Braiding of wire/cable products with Wardwell Rotary Braiders

By *Carter Lloyd and John Tomaz*

Lloyd & Bouvier

New/ Used / Rebuilt Wire & Cable Machinery

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Abstract: *This paper gives a complete overview of the braiding process with 16 and 24 carrier rapid braiders. Special interest items reviewed include: (a) tape applications for both underbraid and overbraid using integral eccentric tape wrappers; (b) fine wire braiding of miniature coax and medical wire catheters; and (c) controlling take-up tension on fine wire products to prevent stretching, crossovers on reel, and maintaining even tension throughout reel buildup.*

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Braiding is the interlocking of wires, yarn or fiber strands to form, shield, or reinforce a product - ropes, cords, cables, hoses, etc… Today, we will be discussing Braiding as it applies to the shielding of Single-conductor, Multiple-conductor, Twisted pairs or Coaxial cables in solid or stranded variations. These cables can further be described as shielded or unshielded, except for coax, which by definition is always shielded. For the purpose of this presentation, we will be considering only shielded cables.

There are several different types of shields, which can be applied to cables, and each has distinct characteristics, effectiveness and performance criteria. Spiral wire shields are similar to braid but lack the structural integrity. The shield may open up when the cable is twisted or flexed compromising its effectiveness. The flexibility of spiral shield is used widely in audio cables applications such as microphone cable.

Other options are braided shields, foil shields, or a combination of the two. When deciding to make a particular cable, how do choose one shield over another? Braiding is slow, labor-intensive and, arguably, the most expensive step in the process of cable manufacturing. Foil, by comparison, is inexpensive, easy to apply, and performs well as a shield at frequencies over MHz. However, at lower frequencies, foil shields lack the mass of braided wire and deliver poor to average performance.

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Braiding consists of wires applied in one direction crossing over and under wires applied in the opposite direction. The crossovers create gaps, which diminish the effectiveness of the shield. Braid shields perform best in the frequency range of 1,000 Hz to 50 MHz, where its low resistance is an advantage.

The best and, increasingly, more popular option is a combination shield consisting of braid and foil. This type of shield is the most effective but also the most expensive. As previously described, the braid shield performs best in the 100 Hz to 50 MHz range while the foil shield is most effective at frequencies above that range. Therefore, the combination shield with a braid and a foil provides the best broadband coverage.

Thus far, we have established that braiding is often a slow and expensive but necessary step in the process of manufacturing cable for high performance. Taking this fact into consideration, what are the options available to cable manufacturers?

History

Braiding has been around for centuries. The first record of braiding, as a process, dates back to the 16th century. Braiding, as an industry, began in the mid-1800s with the introduction of the Maypole Braider by New England Butt Co. In 1911, Simon Wardwell introduced the high-speed Rotary Braider with the *deflector* principle. At approximately the same time and working independently in Germany, Guido Horn developed the high-speed Rotary Braider with the *lever arm* design. Today, there are various manufacturers of braiding machines around the globe, and each is a variation of the three original designs.

Conclusion

The Maypole design is not compatible with high-speed shielding of cables for high performance for all the reasons already pointed out. The lever arm style Rotary Braider is clearly the best design and the most efficient of braiding machines. But the large footprint, higher price tag and technical competence requirements make it difficult to justify for a large number of applications. Flexibility, simplicity, and affordable price make the deflector type Rotary Braider the machine of choice for more applications and in more industries around the world. Now we can approach the subject of Braiding capabilities and enhancements in today's electronic cable and Medical Catheter world. The rotary braider can be best described as one size fits all. The 16 carrier Rapid Braider has the capability to run products with a core diameter of .025 up to a 0.500. Initially, in the wire and cable field, cables were of substantial size and physical strength. Care and handling were not a top priority.

Today, because of exotic compounds, miniature conductor sizes, electrical properties that are greatly affected by elongation, and any undue stress, care must be taken in all operations of manufacturing. As the products being braided have become smaller, take-up tension has become more critical when trying to maintain the required electrical properties.

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The take-up on a standard braider does not have any compensation for reel build up which slows the actual reel speed and increases the reel weight three fold as the reel fills. The next photo shows a modified 16-carrier braider in which the standard spring tension clutch has been removed and a 0 - 90 VDC tension clutch has been installed. This allows for the operator the easily adjust tension while the braider is running. The second improvement is the mounting of the take-up reel within a ball bearing cradle. This eliminates the standard take-up shaft, which runs in a metal-to-metal environment and double finger-driving device that unless properly installed and maintained can create tension problems. The final improvement, which can be made on the take-up, is for the control of constant wire tension as the reel builds. A catenary arm can be outfitted onto the machine that will allow product tension to remain constant as the reel builds in diameter. The arm is in constant contact with the reel and decreases the voltage to the electric slip clutch, which provides constant wire tension.

Many of today's coaxes also require taping in some form or another. Aluminum or clear Mylar tapes can be applied either under or over the braid depending on product specifications. This can be accomplished in the braiding operation whether the under braid tape is longitudinally or spirally applied. An over braid tape can only be spirally applied. This in essence combines the two operations of taping and braiding. Control circuitry is added so that if the tape breaks or runs out the braider will shut down and if the braid wire breaks or runs out the tape head will shut off if motorized.

Longitudinal taping devices can be retrofitted to existing braiders in almost any existing plant layout. They can be fitted behind, to the left of the machine, or to the rear left cold rolled vertical support post. Several manufacturers produce tape-folding devices, such as Wire and Cable Fabricators in New York City. The tape folding devices need to be mounted on the braider in such a manner as to make the machine user friendly for the operator and easy to access. Tape tension can be critical on various products as well as the position of the exit end on the tape tube. S fold, Z fold, and cigarette wrap are commonly done on all cable sizes.

The spiral taping heads can run in either right or left hand lay. The tape tension is controlled and adjusted while the machine is in operation. The tape head needs to start and stop with the braider and stop the braider on tape run out. The tape heads can be supplied on a fixed base, which will elevate the braider and require and external payoff, this may require the location of the machine to be addressed.

Tape can also be applied over the braid. In this case a 3-legged stand works best. The stand will be mounted around the braider and support the tape head directly above the capstan. The braided product will exit the braiding guide, pass by the capstan wheel, through the motorized tape head. Around a return pulley directing the product back to the capstan wheel. The wire will be wrapped around the capstan in a conventional manner and proceed to the take-up reel. The motorized tapehead is adjustable for various tape and product widths. Again this machine is electrically connected to the braider to start, stop, and coincide with product run outs.

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The less a product has to be handled the better the quality of the product will be. So, if taping can be accomplished when braiding this eliminates (1) additional handling, (2) additional man power, and (3) maximizes floor space in your factory.

Miniature products also require finer gauge sizes of the braid material. A conventional braider seems to have no problem in braiding up to 3 ends of 38 gauge copper wire. Less than 3 ends or finer gauge sizes than 38 create problems.

Fine wire carriers have been developed which deal with the specific problems created when running fine wire products. Several aspects need to addressed with respect to the carrier design. Bobbins are supplied in various conditions and wear. The hole through the spindle can vary depending on supplier and age of the bobbin. A special carrier will contain the bobbin in such a manner to prevent bobbin wobble. Also the moving items on the carrier specifically wheels, rollers, and spindle are normally a metal-to-metal surface with no actual bearing capacity. These items must be converted to bearings, which reduce drag and improve the wire path.

In my previous career of manufacturing wire and cable, I discovered that the wire coming off the deflector needed addressing. In the finer gauges, the tension lever required to remove the slack from the bottom bobbin of the braid material simply did not have the mechanical strength to withstand the sudden change. The carrier shown minimizes undo stress and shock. This allows products in the range of 2 ends of 44 awg, and single end stainless steel in the catheter industry as small as 0.001, to be run. I have been told of customers running material 0.001 but have not personally been able to obtain any of this fine material to run samples

These devices and modifications allows the rapid braider to compete with the much slower maypole and much more expensive lever arm type of machines in both industries.

For more information on braiders and braiding contact Carter Lloyd at
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