to consolidate the bundle of wires.

Once placed in the braiding fixture, the threads from 12 or 16 bobbins are tied to the cable bundle and the braiding sequence is started in the clockwise direction. The 1A bobbin is lifted over the 1B stop block to the 2A stop block which displaces the 2A bobbin which is moved over the 8B stop to the 3A stop which displaces the 3A bobbin and so forth for all A bobbins. Then the process is repeated in the counterclockwise direction starting with the 1B bobbin being lifted over the 1A stop block to displace the 2B bobbin which is lifted over the 8A stop block which displaces the 3B bobbin and so forth for all B bobbins. And, ta-dah! You have created ½ mm of the finished braid.

So, it takes about 8 hours of actual braiding time to complete a cable; of course, you are not going to do it in one sitting, but it is no problem to do the process for an hour or more at a time…. Put on some music or an old-time radio broadcast and you can quickly get into ‘the zone’ of ‘playing’ your braiding fixture… It can be kind-of nice; although it might sound like an onerous task. It is something akin to what (mostly) women have done for centuries of needle work and lace making. Their sometimes hundreds of hours of labor have produced wonderful testaments to their persistence. Us guys ought to be able to endure for a mere 8 hours, eh?

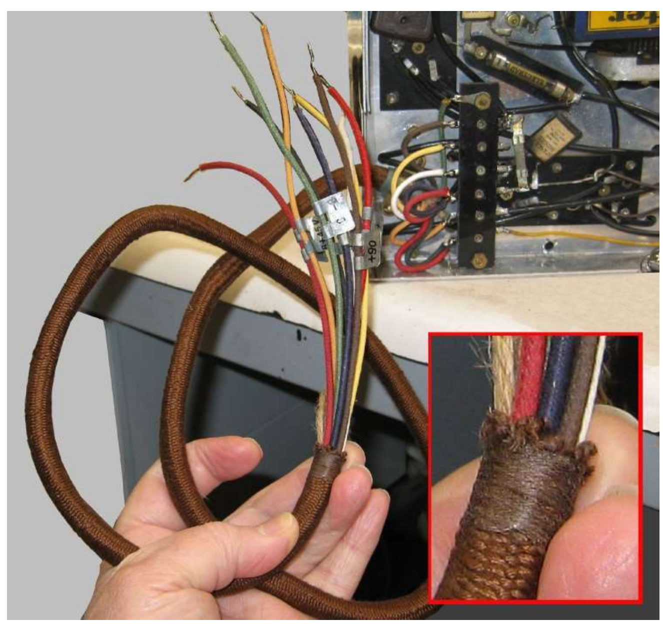


Figure 5 - Completed cable with original metal ID tags in place.

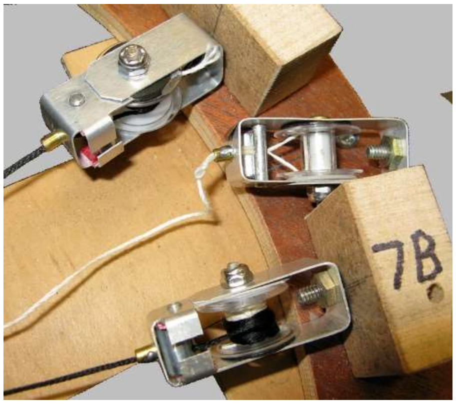
I terminate the braid by tying crossed threads together using a square knot. (Fig. 5) Then the braid is ‘whipped’ like the end of a rope using the same kind of thread. As a final refinement, I saturate the whip with ***Dritz*** brand ***Fray Check*** PVA liquid adhesive. It soaks into the fabric and dries to form an invisible matte film that should keep your work in place for a very long time.

Fabrication details of the bobbin shuttle.

My measurements were dictated by the size of a commonly available plastic sewing machine bobbin. As luck would have it, a length of floss long enough to braid a 4.5 to 6-foot jacket can be loaded on such a bobbin. (One-half of a 'standard' 8.7-yard skein of floss costing much less than a dollar.)

The metal cage is cut from 24 Gauge (0.5 mm) aluminum sheet that is commonly used to form seamless rain gutters and roof flashing. Look for 'soft temper or O-temper' stock for easy bending of the cage. The holes in the cage do need to be accurately punched or drilled. I accomplish this by stacking 8 or 10 strips with holes at each end that are screwed down to a small plate of MDF board. All the other holes are then carefully drilled simultaneously with a very sharp drill bit. After the stack of strips are drilled, the stack is sawn to shape with a metal cutting band saw and finally removed from the MDF carrier. You can send me an e-mail to get free dimensioned drawings.

The bending of the cage requires some care. I made the task easier and more precise by carefully machining two hard blocks to the dimensions shown. You could use aluminum or, as I did, use little blocks of artificial marble, ***Corian*** (TM), salvaged from a bathroom renovation. You can cut it with a hack saw and sand to accurate dimensions. The two tabs on the strip act to cage the super magnet. The magnet is not as long - as the cage is wide; the gap is almost filled on either end of the magnet by tiny squares of plastic or PCB sheet held in place by tiny bits of double-side carpet tape. That keeps the magnet centered within the cage and allows the magnet to rotate as needed.



The bobbin rotates on an axel that is simply a #4x40 or 3mm machine screw captured with a Nylon insert lock nut. The screw is much smaller diameter that the i.d. of the bobbin. I found that there is a common plastic craft bead two of which are stacked to make an ideal bushing.

During assembly, a leader of string less than 18" long is tied through the center of the bobbin and anchors the floss so it can be wound onto the bobbin. I use a common brass eyelet to protect the floss passing through the cage wall and force it to stay within the pinch area between the magnet and steel pin.

The pin is a common ½" semi-tubular steel rivet with a body diameter of 1/8" and long enough to pass through the maximum width of the cage. (Available in small quantities on e-Bay.) A small square of electrical tape does a fine job of holding the head of the rivet in place.

To load the bobbin with floss, all that is necessary is to tie a length of floss onto the leader string and hold the bobbin rim against a rotating rubber faced roller. In my case I simply have a small wood arbor faced with a short length of rubber automotive radiator hose. The thing is chucked into my battery powered drill and within about 20 seconds you can fill a bobbin.

If you have done a really good job, the result of your labor will be a cable that even experienced enthusiasts of the vintage technology will have little cause to question its authenticity. The only thought being brought forward is that it might be a correct, new-old-stock (NOS) replacement.

Don't have the size fabric covered wire you need?

As mentioned above, I have found only #22 and #20 AWG stranded wire with fabric braided cover. One of my needed cables was built with two #16 AWG wires in the bundle. These were sized to handle the filament current for eight ¼ Ampere tubes. The only fabric covered wire of that gauge I have is a large spool containing a stranded core with extruded black rubber insulation and a green dyed wire covering. The graphics on the metal spool indicate that this wire must have been made in the 1950s. The key things for me are that the rubber is still very flexible, has good cut strength and is apparently covered with a cotton braid. I found that I could soak a bundle of wire first in mineral spirits to remove any wax, dry it thoroughly and then soak in warm bleach for several hours to remove the green color. After rinsing thoroughly again, I used Red or Black "Rit" brand fabric dye to create sensible colors to use in my battery cable. Yet another small victory in preserving historical accuracy.

For cables that did not have fabric covered conductors, I have found that you can purchase 30 Meter lengths of high flexibility, high service temperature, insulated wire with BLACK silicone rubber covering on e-Bay. Look for UL3135 class wire. Be aware that this wire has a thinner insulation than the old rubber covered wire; therefore, to match the outside diameter of the old wire, specify one wire gauge larger.

What if you need lengths of wire with a cloth covering in gauges larger than 20 or 22 AWG and cannot find vintage wire you can recolor? There is a way! Craft stores have spools of macramé cord with a white cotton braid covering. Cut a length and pull out the parallel filler strands from the center and dye the braid any desired color. You can then pull this hollow tube of colored braid over the black silicone rubber jacket wire. Admittedly it is not a fun task, but I have done this several times in recent years. On completion I can loudly proclaim in my audience-free workshop, "I have **NOT** been defeated!!!"

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